ATHLETIC THERAPY:
A REWARDING PROFESSION

GENA BUGDEN

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ATHLETIC THERAPY: A REWARDING PROFESSION

by

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Abstract

Based on an eight month internship period at the University of New Brunswick, the following information has been gathered which pertains to the authors experiences. Section one describes the role of the athletic therapist, the work environment as well as treatment options available at their disposal. Section two continues by briefly describing the injury profile of three sports; ice hockey, rugby, and volleyball, which the author has had ample field experience. It further describes common injuries which continuously presented themselves among the athlete population in the clinical environment. It is by no means a literature review, as it focuses only on practical experience gained by the author.

Acknowledgements

A very special thanks to my Supervisory Athletic Therapist, Joe Glenn at the University of New Brunswick, for without whom this initiative would not be possible. Your wisdom and expertise will never be forgotten.

To by professors and graduate advisors, thank-you for your patience and guidance. You have made the "light at the end of the tunnel" so much clearer as well as closer.

And to my family, thank-you for your encouragement and support. Your steadfast belief in my hopes and dreams has been a driving force in my achievements. You will always be an important part of everything I do.

-G.N.B-.

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Introduction

This report is compiled in fulfilment of the Masters of Physical Education degree at Memorial University of Newfoundland. It will serve as an overview of duties performed during my eight month internship at the athletic therapy facility at the University of New Brunswick. It is not meant to be a literature review, yet to simply serve as a brief introduction to the field of athletic therapy.

The profession of athletic therapy is becoming increasingly popular within Canada. Previously, Western and Central Canada offered the nucleus of the employment opportunities for the profession. However, the prevalence of athletic therapists in Atlantic Canada is rising. This is due in part to the recognition of the discipline as an Allied Health profession. Furthermore, Athletic Therapists are no longer employed solely by sport organizations. Opportunities exist in medical clinics, university or college settings, or in conjunction with other rehabilitative services. Thus, there is great diversity within the professional boundaries of the discipline.

The university/college setting will be used for the purpose of the report. It briefly entails the role of the Athletic Therapist, the working environment, roles and responsibilities, as well as treatment and rehabilitation options. It surely does not encompass all of the aspects of the athletic therapy profession, yet it thoroughly outlines the practical experience and professional applications obtained through this internship.

There has been an amazing expansion of material within the field in the past two decades. Therefore, it is impossible to experience and articulate each facet of the discipline within an eight month period. Inevitably, this experience has served as a stepping stone through which further professional expertise can be obtained.

The Athletic Therapist is an integral part of the sports medicine team. However, the role of the Athletic Therapist is distinct from other medical professionals. It is the Athletic Therapist who provides emergency care and immediate treatment of injuries in the athletic setting. This highly trained professional is an integral component of the sporting community. Unfortunately, this role often goes unnoticed and unappreciated.

The Athletic Therapist

The Athletic Therapist provides the vital link between sporting participants and the medical community. It is noted that the field of athletic therapy has drawn from the disciplines of exercise medicine, physical therapy, physical education, and sports since early Ancient Greece (Arnheim and Prentice, 1999). The Early Greek civilizations were not competitive. Sport was not highly organized and thus involved peaceful and cooperative participation opportunities. O'Shea (1980) has written that Early Greek and Roman Civilizations observed a similar structure to their sporting programs as we do today. Athletes had access to coaches, physicians, as well as trainers. The trainer was responsible for assisting the athletes in attaining their top physical fitness.

Shortly after the fall of the Roman Empire, interest in sport and athletics declined steadily. With the advent of the Renaissance period, interest and participation began to increase. The field of athletic therapy was not organized in the manner in which we know it today until the introduction of structured interscholastic athletic programs in the United States in the late nineteenth century. Early trainers often massaged athletes, applied ointments or oils to combat irritants, or endorsed home remedies to alleviate ailments. They had no formal education or practical experience (Arnheim & Prentice, 1999). Unfortunately, the plight of athletic trainers continued until late into the last century. Although educational programs for accreditation as a trainer had become more accessible, the respect received as a reputable profession continued to struggle.

Today, there is still much confusion with regards to terminology concerning our field. Our professionals are referred to as trainers, athletic therapists, athletic trainers, or physios. Only candidates certified by the Canadian Athletic Therapists Association (CATA), may call themselves "athletic therapists (AT's) and use the notation CAT(C) after their name. The C in brackets signifying certified. Our American counterparts, the National Athletic Trainers Association (NATA), identify their membership clientele as athletic trainers. They use the notation ATC after their name. Those who possess an interest in the field and have not completed the educational and practical requirements may only refer to themselves as therapists or trainers in the United States. Due in part to the above rules and regulations, the athletic therapist is becoming increasingly recognized as an essential part of the medical community.

Athletic Therapists can be employed in a number of settings: high schools, universities, clinics, and professional, amateur, or Olympic sports organizations. At the high school level, the therapist often doubles as a teacher. Likewise in universities, therapists often supervise student trainers in addition to a course load. Those who are employed in a clinical setting often work with local teams in the evening. Finally, those who work for various sport associations may be responsible for other duties besides athletic therapy. This may include equipment and travel arrangements.

Athletic therapists provide a central link between the athlete and the team doctor, coach, parents, and teammates. They perform the first-line of health care when an injury occurs. Despite educational qualifications, the athletic therapist adds something to an educational setting that the team physician often does not bring. Therapists have daily contact with the athlete and are a liaison between the coach and the athlete. In this respect, the therapist treats the whole athlete, not just the physical complaint. Emotional support and counselling are a central part of the treatment.

The first book addressing the field of athletic therapy was published in 1917. The Trainer's Bible, written by Dr. S. E. Bilik, wrote about the scope of practice of athletic training and the treatment of injuries. Shortly after in the 1920's, a Kansas family began to market a liniment to treat ankle sprains. This product was a popular item. In an effort to increase sales, and as a marketing ploy, the family began to publish The First Aider in 1932. It was hoped that this publication would facilitate a free exchange of ideas among athletic program personnel. Moreover, it served as a means of disseminating information regarding the field of athletic therapy among the general population. The Cramer family markets a line of athletic therapy products to meet a wide range of needs.

The National Athletic Trainers Association was formed in the late 1930's through a cooperative effort among various universities. The association struggled to maintain status and at one point had all but disappeared. Again in 1947, trainers at American universities attempted to form an organization to represent their needs and concerns. After organizing themselves by area of proximity, over one hundred trainers met in

Kansas in 1950 and formed the National Athletic Trainers' Association.

In 1999, the National Athletic Trainers' Association Board of Certification developed a list of roles and responsibilities which compiled the scope of practice of an athletic trainer (AT).

- prevention of athletic injuries
- recognition, evaluation, and assessment of injuries
- immediate care of injuries
- treatment, rehabilitation, and reconditioning of injuries
- administrative duties
- continuing professional development

Injury Prevention

Injury prevention is perhaps the most important role of an athletic therapist. In fact, a thorough injury prevention program makes his/her scope of practice much easier. An Athletic Therapist must inspect the playing environment for any dangers that may cause injury to an athlete. A pro-active approach is the best way to minimize risks for an athlete. Preventing an injury is preferential to treating an injury after the fact. Therapists should ensure that all protective equipment is safe and sanitary. Additionally, the equipment should fit properly. Equipment that is too loose or too tight will not only be ineffective but will also present a hazard to the athlete. Finally, athletes, trainers, and coaches need to work together to ensure proper nutritional practices, and to discourage the use of banned or harmful substances whether for recreational or ergogenic use. Education is the key for promoting a healthy, natural attainment of athletic prowess. The athletic therapist should discourage diet fads such as "the no-carbohydrate diet" or exercising in rubber sweat suits" to increase perspiration and promote fast weight loss. Athletes should be aware of the dangers and determinants of such practices and the consequences of such actions. The therapist plays a central role in guiding the behaviors of his/her duties.

Recognition and Evaluation

Usually the athletic therapist is the first to examine an injured athlete. Therefore, they must be both skilled and knowledgeable in the recognition of the signs and symptoms of injuries. Quick and efficient emergency measures must be used in times of on-field injury. After the injury is initially evaluated, appropriate and effective care must be provided to the athlete. If the injury is beyond the scope of practice of an Athletic Therapist, appropriate referral to further medical care is needed.

During the pre-season the athletic trainer should obtain a relevant and updated medical history of both the athlete as well as his/her parents and siblings. This will serve as a screening for any activities that may be contra-indicated. Anything that may cause potential problems during the season should be avoided or corrected. The examination should also include a physical examination by the affiliated medical doctor. This will highlight any existing or predisposing conditions that may be dangerous considering the athlete's activity.

Furthermore, although signs and symptoms may be gathered during the initial examination, it is pertinent for the Athletic Therapist to observe as much of the activity as possible. Thereby, an Athletic Therapist can see the mechanism of injury, which may be important when forming an index of suspicions or deciding on the severity of the injury.

Certainly, an index of suspicion cannot be formulated without an in depth knowledge of the pathology of injury. Therefore, an AT must have extensive training in the areas of anatomy and physiology of the muscular, cardiovascular, respiratory, and nervous systems. They must understand the healing process including the stages of tissue repair, as well as the stages of rehabilitation. An Athletic Therapist must use the body□s natural healing process as a guide - prescribing only the treatment that is appropriate to the injury□s stage of rehabilitation. Progressing beyond the appropriate injury stage before the body is ready will only cause set backs. Although it is nearly impossible to speed up the body's natural healing process, much can be done to hinder it.

Since the athletic therapist is usually responsible for the initial diagnosis of an injury, it is pertinent that ATs are thoroughly trained in emergency care procedures. Athletic Therapists are required to have current cardio-pulmonary resuscitation (CPR) as well as emergency first aid. Therefore, it is the responsibility of the AT to invoke a plan of action in the event of an emergency. It is also their responsibility to ensure that equipment such as spinal boards, oxygen tanks, slings, and splints are readily available in case of an emergency in an area of close proximity to the event area. Table 1 outlines a list of emergency-care equipment that should be available at all athletic venues.

Table 1: Athletic Venue Emergency Equipment. (Hillman, 2000).

Emergency Care Equipment	Typical Application Purpose
Spine board	Immobilization of spine while on the field
Nonstretch tape	To secure athlete to the spine board
Stretcher	Transport of spine board
Immobilization device	Head/neck stabilization padding and straps
Pocket mask	For rescue breathing
Airways	For obtaining an open airway
Automated external defibrillator	For cardiac conversion
Sterile gauze, cotton, and bandages	For lacerations, abrasions, and other wounds
Rubber gloves	Universal precautions for contact with blood
Splints and slings	Treatment of fractures and dislocations
Tape or elastic wrap	For securing bandages or splints

Immediate Care

The Athletic Therapist is responsible for immediate on-site care of the injured athlete. Additionally, they are also responsible for summoning advanced medical care if required or providing transport to a medical facility if applicable.

Treatment and Rehabilitation

An athlete's treatment and rehabilitation protocol is designed with two goals in mind. First, the therapist will aim to return the athlete to his/her pre-injury level of conditioning. Second, he/she will attempt to return the athlete to play as quickly as possible (Arnheim & Prentice, 1999). The rehabilitative process begins immediately after the injury. The therapist will modify the rehabilitation process according to the stage of healing. Consequently, they are responsible for re-conditioning the athlete progressively toward a more sport- specific program.

Administrative Duties

The AT is often very much his/her own boss. This too is the case if they are employed within an educational institution. However, they are responsible for outlining a budget in accordance with the athletics department. This would include such things as tape, first aid materials, braces and bandages, and exercise equipment, to name a few. Unfortunately budgets for such items are often limited, and quality may have to be compromised for quantity. In light of this, records kept years prior often dictate the quantity of supplies ordered in the future. For example, if in 1999, the clinic used 500 rolls of linen tape, then it is reasonable to assume that approximately 500 rolls of tape will be used again this year. Therefore, the taping budget cannot be cut in an effort to find the funds to purchase new equipment such as proprioceptive balance boards.

Athletic Therapists are responsible for designing and implementing rules and regulations with regards to methods of referral to medical attention, sanitization, and

emergency action plans. Even more importantly, is their role in the supervision of student trainers. It is the supervisory therapists' role to educate and monitor the performance of his/her students. This is essential for two reasons. First, the health care profession poses a huge threat of malpractice. It must be assured that student trainers are using the modalities correctly, adhering to proper stages of rehabilitation, and that they act with professionalism. Similarly, ATs must ensure that accurate records are kept, with up-to-date medical treatment records as well as medical history forms. This will be of benefit if a lawsuit should arise in the future.

Continuing Education

An AT is required to submit a maintenance of certification form annually to the Canadian Athletic Therapists Association (CATA). Additionally, to remain a certified member, each individual is required to complete a number of continuing education credits. The number of credits required will depend on the number of years that the individual has been certified. These credits can be obtained through self-study courses, conferences and educational seminars, instructing courses related to the field of athletic therapy, or supervising certification candidates (CC).

The Canadian Athletic Therapists Association

The Canadian Athletic Therapists Association (CATA) is a national not for profit organization which advocates for the advancement of the athletic therapy profession on behalf of its members. As of May 2001, there were 465 certified athletic therapists and 650 certification candidates in Canada.

An educational pamphlet circulated by CATA in 2001, in an effort to promote the Athletic Therapy profession, outlines the mission statement of the organization as recognizing the association as a leader within the sports medicine community. It is dedicated to the promotion and delivery of the highest quality care to active individuals through injury prevention, emergency services, and rehabilitation techniques. In conjunction with other Allied Health Associations, the CATA creates a healthier environment that encompasses the needs of the active community through the high performance athlete.

The CATA's national association is located in Calgary, Alberta. An elected Board of Directors is responsible for the daily operations through the Office Manager. A president is elected by the CATA members annually.

Certified athletic therapists have the opportunity to work many major sporting events such as the Olympics, the Paraolympics, the Commonwealth Games, and Canada Games among other events. Together with its health delivery partners, a contingent of professionals is chosen to represent Canada at the games. Besides the CATA, input regarding selection is usually received from the Canadian Academy of Sports Medicine, Sport Physiotherapy Canada, the Canadian College of Sports Chiropractors, and the Sports Massage Association in conjunction with the Games Medical Committee.

The CATA has evolved from the former Canadian Athletic Trainers Association. The latter, founded in 1965, was formed by a small group of trainers who were working with professional football and hockey teams. At that time, they perceived a means through which they could advance their skills and injury management techniques. Today, the association's membership profile includes certified therapists, certification candidates, associated members, and honorary members. In 1975, the name was changed to the Canadian Athletic Therapists Association, as it stands today. The change occurred in hopes of promoting a more professional standpoint among other health professionals.

According to the CATA Certification Manual, the profession of athletic therapy involves a wide scope of services. However, they can be grouped into three major categories:

1) Prevention - strategies to help individuals avoid the possibility of injury or reduce the possibility of injury.

2) Immediate Care - on-site or immediate assessment of the injury, first-aid treatment, and referral to the appropriate health care professionals.

3) Rehabilitation - rehabilitation techniques that focus on returning the individual to pre-injury level of activity. This may include physical conditioning, and manual therapy among other techniques.

Currently, the certification process for an aspiring athletic therapist is two-fold. First the candidate must attend an accredited injury management program. The following five Canadian schools have been accredited by the CATA:

1) Concordia University - Montreal, Quebec

2) Sheridan College - Oakville, Ontario

3) York University, North York, Ontario

4) University of Winnipeg - Winnipeg, Manitoba

5) University of Manitoba - Winnipeg, Manitoba

During enrolment, or after completion of one of the above programs, the candidate must complete 1200 hours before attempting the certification exam. Six hundred of these hours must be completed in a clinical setting, while the remaining six hundred must be field hours in the practice or game setting. Successful completion of the written exam with a grade of at least 70% permits the candidate to attempt the practical exam. The practical exam consists of two stations: the first a field setting which requires the initial management of an injury, for example, a concussion or broken bones. The second setting involves the implementation of a rehabilitation program for an orthopedic injury. The candidate must effectively demonstrate the assessment, initial treatment, use of modalities, and development of a rehabilitation program in order to receive a pass at this station. At the completion of this process, the candidate is considered a fully certified member of the profession in good standing. This allows the individual to assume the following scope of practice as outlined by the Canadian Athletic Therapists Association in the afore mentioned pamphlet:

> "Prevention includes musculoskeletal and postural evaluation, equipment selection, fitting and repair, warm-up, conditioning programs, prophylactic or supportive taping, and adapting to the activity environment and facilities."
>
> "on-site immediate care delivered by an athletic therapist includes: injury assessment, basic emergency life support, recognition and management of acute traumatic neurological dysfunction, provision of first aid, preparation for entrance into appropriate health care delivery systems, or, where appropriate, utilization of techniques facilitating a safe return to participation."
>
> "...utilizes contemporary rehabilitation techniques, therapeutic modalities, soft tissue mobilization, physical reconditioning, and supportive strapping procedures to promote an environment conducive to optimal healing..." (CATA educational pamphlet).

The Athletic Therapy Facility

Athletic therapy is a growing field within the sporting community. An effective program requires highly trained personnel along with sufficient financial resources. An athletic therapy facility must be designed to meet the demands of its athletes' needs. Unfortunately, this is often not the case. In many Canadian institutions, athletic therapy is a new field. Thus, training rooms and rehabilitative facilities are often located in tight quarters where space is not of abundance. As a result, athletic therapists and student trainers are not able to offer rehabilitative and/or preventative services that many other clinics can afford. Forseth (1986) has noted that in order for athletes to receive the best care possible, a therapy room must also serve as a health care centre.

It is important that a therapy room develop and abide by policies and procedures both for the protection of its clients as well as for legal responsibilities. Sanitation standards must be set to ensure that equipment and supplies are sanitized to meet health standards. An insurance policy must be implemented to cover liability for the therapist(s) or student trainers that have contact with the athletes. In turn, such a policy will entail who will receive treatment at the facility. That is, are students permitted to be treated throughout the whole year or simply during the school year? Are outside individuals permitted to use the facilities? If so, how is the cost of the treatment absorbed?

Additionally, appointments must be booked according to a set schedule, as many Athletic Therapists are also responsible for teaching course material within the university community. Secondly, adequate time must be slotted to treat the patient thoroughly. Also, when scheduling "x" number of patients per hour, space and availability of equipment must be considered. A cancellation policy should be in effect along with an appropriate amount of time for charting and filing.

Patient records and assessments of treatment are very important as they would be in a hospital setting. It is imperative that the therapist keeps accurate records of all patients treated. Thus, if legal action should ensue, the therapist would have an initial assessment of the injury, all the relevant records of treatment, as well as updated files on the patient's condition. Sufficient documentation would work in the favor of the therapist if such an instance should occur.

Arnheim and Prentice (1999) state that the training room should be used only for the prevention and treatment of injuries. There is a tendency for the area to be a gathering spot for the uninjured as well as the injured athletes both before and after practice. This ritual makes sanitation and safety practices difficult. The aforementioned authors have offered the following practices:

1) Shoes are not to be worn on treatment tables.

2) No cleated shoes are allowed. Such footwear traps dirt, tracking it over the floor making it extremely difficult to keep clean.

3) Athletes and therapists alike should behave in a manner that is professional and representative of the institution. Inappropriate behaviour may be demeaning to the profession of athletic therapy.

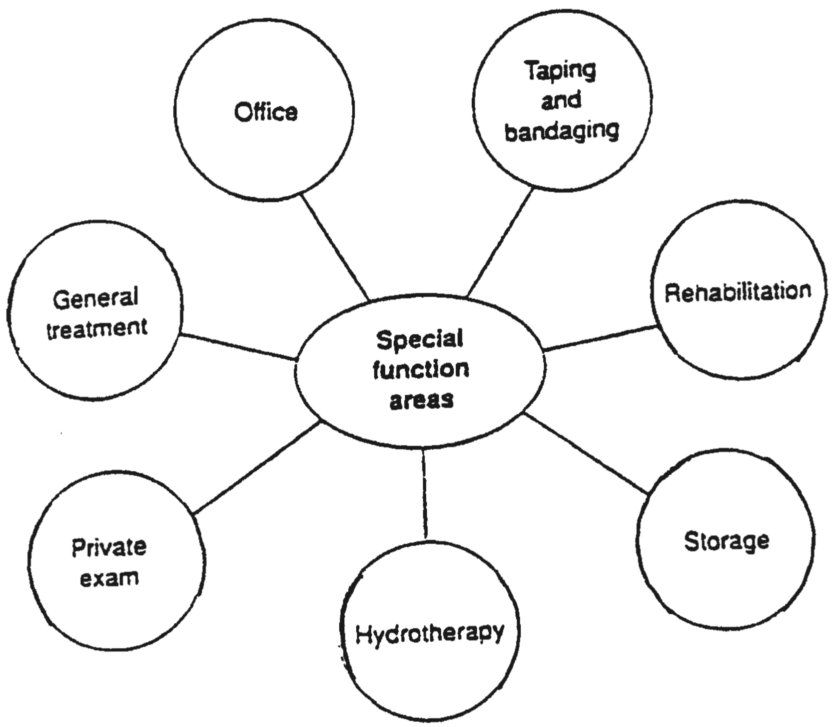
4) No food should be permitted in the treatment area.

Depending on the institution, janitorial duties may be shared by or solely dependent on the athletic therapist and his/her staff or the janitor. However, the following items are the responsibility of the therapist:

- ensure treatment tables are disinfected and cleaned between patients
- thoroughly clean whirlpools daily with a disinfectant
- disinfect exercise equipment
- clean modalities at least once a week
- ensure that each individual has a clean towel and prohibit the practice of sharing in an effort to combat the spread of infectious diseases
- place a towel between hot packs and the skin to prevent cross-contamination between athletes
- do not allow athletes to place their fingers in jars of lotion or to apply the tip of a tube of ointment directly to their skin. Moreover, do not allow them to contaminate bottles of antiseptic by re-immersing applicators that have already touched their skin.

Ray (1994) states that there are seven specialized areas within the sports medicine facility: the office, taping and bandaging, hydrotherapy, general treatment, rehabilitation, storage, and private examination. Figure 3 shows a schematic diagram of Ray's work.

Figure 2: Special Function Areas of an Athletic Therapy Facility



The Office

Ray (1994) notes that the Athletic Therapist's office is generally located in the clinic. The medical records of athletes, insurance information, educational pamphlets and the like are stored here. Secondly, the office serves as a workstation for the athletic therapist to do charting, filing, and follow-up care. Moreover, when space is unavailable, the office can serve as a consultation room.

The office should have a clear view of the rest of the clinic especially areas where supervision is pertinent. If the office is going to double as extra examination space, it needs to be equipped with a plinth and privacy curtains. Finally, adequate space to hold consultation sessions with athletes, coaches, and parents should be available if needed.

Taping and Bandaging

The taping area is perhaps the busiest area in the clinic. There is increased traffic flow to this area so it is important to locate this area where it would not disturb other patients. The taping area should include an adequate number of taping tables to increase clinic efficiency. Moreover this will prevent a back-log of people from gathering in one area. Cady (1979) states that the taping tables can be individual tables or one large platform to accommodate several individuals. The table should be of a comfortable height for the therapist to prevent undue stress or strain on the back of the therapist. The surface of the taping table should be easy to clean and should be stain resistant. Skin lubricant, adherent, and remover can leave residue or stains that can be difficult to remove (Ray, 1994).

Hydrotherapy

This area of the clinic should be separate from other areas because of the noise from the turbines and due to the possibility of water spills. However, the physical separation makes it difficult for the therapist to provide constant supervision to the athlete. Therefore, the athlete should be situated in the tub, the therapist turns on the turbine, and intermittent supervision should follow until treatment time is completed. The therapist should turn the turbine off and assist the athlete in exiting the tub. These areas need to be equipped with Ground-Fault Indicators (G.F.I.) in case of an electrical mal-function (Ray, 1994). Such devices would prevent electrical fires or other mishaps from inflicting harm on the patient.

This room should have sloped floors and adequate drainage to prevent water build-up on the floors. Other equipment requiring water such as ice machines and hydrocollators should also be situated in this area. Due to the presence of water, electrical outlets should be away from water sources and covered.

General Treatment

The general treatment area includes treatment tables and electrical modalities. It is generally the largest area of the sports medicine clinic (Ray, 1994). The treatment tables should be surrounded by privacy drapes with adequate spacing between tables for the therapist to work. This area will vary greatly from clinic to clinic depending on the particular needs of the clientele. Additionally, the general treatment area may contain exercise equipment such as exercise balls, stationary bicycles and thera-band if space does not permit elsewhere. General clinic supplies such as first-aid supplies, tape, slings, bandages, and towels will also be located in this area.

Exercise and Rehabilitation

Rehabilitation areas require a lot of space for exercise equipment, exercise mats, floor space, and cardiovascular exercise equipment. Athletic therapists have generally placed the rehabilitation area in a multi-purpose weight-room or in an adjacent room to the treatment area. Combining the rehabilitation area within another area designated for other purposes places patients and staff at risk of injury due to lack of physical space. However, sending an athlete to an outside weight-room is not a safe practice. Therefore, if this set-up is used by the therapist, a student therapist or assistant should be sent to assist the athlete while outside of the actual clinic (Ray, 1994).

Storage

The storage area should be located near the taping area. This makes it convenient to re-stock supplies when they are depleted. Secondly, it should be a secure area to prevent the unauthorized removal of supplies. The implementation of an inventory system should be used to account for supplies. Student therapists who require additional supplies for team kits should sign out what they need in a log book. At the end of the season, supplies that are returned should be logged in the same manner to assess exactly how much has been used. It is important that this area be cool and dry to prevent the deterioration of supplies such as tape. When humidity is high, the tape becomes "gummy" and does not release easily from the roll or lay over existing tape very well (Ray, 1994).

Private Examination

Some injuries require privacy in order to evaluate the injury accordingly. Moreover some patients feel calmer when they are not being observed by a room of people. If a separate room is used for private examination, supplies that are used regularly should be readily available in the room. Examples of such supplies would be: gowns, towels, gloves etc.

Although this model represented by Ray (1994), is only one method of organizing an athletic therapy facility it presents an efficient and organized facility plan. Unfortunately, many Athletic Therapists are not blessed with all of the resources, whether physical or economical, to design such a facility. Therefore, alternate designs would serve the same purpose as long as the major elements of each treatment area are met.

Legal Concerns

Recently, there have been an increasing number of lawsuits brought against coaches and trainers for negligence and malpractice. Not only has the number of these lawsuits increased, but the monetary value of such awards has also increased (Berg, 1987).

Although the field of medicine has ancient roots, the discipline of sports medicine is relatively young and therefore still developing. Hence, lawsuits in this area are also evolving. Generally, the majority of legal problems in the field of athletic therapy are negligence suits. (Drowatzky, 1985). One of the greatest factors contributing to such lawsuits is the definition of the scope of practice of an Athletic Therapist. Other professionals in the medical field have very clearly defined protocol with regards to their duties and responsibilities. Yet, because Athletic Therapists work in such a versatile environment with many variables, their scope of practice often cannot be limited in the same manner.

Secondly, Athletic Therapists once were only found in the college or university setting. Today, Athletic Therapists can be found at the high school level serving a dual role as both a coach and a therapist. They are also self-employed in a clinical setting or as part of a team of medical professionals in a health care setting. This versatility entails a wide range of roles and responsibilities - some of which are more defined than others.

Obviously unclear delineations of duty allow for liability issues to develop.

A Careers Placement Information Brochure published by NATA in 1984 outlined the Athletic Therapist's duties as follows:

> "implementation of preventative programs as well as immediate treatment and rehabilitation programs for an injured athlete. These programs are to be under the direction of the team physician."

Although one would think that such a statement would clarify any ambiguity with regards to the profession of athletic therapy, this is not the case. Often it is the personal actions of the individual or the initiation of their actions that makes them susceptible to legal problems.

Negligence

There are two areas of negligence that may apply to the field of athletic therapy (Arnheim & Prentice, 1999):

1) Act or Failure to Act:

> "Committing an act which the actor as a reasonable man, should realize that there is an undue risk of causing harm to another individual. Or alternatively, failing to perform an act which would be deemed necessary in order to prevent harm to an individual."

2) Undertaking in Profession or Trade:

Unless an individual states that he/she possesses greater or lesser amounts of skill, that individual is expected to exercise the knowledge and/or practices of members of that profession who are in good standing within their respective governing bodies.

For the above description, NATA insists that there are three principal areas where negligence may be present in the field of athletic therapy:

1. Immediate treatment of injuries. For example, if a therapist fails to assess an athlete's ankle injury as a third degree sprain and allows the athlete to return to play causing more injury, the therapist would be liable.

2. Rehabilitation and supervision of treatment. If an athlete is using a heat pack for a sore muscle and the therapist does not ensure that there is adequate padding between the pack and the athlete, a burn may result. If so, the therapist would be liable.

3. Injury prevention programs. An important part of the therapists' duties is to prevent further injury to his/her athletes. In some cases, if a therapist is negligent in ensuing that his/her athletes avoid re-injury, legal action may result. This stresses the importance of designing individual injury prevention programs for athletes.

Likewise, an athletic therapist must ensure that there are proper safety equipment and supplies on-site in the event of an emergency. For example, if supervising a diving competition, it would be reasonable to assume that there would be a spinal board nearby in case of a spinal injury. If the board was not there, and such an injury did occur, then a negligence suit could result.

Lastly, as the supervisor of athlete medical services, it is the athletic therapists' responsibility to ensure that all student trainers or first aid personnel are trained in emergency first aid by accredited institutions. Furthermore, it must be made clear that tasks which are considered beyond their (the students) field of training, must be referred to appropriate medical personnel. Any attempt(s) to render such tasks, automatically makes them accountable under the normal standard of care of a physician. However, if more advanced medical care is not immediately available; arrangements must be made to have them transported to the nearest medical facility. It is important to note that the athlete must continue to receive treatment until that time.

Evaluation and Management of Athletes

It is often the responsibility of the athletic therapist to perform pre-season screening to flag any conditions that may pre-dispose an athlete to injury or to cause further damage. It is also their responsibility to ensure physician referral as well as following up these visits. The athletic therapist may also be involved in on-site sport specific activities such as altitude adjustment if training for mountain climbing competitions. Moreover, another example of such an activity may be monitoring the water intake of athletes to ensure proper hydration levels. Regardless of the activity, the role of the athletic therapist is to prevent the athlete from forseeable injury or harm which may have otherwise been preventable (Arnheim & Prentice, 1993).

.Rehabilitation

After the injury has been assessed, whether by the athletic therapist or the team physician, the athletic therapist is then responsible for the supervision of the rehabilitation process. This process may involve the use of exercise and/or modalities. It is essential two things: first, whichever rehabilitative route is chosen, it must be assured that the athlete will not suffer any further injury or damage. That is, are the athletic therapists'choices appropriate for the athlete's current injury phase? Secondly, the athletic therapist must be well educated with regards to the safe use of modalities. Therefore parameters and treatment times must be chosen appropriately as to not hinder the treatment process (Hillman, 2000).

It is important to note that although accident reports, records of treatment, and pre-season screening medical reports do not <u>eliminate</u> liability issues, they do, however, aid the athletic therapist in defending their practices and roles if a lawsuit was to develop (Ehrlich, 1985).

An injured person may choose to pursue legal action through one of two avenues. First, through civil action that acts upon conduct based on that of a reasonable person. Individuals who are deemed not to have acted in the manner of a reasonable person may face liability charges. Suits such as these compare the actions of the individual to those that a reasonable person would do in the same situation. Klafs and Arnheim (1981) state that the uses of a common sense approach as well as the proper precautions unique to that situation will be deterrent to civil action lawsuits.

Secondly, lawsuits pursued under tort law state that the actor must act in the same manner as another member of their profession - in this case, an athletic therapist. This holds the individual to a higher standard of care than under civil law. Negligence is the most prevalent tort in the field of athletic therapy (Bjarnason, 1991). However, the athletic therapist can only be found negligent if the injury sustained by the claimant was foreseeable. For example, an athletic therapist would be guilty of negligence if they removed the helmet of a hockey player who had been checked from behind into the boards without providing any spinal stabilization. If the athlete had suffered spinal cord damage, it is possible that the removal of the helmet further aggravated the injury. Conversely, removing the helmet of a hockey player who has suffered a separated shoulder would have no bearing on the degree of stability in the shoulder post-injury.

Hence, Bjarnason (1991) states that in order for an Athletic Therapist to be proved negligent, the following factors must exist:

1) There is an obligation to act with a certain standard of care.

2) The athletic therapist failed to meet the set standard of care.

3) There is a direct correlation between the actions of the athletic therapist and the resultant injury.

4) The resultant injury was foreseeable and would have been preventable if the actor had acted in the manner that a reasonable athletic therapist would have.

5) The claimant has suffered loss or damage. The Athletic Therapist must have made an existing condition worse or have caused an actual injury.

Assault

An athletic therapist may be found guilty of assault in a number of ways. For instance, applying undue force to an individual which either causes physical harm to them or makes them feel uncomfortable constitutes grounds for assault. Additionally, any sort of treatment that the patient feels uncomfortable with, such as massage in the buttocks area, may be used as an instance of assault, if consent was not first obtained from the athlete. Remarks of a sexual nature or threats of a person's safety are also ways in which criminal liability could result (Graham, 1985).

Although all of the above circumstances may deter an athletic therapist from working closely with an athlete, abandoning an athlete is not an option. Abandonment is also grounds for criminal action. The athletic therapist has an obligation to perform their duties when consent is given.

Before any attempt(s) is made to assess or treat an injured athlete, consent must be given by the athlete in order for the athletic therapist to begin their duties. If the athlete does not give this consent, the athletic therapist can face both criminal and civil charges. Therefore, treatment should <u>never</u> be given without consent. There are two ways in which consent may be given (Graham, 1985):

1) <u>Explicit</u> - this is the most common type of consent. It can be achieved in one of two ways:

a) the athlete is injured and knowing that the individual is an athletic therapist, approaches him/her seeking medical attention

b) or the athletic therapist recognizing that the individual is injured, approaches him/her offering their services.

This form of consent will continue to exist throughout the treatment period provided that the athletic therapist explains the treatment protocol to the athlete. However, consent will cease at the moment when the athlete decides to terminate the treatment or the athletic therapist begins treatment for other things besides the initial injury for which consent was given. For example, if the athlete is being treated for an acriomoclavicular joint sprain and the athletic therapist beings treatment for a sore groin, then consent would cease.

2) Implicit - this form of consent is rare. If an athlete is unconscious, yet seriously injured, an athletic therapist is entitled to begin emergency care when the athlete is in need of it. This covers only the treatment needed to alleviate life-threatening conditions. It does not cover any further treatment for other injuries.

Children under the age of eighteen should not be treated by an athletic therapist unless consent is given by the parents. Although, implicit consent would apply if in the event of serious injury and the parent or guardian is unavailable. Having a parent/guardian sign a waiver has little credibility in a lawsuit. A waiver does not free the athletic therapist from a reasonable duty of care and the athletic therapist is still expected to act accordingly (Berg, 1987).

Athletic therapists are not perfect. Occasionally, no matter how many precautionary measures are taken, mistakes sometimes happen. Often, these instances occur through no fault of the athletic therapist. However, filing an injury report can help protect the athletic therapist in such events. According to Bjarnason, (1991), a proper injury report should include the following:

1) Date, time, and place of injury
2) The athlete's sport
3) Type of injury
4) Date of injury
5) Structures injured
6) Severity of injury
7) Mechanism of injury
8) A brief history of the circumstances surrounding the injury
9) Have they seen a doctor?
10) Observations
11) Palpation

Please refer to Figure 3 on the following page for a sample injury report from the University of New Brunswick. Due to the fact that the judicial system is often a very lengthy process - having written documents to complement your testimony if a lawsuit should arise would strengthen your defence.

Figure 3: University of New Brunswick Sample Injury Report

UNB Athletic Therapy Clinic Injury Report

Name:____________________ Code:__________ Date:______________
Injury Date:____________ Sport:_________ Body Part:_______ Side:___
Structure:_____________ Spec. Structure:_________ Onset:_________
Injury:__________________ Mechanism:___________________________
Causal Factors:______________________ Severity:_________________
Activity at Injury:_______________ Hospital?____ Physician:__________

History:____
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Observation:____
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Palpation:____
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Tx
Plan:____
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Therapist:____________________

Although waivers act to place the onus of sport participation on the parent and not the athletic therapist, there is an assumption of risk when one participates in sports. An athlete must be aware of the dangers of that activity before voluntarily choosing to participate.

Graham (1985) posits the following points to reduce the risk of litigation:

1) Establish good relationships with athletes, parents, and co-workers

2) Maintain policies and procedures

3) Develop an emergency plan

4) Know your athlete's medical history

5) Keep updated and thorough records

6) Obtain written consent forms from the parents of minors

7) Exercise caution in the administration of non-prescription medication

8) Keep medical records confidential

9) Acquire professional liability insurance

Epidemiology of Injury

Sports injuries are very similar to injuries which arise from other sources. Although Garrick and Webb (1999) state that sport-related injuries are perhaps easier to treat and most certainly could have been prevented. The therapist often witnesses the mechanism of injury in the sport setting. This visual cue helps develop an index of suspicion. Secondly, the injury may have occurred due to faulty equipment such as a loose chin strap on a football helmet which resulted in the helmet slipping too far forward on the athlete making them susceptible to head/neck injuries. An improperly cared for playing surface can be dangerous for an athlete, predisposing them to ankle sprains or other lower extremity injuries.

Generally athletes are more eager to recover and are more compliant to their treatment regime than the general population. However, their drive and tenacity to compete again often compounds the healing process. Their motivation may push them too far, too soon causing further harm. Furthermore, bringing the patient back to a normal state where activities of daily living are completed in a pain-free state is enough for the normal patient population but not an athlete. The athlete needs to return to the "state of excellence" that he/she holds in their mind. Functioning like the average individual is not enough for an athlete.

Physicians and therapists that deal with athletes do not have time on their side. They must utilize means that will return the athlete to pre-injury form in the least amount of time. Moreover, questions such as "How long will I be out?" may be very difficult for the medical staff to answer. When a definitive answer cannot be given, they are often viewed as incompetent. However, athletes, coaches, and parents fail to understand that a time line cannot be placed on the natural healing processes of the body.

Sprains

Sprains are injuries occurring to ligaments. According to Garrick and Webb (1999) ligaments serve two purposes: assist muscles in stabilizing the joint and prevent abnormal movement at the joint. However, ligament laxity and strength are not uniform among individuals. Some people have extremely lax ligaments that allow them to move their joints to excessive endpoints with no pain. Conversely, others possess very tight ligaments that restrict the amount of ROM at the joint.

In light of this, something else must act to stabilize a joint that is affected by abnormally loose ligaments. Therefore, the musculature around the joint should be strengthened to assist the ligament. An example of this would be an injury to the anterior cruciate ligament (ACL) in the knee. When stretched or torn, the ACL is incapable of holding the tibia in place. Thus, the hamstrings must be strengthened to aid in this task.

Generally sprains occur because the ligament is forced beyond its normal range of motion (ROM) or if movement is forced in a plane where there is not a lot of movement possible. For example, an ankle has very little inversion and eversion compared to plantarflexion and dorsiflexion. When movement in the former plane is forced, damage will occur to the ligaments. Although inversion sprains seem to outnumber the incidence of eversion sprains, sprains in either of these planes are possible (Garrick & Webb, 1999). As with any injury, pain is generally present after ligament sprains. However, it is not uncommon for pain to be absent in severe sprains such as third degree sprains. The integrity of the ligament is disrupted enough that no discomfort is felt by the athlete. However in this instance, the athlete is usually limited in his/her range of motion (Arnheim & Prentice, 1995). This problem can be further compounded by the presence of swelling. The athlete's range of motion decreases further as time goes on. The athlete will usually complain about a sense of instability in the body part. Statements such as "My knee is giving out" or "My leg is wobbling" are frequent comments.

The ligament should be properly evaluated as to the extent of damage suffered. Ligament sprains are graded from 1 to 3, with third degree being the worst (Arnheim & Prentice, 1993). Ligaments contain parallel collagen fibres. When sprained, some of these fibres are stretched or torn. Minor sprains often occur without lengthening the ligament. According to the above authors, grade one sprains present no increased lengthening in the ligament and no feeling of laxity. Grade two sprains usually have some tearing of fibres as well as some laxity. Finally, a grade three sprain is a complete tear of the ligament.

Strains

A strain is an injury occurring to muscles and tendons. The strain can occur at a number of places in the musculotendinous unit: at the tendon, at the junction of the tendon and muscle, or where the tendon meets the bone (Mellion, 1999). The latter often results in an avulsion fracture. The tendon is stretched beyond its limits, pulling a small piece of bone from its attachment (Mellion, 1999).

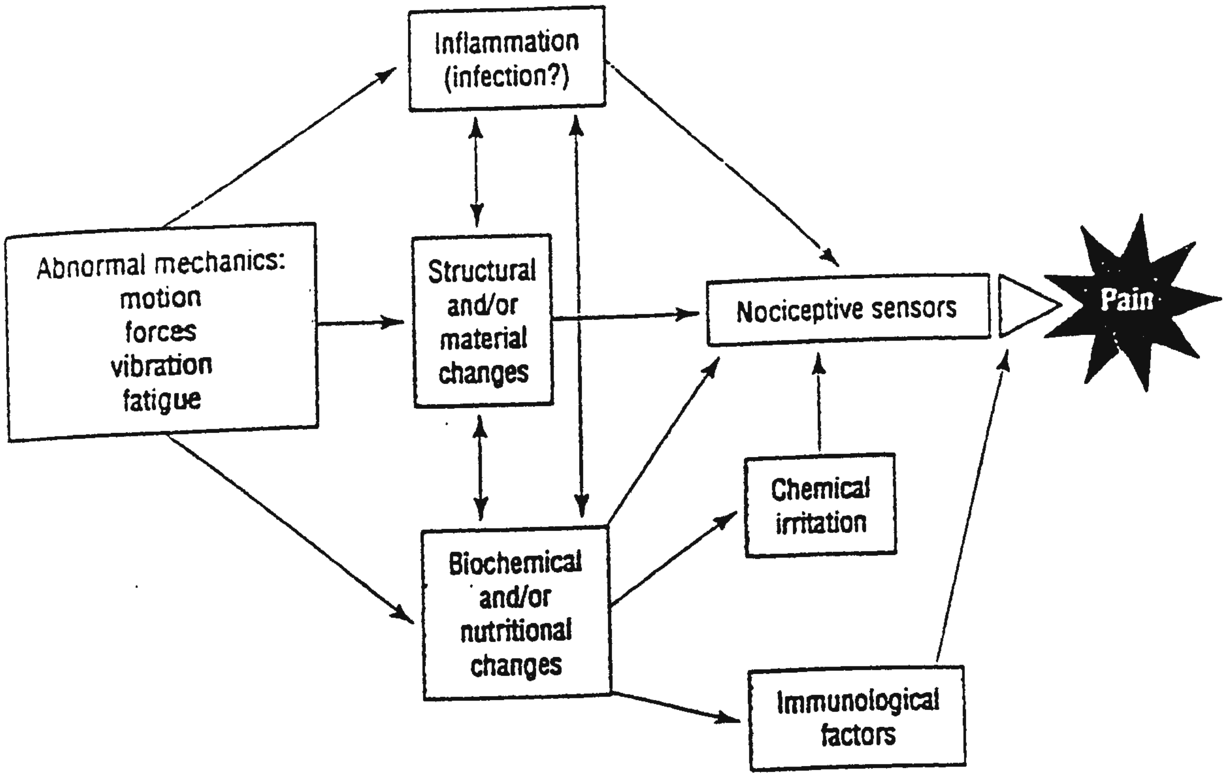
Strains usually result from a sudden increase in tension within the muscle. Such would be the case in a biceps tendon rupture suffered while doing bicep curls with excessive resistance. Muscles act to produce movement and to stop movement. It is in the deceleration phase during the eccentric movement that strains usually occur (Roy & Irvin, 1983). Antagonists muscles work to oppose the action of the agonists. When the agonist is overloaded, equivalent strength must be found in the antagonist to counteract it (Roy & Irvin, 1983). Many rehabilitative programs focus on stretching the muscle to prevent sprains. Whether the muscle is tight or long, weak muscles are susceptible to damage. Strength and flexibility should go hand-in-hand. However, flexibility often takes precedence over strength. Athletes notice when there is a decline in flexibility, yet decreases in strength go unnoticed. Gains cannot be achieved in one area without improving the other.

Injury Management

Regardless of the nature of an injury, the initial management stage will be the same. That is, regardless of an ankle sprain or a quadriceps contusion, the athletic therapist should follow the same procedures. The acute phase of an injury is universally treated according to the RICE principle. RICE is an acronym for rest, ice, compression, and elevation. Some texts, such as Arnheim & Prentice (1993), follow the PRICE principle, with the P meaning protection. As the acute stage of an injury can last 48-72 hours or beyond, these steps can be employed until the therapist is certain that applying heat to the injury will not cause further edema. It has been generously stated throughout the literature that effective management of an injury in its acute stage can lead to a much speedier recovery.

Many acute injuries, such as sprains, will exhibit edema. If the therapist can control the edema, they are assisting the body with its natural healing processes. Swelling or edema has an adverse affect on the tissues for a number of reasons. First, swelling increases pressure within the tissue. This is uncomfortable as well as painful (Wells, Frampton, & Bowsher, 1988). Secondly, the previous authors have also noted that this added pressure can inhibit the transfer of impulses along neural pathways thus eliciting only a weak contraction. This leads to a vicious cycle of pain and spasm followed by atrophy of the muscle. Figure 4 describes the pathophysiology of pain.

Figure 4: The Pathophysiology of Pain (Prentice, 1990).



With the ultimate goal of ridding the injury of the swelling, the PRICE or RICE principle should be administered. The following sub-headings describe the principle according to Arnheim & Prentice (1999).

Protection

The injured area should be protected from further injury. This would involve immobilizing or stabilizing the injured area as to alleviate weight-bearing or to prevent the structure from moving. Examples of protective measures include: splinting a broken finger, applying a sling to a dislocated shoulder or using crutches if a lower limb is injured. The duration of the immobilization will depend on the athlete's natural healing process. Moreover, it will further depend on how the athlete responds to the injury. That is, is the athlete resting the injured area? Is he/she following an adequate diet to supplement the body's needs? Finally, has the athlete been given a comprehensive home program or instructions to augment the program initiated at the treatment facility?

Rest

Rest is essential for the athlete during the first 48-72 hours of the injury. However, rest does not mean being inactive. The athlete should rest the injured area, but it does not mean that he/she needs to be totally inactive. For example, if an athlete sprains his/her wrist, there is no reason that the athlete cannot train his/her lower body during this time. Afterwards, the therapist should devise ways of resting the affected area while still maintaining cardiovascular fitness. For example, a volleyball player who has a tear in their rotator cuff can still bike or run in the swimming pool to maintain cardiovascular fitness.

The rest phase of this process is extremely important as it is crucial not to expose the injury to any undue stress or strain that may cause further damage to the integrity of the tissue and/or hinder the healing process.

The Function of Ice

The use of cold for all injuries is indicated within the acute stages. It is also the modality of choice when the therapist is unsure of the nature or stage of an injury. The primary function of ice is to decrease pain. Moreover, cold is known to decrease muscle spasms that are painful for the athlete. As mentioned previously, the application of cold delays the transmission of painful stimuli along the neural pathways. It has also been proposed by Prentice (1990) that because the body is overwhelmed by the "cold" stimuli at the sensory nerves, the "pain" stimuli is forgotten.

Ice or other forms of cold should applied on regular basis for the first 72 hours or until inflammation subsides. Application of cold should generally last for 15-20 minutes with an equivalent "off" time between applications.

Compression

Compression has been noted as the most important factor in controlling swelling. Its foundation follows a simple mechanical principle; two things may not occupy the same space at the same time. Therefore, by compressing the tissue, the interstitial space between the cells is decreased. This inhibits the formation of edema.

Compression wraps or socks should be applied distally to proximally. This pushes the swelling upwards towards the heart to promote lymphatic drainage. Wraps should be applied with even and consistent pressure. However the wraps should not be worn to bed in the event that circulation may be impaired. Cameron (1999) notes in her book "Physical Agents in Rehabilitation From Research to Practice" that the potentially adverse effects of compression generally result from aggravating the condition or impairing the circulation instead of improving it. If too much pressure results from the compression wrap, it acts like a tourniquet impeding arterial circulation causing tissue necrosis. Therefore, it is important to educate the athlete with regards to the application of the wrap, its removal and alterations in circulation.

Elevation

Injured body parts should not be placed in a gravity-dependent position. Such a position would cause blood to gather in the distal part of the limb. This excess blood flow and its conglomerates would disallow drainage and contribute to more edema formation. The greater the height of elevation, the more effective the lymphatic drainage will be. Yet as a general rule, the body part should be elevated to the level of the heart.

The Rehabilitative Process

Rehabilitative goals are a means of therapeutic intervention. These goals are decided after an athlete undergoes an initial evaluation. After such an evaluation, a treatment plan is formulated to meet the rehabilitation goals. Each athletic therapist has two main rehabilitative goals in mind. First, they wish to ensure that the athlete is not susceptible to any further injury. Second, they want to return the athlete to play as soon as possible (Prentice, 1994).

The second goal of rehabilitation programs is best achieved through a combination of three factors. An accurate injury evaluation, prompt treatment, followed by a structured rehabilitation program will return the athlete to a pre-injury state of physical conditioning as quickly as possible. Therapeutic exercise has been shown to be the most effective way of achieving rehabilitation goals (Roy & Irvin, 1983).

Essentially there are three distinct stages to an injury. However, each stage may not be well-defined and they may overlap. Yet within these three stages: acute, sub-acute, and rehabilitation, there are distinct goals to which the therapist, the athlete, and the coaching staff must adhere.

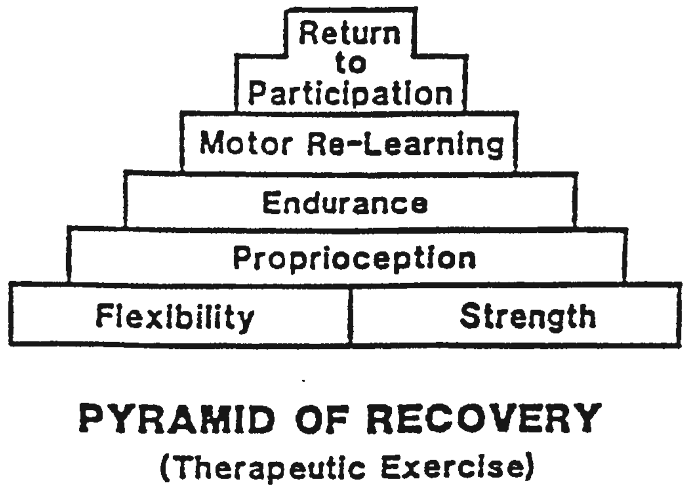
As mentioned previously the acute stage of an injury usually lasts 48-72 hours. It is within this time that the inflammatory reaction begins. Adhering to the (P)RICE principle outlined earlier, this should be the staple treatment effort during this time. The application of the RICE principle disallows the formation of edema and limits hemorrhaging within the tissue.

The sub-acute stage begins after the inflammatory reaction has subsided or when the inflammation is under control. There are a number of goals that should be noted in this stage (Arnheim & Prentice, 1999):

- re-absorption of exudate
- re-align fibres which may have been injured
- decrease atrophy of the muscle
- stimulate proprioceptors
- decrease pain/spasm
- protect the area from further injury (Depodesta, 1983)

Many of the same treatment options that would be used in the acute stage are continued into the sub-acute stage. This would include interferential current (IFC), high voltage pulsed stimulation (HVPS), and cryotherapy among others. One major addition to the treatment repertoire is heat. Heat in the form of heat packs, contrast baths, or ultrasound may be used to break-down fibrous adhesions and to help remove exudate from the injured area. Massage or frictions can also be used in this stage to break down adhesions. Figure 5 depicts the Pyramid of Recovery (Therapeutic Exercise) proposed by GL. Shelton as cited by Mellion, Morris, B. (1999) in Sports Medicine Secrets.

Figure 5: Pyramid of Recovery (Shelton, cited by Mellion, 1999).



Four principles must be followed in order for therapeutic exercise to be successful (Depodesta, 1983). First, the prescribed exercises should be monitored in the event that training adaptations need to be made. For example, if an athlete with an ACL injury is trying to strengthen his/her hamstrings using the hamstring machine and is experiencing pain, then the exercise should be changed. An alternative measure would be isometric hamstrings contractions assisted by the therapist. This example also exemplifies the second principle of therapeutic exercise; that is, the exercises should not aggravate or cause further harm to the injury. The third principle requires that the exercises follow order and progression. Again with reference to the ACL injury, it is logical that the exercises would commence with non-weight bearing exercises before weights were used to strengthen the surrounding musculature. As Depodesta (1983) stresses the importance and employment of a progressive approach to rehabilitation, it is reasonable to ensure that the athlete is comfortable throughout their full ROM with manual resistance applied by the therapist before they proceed finally to the hamstring machine. The final component of a rehabilitation program is a well-rounded program. The exercises must have variety to prevent boredom and disinterest among the athlete. The program must employ a wide variety of techniques as well as ensuring that body parts that are not integrated into the program are conditioned via other means.

Realistic goals should be set by the therapist and athlete. These should include short-term as well as long-term goals. It is important to design the program so that the athlete can see results. The athlete should be placed on a home program to complement the program at the athletic therapy facility. This enables the athlete to exhibit some control over their rehabilitation. Additionally, a home program does not require the individual to spend countless hours at the therapy facility. The athlete does not regard this portion of the rehabilitation as disruptive as coming to the clinic each day. (Prentice, 1994).

Roy and Irvin, (1983) have proposed the following factors that influence rehabilitation goals:

- Type of Sport - different sports will place varying demands on the individual. Moreover, positions within that sport will influence rehabilitation goals.

- Length of Season - The length of an athlete's season, or more so the current place, in season will influence rehabilitation goals. Injuries occurring early in the season are often treated more conservatively than those which occur leading into the playoff season.

- Rules of the respective sport - Injury rehabilitation may depend on the rules of the game. Does the athlete participate in an individual sport or one that permits substitutions? How much protective equipment is worn, if any? Are prophylactic braces allowed?

- Extrinsic Factors How big a role does sport play in the individual's life? Is there a possibility of playing professionally afterwards? What role, if any, will the parents and/or coaches play? Will they support the athlete's return to play or will they encourage retirement?

- Intrinsic Factors - How is the athlete responding to the injury? How great is their desire to recover? Will they follow the therapists' advice and suggestions or will they push too hard too soon? Conversely, will they be able to deal with the pain in an effort to rise above the injury?

- Type of Injury - Is it a sprain, facture, or contusion? All of these injuries would require a different treatment approach. Is the injury severe or minor? Again both would require alternative approaches.

Too often athletes are inadequately rehabilitated and allowed to return-to-play too soon. For this reason, it is important that the therapist ensures that the athlete is returned to their pre-injury state of physical conditioning before discharging them. Despite great efforts to design an effective rehabilitation program to take into account the above listed factors, there are many other compounding factors which cannot be foreseen . Depodesta (1983) outlined the following secondary complications:

- Loss of ROM. This will restrict the therapist from progressing onwards to stabilizing and strengthening.

- Atrophy of muscle. A decreased muscular strength will delay the return to play time. The therapist has to work further to get back to a previous state because of the decrement in that limb.

- Fibrous adhesions - a build-up of fibrin tends to form adhesions. These adhesions often limit ROM and can delay the healing process. If left untreated, the adhesions may become permanent scar tissue.

- Loss of strength, power, and endurance. A slow rehabilitation process to accommodate the body's natural healing process may offset the athlete's physical conditioning.

The third and final stage of injury rehabilitation is the rehabilitation stage. Secondary complications often occur in this stage. This main aims of this stage are as follows (Depodesta, 1983):

1. Regain Normal Pain-Free ROM: Perhaps the most effective method of regaining ROM is through active exercises. This is aided by massage to break down any scar tissue. When joints are involved, accessory motion is often comprised due to a build-up of adhesions within the joint capsule. Mobilizations and glides can be used by

the therapist to loosen any intra-articular adhesions limiting ROM.

2. Regain Normal Weight-Bearing Function: A progressive approach should be employed from crutches to full weight bearing. For example, from using crutches and placing no weight on the affected limb, the athlete can proceed to using crutches with partial weight-bearing to finally walking with no crutches. Single crutches and/or canes should be avoided so that postural abnormalities do not develop. When the athlete reaches the progressive weight bearing stage, prophylactic braces, canes, and crutches may be used for additional support.

3. Regain Normal Strength, Power, and Endurance: Exercise during this phase should focus on bilateral fitness components. Ignoring the uninjured limb will lead to imbalances which may lead to further injury. As a rule, the intensity and repetition of the exercises can increased when symptoms subside. Consequently, structures around the injured area must not be ignored. Supporting structures such as joints above and below and agonist - antagonist muscle pairs need to be strengthened to provide much needed support to the injured area. Progressive exercise routines should follow a routine similar to the one below:

1. Active pain-free ROM
2. Manual resistance isometric exercises
3. Isometric exercises throughout different points of active ROM
4. Isokinetic exercises
5. Regain proprioception. Once again proprioception exercises should follow a

logical progression. An example using an ankle sprain is as follows:

1) stork stand

2) stork stand with trunk flexion

3) stork stand with trunk flexion and eyes closed

4) sit-fit

5) round wobble board

6) square wobble board

7) trampoline

All of the above exercises focus on returning the athlete to their respective sport. However there is no assigned time line for the re-introduction of proprioceptive exercises. There is a general theme across many of the literary sources consulted for this report that in order for an athlete to return-to-play, two criteria must be met. First, the athlete must have full range of motion with no perceived pain with exertion. Second, the athlete must possess at least 85% strength with respect to their previous physical conditioning. However, when this goal is attained, the athlete should still be closely monitored for setbacks or complications. As the therapist often does not have close contact with the athlete once they return to their sport, they must be educated as to notice "trouble signs". For this reason, a good rapport between the therapist and the athletes is important. Such a rapport would increase the likelihood that an athlete will return to the therapist if problems arise.

Athletic Taping

The use of prophylactic taping is often used to assist the athlete in a quick return to play following injury. Yet the use of taping alone is not enough. Such measures must be accompanied by a treatment and rehabilitation protocol. Ideally this will act to strengthen and provide support to the injured area without causing further injury to the body part. For this reason, Frette (1999) has highlighted two main goals of the application of tape: to prevent injury and to promote a faster return to play.

Taping procedures allow a body part to be functional yet does not allow it to be placed in a compromised position (Anderson & Hall, 1995). This compromised position may be one which is dangerous to an injured or uninjured athlete. Taping must only be done for a specific reason. Taping for no reason or taping ineffectively can cause further damage to the body part. Although many current studies have been inconclusive, many researchers believe that the body part may become dependent on the support of the tape. That is, the body part may develop dependency on the tape and may exhibit instability and weakness in the absence of the added support provided by tape. For example, Arnheim, (1995) states that the joint proprioceptors and Golgi tendon organs lose their sense of awareness when prophylactic taping is used. Conversely, other authors have disputed this fact, arguing that it is the pressure from the application of the tape that stimulates these receptors contributing to joint stability. Thus, it is important to incorporate a proprioceptive training program in the early stages of injury.

Injuries that require extensive rehabilitation and stabilization may not be suitable for taping injuries. Such injuries may require braces, or cessation of participation. Braces have been proven effective in the protection of an injury without diminishing the athlete's performance (Paris, 1992). Another advantage of bracing over taping is that an athlete can use the brace without the supervision of a therapist. Conversely, a therapist must be available to tape an athlete. Again, tape applied incorrectly can be dangerous for the athlete. Furthermore, braces can provide a mode of continuous support which taping cannot provide. Tape can often lose its structure before the competition is over thereby decreasing the support to the injured body part (Bunch et al. 1985). It has also been proposed that bracing may work effectively for the psyche of the athlete because they can apply the brace themselves. Athletes tend to rely on their own efforts rather than those of a therapist when their performance is at stake.

Taping is not suitable for all injuries. Areas which allow a great deal of ROM or torsion at the joint often do not respond well to prophylactic taping. Therefore the tape may not adhere to the area decreasing the amount of support available. Secondly, severe injuries may require a lot of support which athletic tape cannot give. An example of this would be an ACL injury. Taping the knee would be ineffective in holding the tibia in place. Thus, in this instance, a brace would be warranted. Taping should never be used to restrict the ROM of a joint; the tape should always be applied in a functional position.

Linen tape provides stable support without making the athlete cumbersome. Tape widths usually vary between 1, 1.5, and 2 inch widths. Tape is graded according to the number of longitudinal and vertical fibres per inch. High quality tape contains at least eighty-five longitudinal fibres and sixty-five vertical fibres. The adhesive on the tape should contain few skin irritants and should adhere to the skin even in the presence of sweat or hair. The tape should be easy to remove with little residue remaining on the skin after the tape has been removed (Frette, 1999). Tape should be kept in a cool, dry place to prevent it from becoming "gummy". Furthermore, the tape should not be placed on its side in the event that it may distort the roll. A non-uniform roll makes it difficult to unwind and to keep tension in the tape. Both of the above qualities are important when applying an even, consistent tape job.

The skin should be clean and dry before the tape is applied. Shaving the area will improve the tapes' adhesion to the skin. The area should then be sprayed with adherent to help the tape stay in place. Pro-wrap is then applied over the whole area to prevent skin irritation. Although, it is true that some support is lost through the application of pro-wrap it is a trade-off against possible skin irritations.

When taping a joint, the joint should be in a functional position. Yet it must be in the position where stabilization is needed (Frette, 1999). For example, if the therapist was taping for wrist hyperextension, the wrist should be taped in a position of flexion to limit the amount of extension possible. Taping over muscles should involve the use of elastic tape in an effort to prevent cramping in the muscle. The muscle must be contracted when applying the tape to allow some room for muscle relaxation. Non-stretch tape should always be overlapped by half and should never be applied in a continuous motion (Arnheim & Prentice, 1999). That is, with each encirclement, the tape should be torn. The tape should be molded to the body part as if the therapist was applying a cast. The therapist should mould the tape to follow the contours of the body in order to prevent wrinkles or gaps which may cause blisters.

Removing tape can be done manually or with a shark or scissors. A shark has a blunt end that slips under the tape with a razor blade to cut the tape. Tearing the tape manually may irritate or tear the skin. If manually removing tape, the therapist should use both hands, one to remove the tape and the other to press the skin downwards away from the tape. This method seems to work best to protect the skin from irritation.

Tape can prove to be a very beneficial tool for the athletic therapist. In addition to allowing the athlete to continue playing, as well improving the psychological state of the athlete, athletic tape can accomplish the following things:

1) protect a body part from injury

2) protect an already injured area from further injury

3) restrict hypermobile joints or limit ROM in those which are vulnerable

4) enhance propioception through the golgi tendon organs. These structures can sense the tape which supports the body part

5) permits the athlete to participate with as little restriction as possible (Johnson, 1998)

Therapeutic Modalities

A modality is the application of some form of stress applied to the injury site for the purpose of provoking a response (Prentice, 1990). The use of modalities does not speed up the healing process. However, it attempts to provide an optimal environment for the injury to heal. In addition, the injury should be protected to facilitate its return to a pre-injury state (Knight, 1985). Modalities are a therapeutic means of injury rehabilitation; therapeutic meaning that they facilitate the healing process. Modalities may use heat, cold and/or electrical current to accomplish this.

Thermal agents use a temperature gradient to transfer energy to and from the tissue. The application of cold will have the opposite effects as those of heat. The effect that electricity has on the body is difficult to understand. Due to the many treatment parameters that can be modified, each modaltiy can produce their own characteristic response in the tissues producing their individual therapeutic results. The effects of electrical modalities transmitted through the body elicit thermal, chemical or physiologic responses. All biological tissue will have the same response when electrical energy is passed through it. It is the extent of the response that will influence the response elicited (Starkey, 1993).

Cold Modalities

The application of cold will decrease the speed of the tissue molecules. Cold modalities range in temperature from 32-65°F. The use of cold modalities is collectively known as cryotherapy. During the treatment, heat is removed from the body and absorbed by the cold modality. This elicits a series of local as well as systemic responses. The degree to which these affect the body, depend on the temperature of the modality, surface area covered by the treatment, as well as the duration of the treatment (Starkey, 1993). Generally, treatment times last between fifteen and twenty minutes. The following list contains examples of some of the local effects obtained from cold modalities (Starkey, 1993):

- Vasoconstriction
- Decreased rate of cell metabolism which leads to a decreased need for oxygen at the cellular level
- Decreased cellular waste
- Decreased inflammation
- Decreased pain
- Decreased muscle spasm.

When cold is applied to the skin, the body attempts to conserve heat in its core through a homeostatic response. This is the basic premise on which cryotherapy is efficacious. Belitsky et al., (1993), as stated by Starkey, (1993), notes that the greater the amount of cooling applied to the skin, the greater the amount of cooling felt by the underlying tissues (Belitsky et al., 1993). As the hypothalamus responds to the application of cold to the skin, it automatically re-routes the body's internal heat to the core in an attempt to maintain the temperature of the vital organs. Therefore, the local temperature of the extremities decreases, thus producing the desired effect. Table 2 shows the response of the body in relation to the application of cold.

Table 2: Physiological Response to Cold (Arnheim & Prentice, 1993).

Response	**Estimated Time after Initiation**
Cold sensation	0 to 3 minutes
Mild burning, aching	2 to 7 minutes
Relative cutaneous anesthesia	5 to 12 minutes

Systemic effects of cold application are achieved when the temperature of the circulating blood decreases by 0.2°F. The following list summarizes the systemic effects of cold (Starkey, 1993):

- Vasoconsriction (Whole Body)
- Decreased Respiratory and Heart Rates
- Increased Shivering

- Increased Muscle Tone

Cold modalities have been proven effective when used properly throughout all stages of rehabilitation. However, it is important to explore any contradictory conditions that the athlete may have toward cold. For example, Raynaud's Phenomenon occurs in those individuals who have extreme sensitivity to cold or are "allergic" to cold therapeutic applications. It is caused by a vasospasm in the arteries of fingers and toes which can last for minutes or several hours. These spasms drastically reduce the blood flow to the area thus depriving the tissues of oxygen. If undetected, tissue death, or necrosis, may result. Such attacks cause bilateral blanching of the skin which is followed by redness before the skin returns to its normal color. Individuals do not usually experience pain, but sensations of numbness, burning, or tingling are not uncommon. Anderson & Hall (1995) propose the following list of indications and contraindications for cold application:

Indications:

- Acute injury and/or inflammation
- Pain
- Muscle Spasm (Acute and Chronic)
- Post-surgical pain and edema
- Superficial first degree burns
- In conjunction with rehabilitation exercises

Contraindications:

- Decreased sensation
- Circulation Problems
- Raynaud□s Phenomenon
- Hypertension
- Open Wounds

Table 3 summarizes the indications and contraindications of cold application as proposed by Starkey (1993).

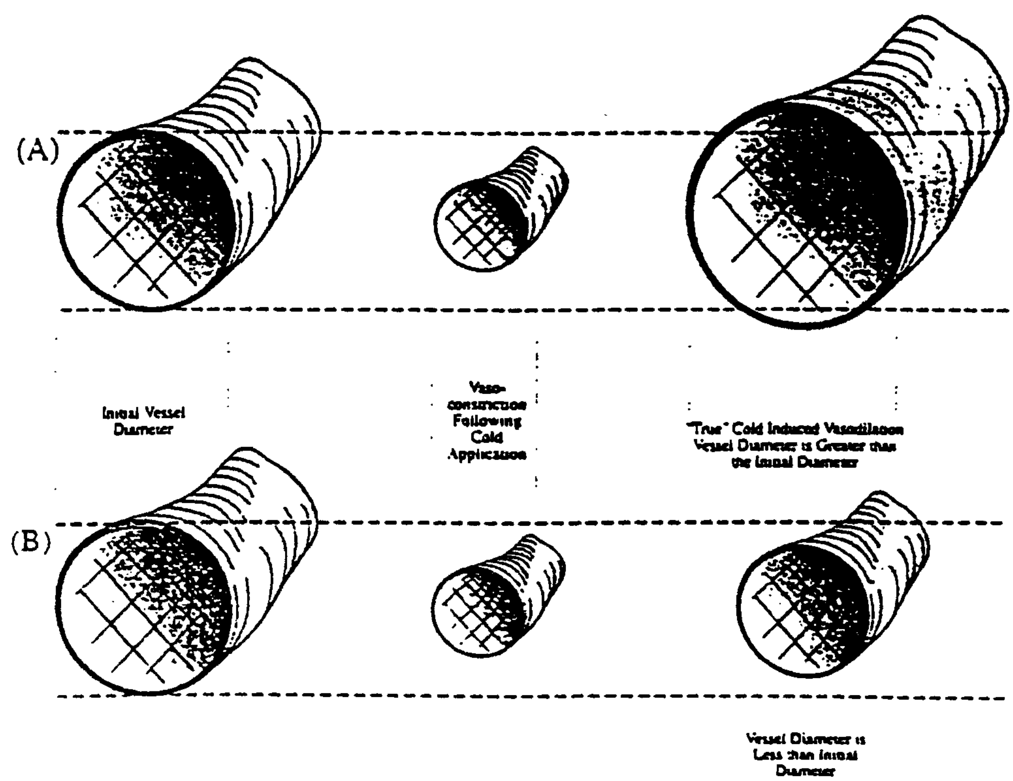
Table 3: Indications and Contraindications of Cold Application. (Starkey, 1993).

Indications	Contraindications
Acute injury or inflammation	Cardiac or respiratory involvement
Acute or chronic pain	Uncovered open wounds
Small, superficial first-degree burns	Circulatory insufficiency
Postsurgical pain and edema	Cold allergy
In conjunction with rehabilitation exercises	Anesthetic skin
Acute or chronic muscle spasm	Raynaud's phenomenon

Physiological Sequence of Events:

After fifteen minutes of cold application to the skin, vasoconstriction begins in both the venules and arterioles. The smooth muscles increase their muscle tone relaying the message to the body's sympathetic nervous system. This causes an increase in secretion of epinephrine and norepinephrine. As the velocity of the blood flow slows, its viscosity thickens. (Prentice and Bell, 1999). Please refer to Figure 6 outlining the vascular response to cold application. Continuous application of cold for periods greater than fifteen minutes, will cause vasodilation of the blood vessels for approximately four to six minutes. This is referred to as the hunting response (Knight, 1995). It acts to protect the tissue from the dangers of prolonged cold exposure. However, the tissue temperature does not return to levels maintained before the application of cold (Knight, 1995). Thus, the body still benefits from the exposure of cold.

Figure 6: Vascular Response to Cold Application. (A) Cold induced vasodilation. (B) Knight proposes that a dilation follows the initial vasoconstriction, however the diameter is still less than the original diameter. (Prentice, 1990).



Much of the damage suffered by tissues after an injury is due to an occluded blood supply. During the acute state of an injury, there is often a considerable amount of edema as well as an aggregation of cells that migrate to the trauma site to repair the damaged tissue. The application of cold slows the metabolic rate of the cell thereby decreasing its need for oxygen. Thus, the instance of secondary tissue necrosis actually decreases. Similarly, the decreased metabolic rate actually lowers the incidence of muscle spasm due to a decreased amount of cellular waste. Cellular waste when accumulated in a localized area, acts as an irritant to the cell. As a protective measure, the muscle spasms, attempting to limit the amount of toxins exposed to its' tissues.

Studies concerning the effect of cold modalities and the reduction of edema are inconclusive (Baker and Bell, 1991). Much of the faith has been lost in the effectiveness of cold with regards to decreasing edema. Likewise the mechanisms surrounding this phenomenon are unclear. A study by Cote et al. (1988), published in Physical Therapy, reported that edema increased after an ankle sprain was immersed in cold water. Treating an acute injury with the RICE principle (Rest, Ice, Compression, Elevation) seemed to limit the amount of new edema formation and secondary tissues necrosis. However, it did not significantly decrease the amount of edema already present.

Wilkerson (1985) has contributed that the application of cold to an injury actually decreases inflammatory reaction. In turn, this relays a similar effect on the control of edema. Cold modalities decrease inflammation in the following ways:

1) Decreased synthesis of prostaglandins

2) Permeability to capillaries is less

3) Decrease of inflammation mediators such as enkephalin and beta-endorphins.

Table 4 describes the effects of cold on the body tissues (Starkey, 1993).

Table 4: Physiological Effects of Cold. (Arnehim & Prentice, 1993.)

Variable	Effect
Muscle spasm	Decreases
Pain perception	Decreases
Blood flow	Decreases up to 10 minutes
Metabolic rate	Decreases
Collagen elasticity	Decreases
Joint stiffness	Increases
Capillary permeability	Increases
Edema	Controversial

The application of cold lowers the sensitivity threshold of different nerve endings as well as the muscle spindle. Combined, these two effects help decrease a muscle spasm, through inhibition of the stretch reflex mechanism (Halvorson, 1990). The stretch reflex produces a reflex resistance to stretch as the Golgi Tendon Organs (the sensory part of the tendon) signals the muscle to relax in response to the stretch. This brief absence from spasm can lead to long-term relief. Since nerve conduction and the sensitivity of the muscle spindle are decreased, the ability to perform rapid movements after cold application is also decreased.

Whirlpools

Cold whirlpools are best suited for sub-acute or chronic injuries. Due to the force of gravity exerted on the body part immersed in the tub, edema is more likely to form in the distal extremity instead of increasing venous return (Starkey, 1993). Therefore, in treating an acute injury, elevation and compression should be used after the cold tub to enhance lymphatic drainage. Secondly, immersing a limb in these tubs, places the individual at a risk of developing frostbite in the digits unless covered with neoprene "booties". Furthermore, these tubs are not practical for treating the core area due to the large surface area to be immersed. However, when supervised closely, the cold tub offers an effective means of alleviating chronic pain and inflammatory conditions (Anderson & Hall, 1995). The turbines offer a therapeutic effect from moving water similar to that of a massage.

Similarly, the cold tub offers a great opportunity to practice active range of motion. When the limb is "numbed" by the effects of the cold, the athlete can often attain a greater range of motion. When the athlete is practising range of motion exercises without the application of cold, there is often a pain inhibition that limits the range attained by the athlete. The combination of cold and range of motion - cryokinetics - has proved to be very useful in overriding this response. Secondly, the buoyancy of the water aids the body in supporting the weight of the limb and assists it with active range of motion (Arnheim, 1995).

Ideally, this modality should be kept between 8-12°C. According to the previous author, the power switch should not be within reach of the athlete. Table 5 delineates a subjective guide to the perception of cold by the athlete in relation to whirlpool temperature.

Table 5: An Athlete's Perception of Cold (Arnheim & Prentice, 1993).

Descriptive Terms	Temperature
Very cold	> 55°F
Cold	55°-65°F
Tepid	80°-90°F
Neutral	92°-96°F
Warm	96°-98°F
Hot	98°-104°F

The tub should be turned on and off by the therapy staff. Both of these precautions should be taken to protect the athlete from electrical shock. The tub should be sanitized daily with a disinfectant solution to prevent the spread of contagious disease.

Ice Packs

Ice packs are available in three forms. The most common form being plastic bags filled with crushed ice. A second form is the re-useable ice pack, with the latter being a one-use cold pack (Starkey, 1993).

The conventional ice pack is the easiest and most cost effective to use. The therapist requires only plastic bags and cubed or crushed ice. They are disposable after usage. The re-usable pack consists of a gel, water, and antifreeze in a sealed pouch. Because this method does not actually use ice, it may lower the skin temperature below the freezing point. This places the athlete at risk for frostbite. To reduce this risk, a layer of towelling should be applied to alleviate the effects of the cold. A wet layer works better in transmitting the cold.

The latter modality - the instant cold pack - involves a chemical reaction. The two chemicals, which are organically separated from one another, combine to release cold when the barrier separating them is ruptured. This barrier is usually ruptured by shaking the pack. This does not usually offer relief for as long as the other methods nor does it cool the affected area to the same temperature (Prentice, 1990). Although convenient to store in a therapist's kit for emergencies, they can be expensive since they offer a one time usage. Furthermore, if not supervised properly, the athlete may be at risk of developing serious chemical burns to the skin if the pack ruptures or leaks.

All cold modalities decrease the tissue's need for oxygen. The incremental drop in tissue temperature lowers the metabolic rate of the cell. Therefore, the incidence of tissue necrosis decreases. An effective duration time for cold modalities is fifteen to twenty minutes. It is important to note that because the effects of cold are lasting, cold modalities should not be applied more than once every two hours (Starkey, 1993).

Heat

The application of heat is known as thermotherapy. Thermotherapy, however, is contraindicated in the acute stage of an injury. Heat is defined by the internal vibration of the molecules within the body (Prentice, 1990). Conversely to cold, heat increases the activity of cellular molecules. Unlike cold applications, the different forms of heat offer both superficial and deep heating. Superficial heat is indicated for sub-acute conditions to alleviate pain and inflammation. This method produces a lower tissue temperature at the lesion site in relation to the higher temperature at the superficial tissues. Deep heating is normally used when the injury is in the later stages. The application of heat has a direct effect on the body's metabolism. Generally, the rate of metabolism increases by 13% for each 1 degree Celsius increases in tissue temperature (Starkey, 1993).

Physiological Effects:

Heat is transferred and absorbed by conduction, convection, conversion, and radiation. The response elicited from the body depends on a number of factors:

1) the type of heat applied

2) intensity of the treatment

3) duration of the treatment

4) the type of tissue being stimulated (Arnheim & Prentice, 1995).

There is great debate about exactly how the body responds to thermotherapy. Yet it is known that there is an optimal temperature range for the modality. Too little heat is ineffective while too much heat can destroy a cell. When heat is used properly, the following benefits are achieved:

1) increased collagen extensibility

2) decreased joint stiffness

3) decreased pain/spasm

4) decreased inflammation

5) increased blood flow thereby decreasing cellular wastes and edema in the post-acute stages healing (Prentice, 1999).

Table 6 describes the body's response to the application of heat as proposed by Starkey (1993).

Table 6: Physiological Response to Heat (Starkey, 1993).

Condition	**Response to Therapy**
Muscle spasm	Decreases
Pain perception	Decreases
Blood flow	Increases
Metabolic rate	Increases
Collagen elasticity	Increases
Joint stiffness	Decreases
Capillary permeability	Increases
Edema	Increases

Heat, like cold, stimulates sensory nerve endings to alleviate pain. This may occur through the release of endorphins or through a gate control mechanism (Starkey, 1993). Heat brings an increased flow of blood to the area; this has a number of secondary effects. The metabolism of the cell increases which assists in protein synthesis of the structure. The temperature of the area increases and the pH falls. Thus, the exchange of nutrients and oxygen across the cell is encouraged by the capillaries. This process ensures that the oxygen needs of the cell are met (Starkey, 1993)

Superficial heat directly causes an increase in the superficial skin as well as indirectly heating deeper structures. The increase in tissue temperature and blood flow causes the same response in muscle primarily through conduction (Anderson & Hall, 1995). Of course there are contraindications to the application of superficial heat that must be observed:

1) do not apply heat over areas where there is a loss of sensation

2) heat should not be applied in the acute stage of an injury

3) heat should not be applied over the eyes or the genitals

4) do not place heat on the abdomen of a pregnant woman

5) heat should not be applied over infected cuts or lesions

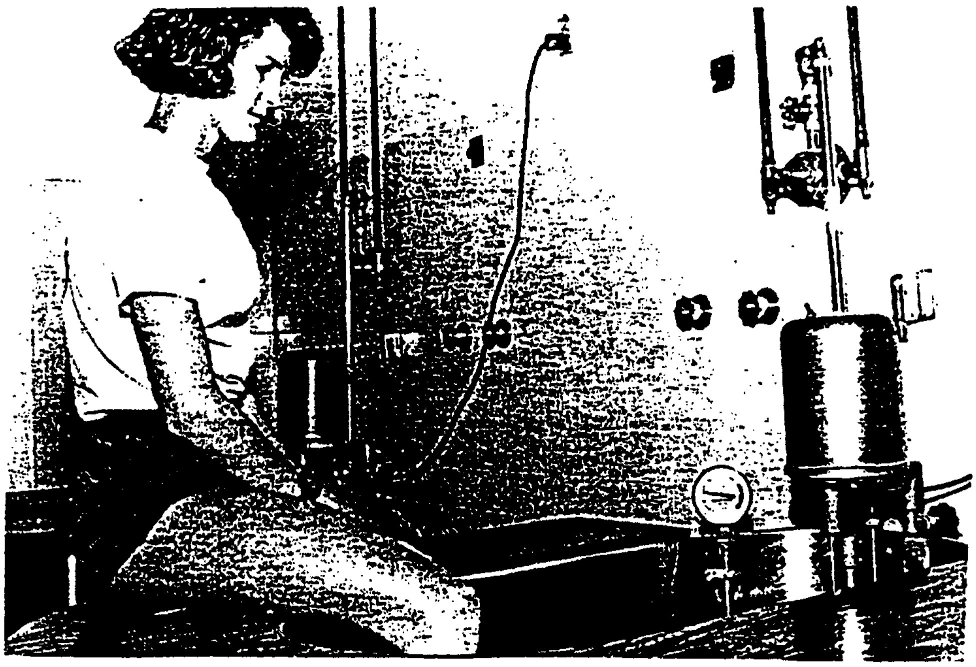
Table 7 shows the indications and contraindications of thermotherapy as noted by Anderson & Hall (1995).

Table 7: Indications and Contraindications of Thermal Therapy (Anderson & Hall, 1995).

Indications	Contraindications
Subacute or chronic injuries to :	Acute inflammation or injuries
Reduce swelling, edema, ecchymosis	Impaired or poor circulation
Reduce muscle spasm/guarding	Subacute or chronic pain
Increase blood flow to:	Impaired of poor sensation
Increase ROM prior to activity	Impaired thermal regulation
Resolve hematoma	Malignancy
Increase tissue healing	Patients, either elderly or infants, who cannot report their reactions
Relieve joint contractures	
Fight infection	

Similar to cold whirlpools, hot whirlpools offer a similar therapeutic environment. Active exercises are supported by the buoyancy of the water. Joints which are stiff can achieve greater ROM due to increased extensibility of tissue and the decrease of chronic muscle pain and spasm. However, it is difficult to maintain a constant temperature in the tissues due to the large loss of heat through dissipation (Starkey, 1993). Figure 7 on the following page illustrates the use of a warm whirlpool.

Figure 7: Use of A Warm Whirlpool (Arnheim & Prentice, 1993).



Heat Packs

Hydrocollator packs use moist heat. They are kept in a hydrocollator at a temperature of 160°-170°F. These packs contain a silicon gel covered by a cotton shell. Figure 13 on the following page displays a heat pack being removed from a standard hydrocollator. The heat pack needs to be covered by two terry cloth covers (2) and a towel (for sanitary reasons). Heat and water are maintained in these packs for approximately twenty minutes. Figures 8 and 9 on the following pages show a common hydrocollator.

Figure 8: Hydrocollator (Arnheim & Prentice, 1993)

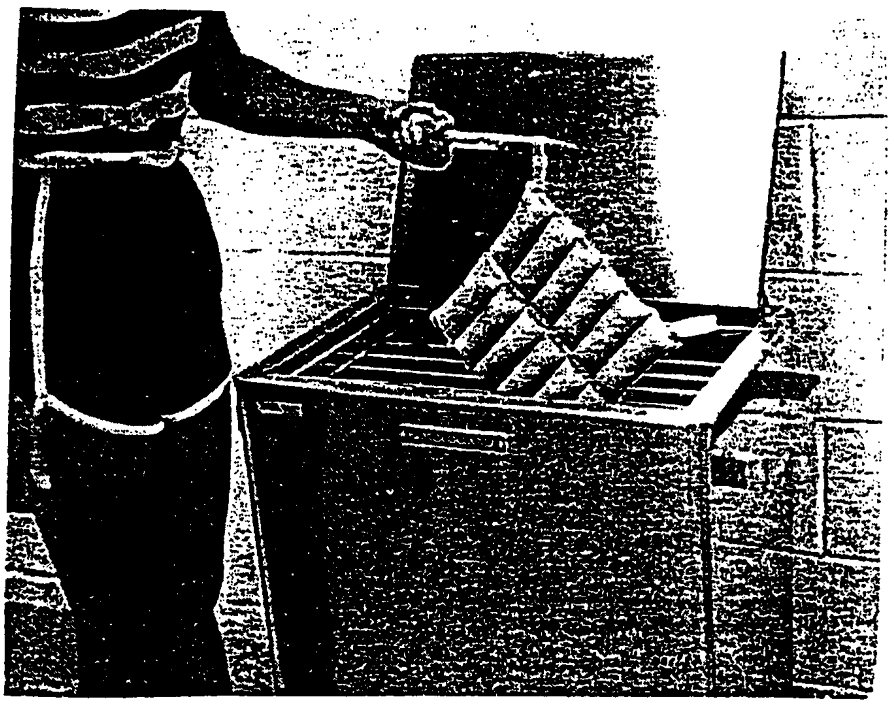
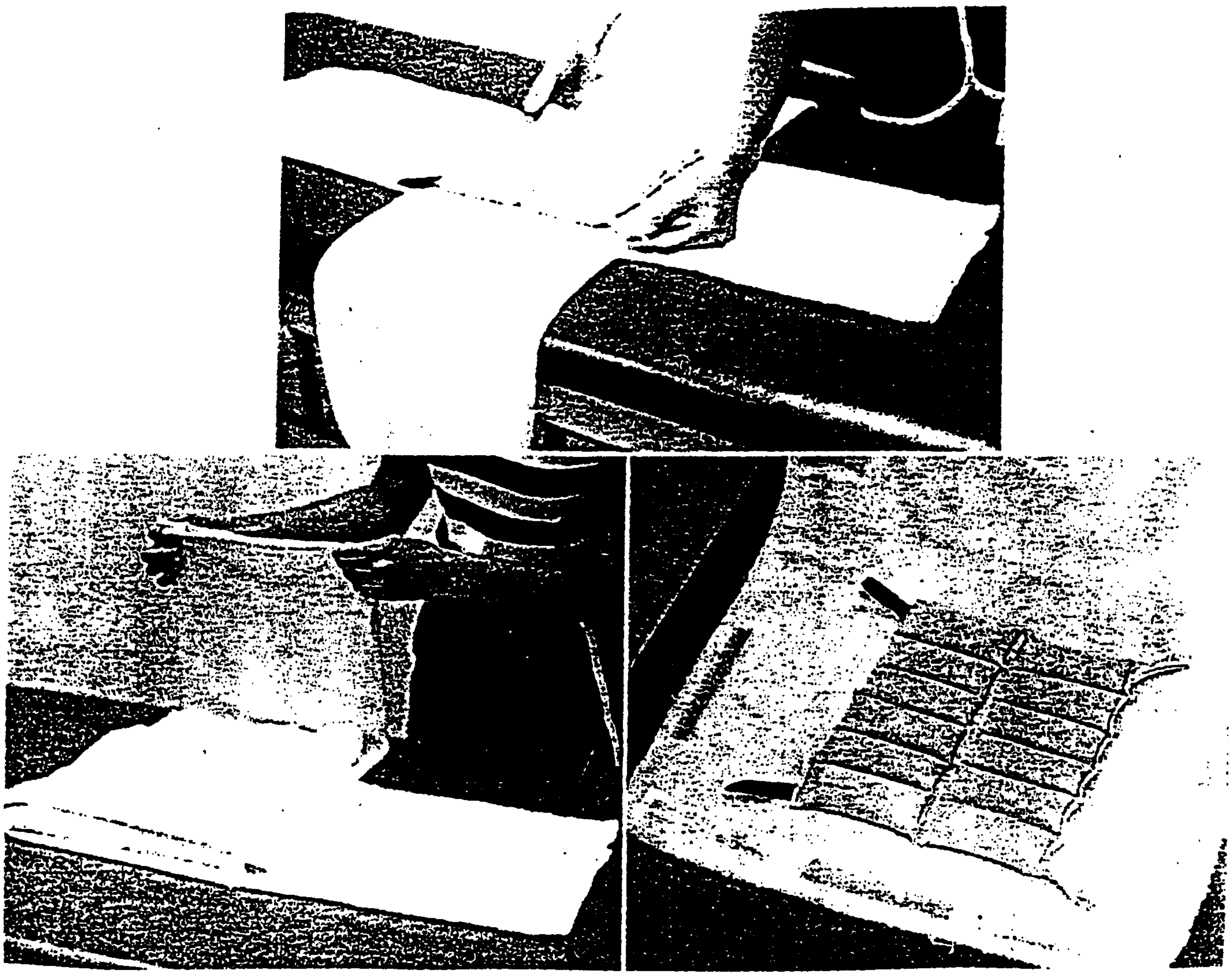


Figure 9: The Use of a Towel Covering when Utilizing Heat Packs (Arnheim & Prentice, 1993).



The application of such heat relaxes the muscles releasing tension. It inhibits the pain-spasm-ischemia-hypoxia-pain cycle (Starkey, 1993). However, heat packs do not transfer heat to deep structures. Thus, this form of thermotherapy is beneficial only for superficial structures. Subcutaneous fat, acting as an insulator, prohibits heat transfer to the deeper structures. This transfer of heat is also affected adversely by an increased blood flow to the skin. The increased blood flow carries the heat away from the site of application in an attempt to cool the skin preventing cellular damage (Lehmann and DeLateur, 1982).

Contrast Baths

Contrast baths involve the athlete alternating between hot and cold modalities. Either stationary applications or whirlpools may be used to apply the contrast. Generally, the modality from which the effects are most desired concludes the treatment. This form of therapy is generally used to treat injuries of the extremities. The temperature ranges should facilitate a mild temperature increase in the limbs. The result is a cycle of vasoconstrictions and vasodilations of the blood vessels in the treatment area. This simulated pumping action causes an increase in peripheral blood flow and aids venous return (Starkey, 1993). This "pump" increases vascular circulation in both the affected and contralateral limbs.

Applications usually involve two to three minutes of each modality alternated for approximately forty-five minutes. The most effective time ratio between modalities has yet to be determined, although Starkey (1993) notes that the most commonly used ratios are 3:1 or 4:1 (hot:cold). This treatment modality has been somewhat effective in eliminating edema and ecchymosis from areas that may be contraindicated to the use of electrical modalities. However, the efficiency of this modality is often disputed by many authors. There are some conditions for which contrast baths may be indicated. For example, due to the close proximity of the sternalclavicular joint to the heart, it is not possible to use IFC to decrease the effusion in the joint. Contrast applications would be ideal in an attempt to achieve the rehabilitation goals for this injury.

Ultrasound

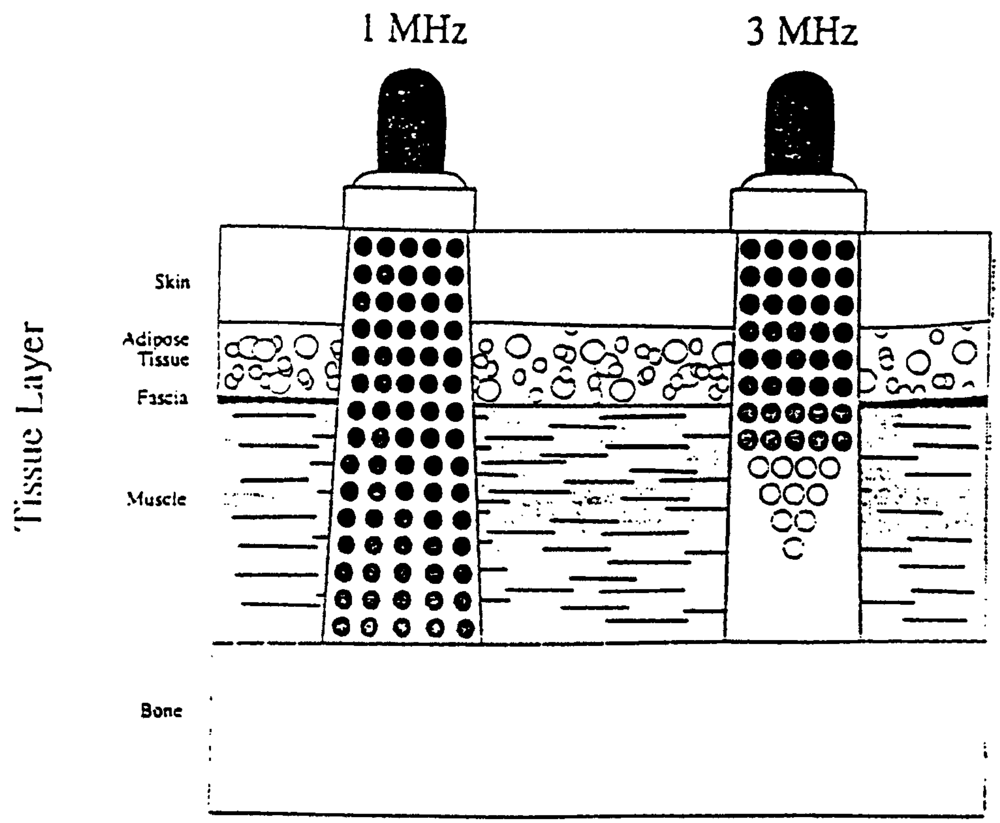
Therapeutic ultrasound is one of the most widely used modalities for treating injuries. Gann (1991) defines ultrasound as 'inaudible, acoustic, mechanical vibrations of high frequency that produce thermal and nonthermal physiological effects." Therapeutic ultrasound has frequencies usually ranging from 0.7 to 2 MHz which differs from diagnostic ultrasound which can have frequencies up to 10 MHz. The most common frequency used for therapeutic purposes is 1 MHz. Ultrasound is generally used to decrease pain and spasm, increase the extensability of collagen fibres, and to reduce inflammation.

Therapeutic ultrasound has been documented for over forty years as a means of stimulating the repair of soft tissue injuries as well as pain relief (Dyson, 1987). It is commonly used to treat soft tissue injuries such as tendinitis, sprains, and strains. However, it has also been shown to be useful in the breakdown of exostoses, bony growths or prominences. Furthermore, ultrasound is an effective way of diagnosing stress fractures in the early stages of the injury. The vibration of the waves over the affected area will cause pain for the athlete if the bone is indeed fractured. The incidence of its usage continues to rise as therapists recognize its effectiveness. Moreover, when used properly, it is a very safe modality of choice for the patient. Yet, if used improperly, the beneficial effects can be decreased or tissue damage may result. In an effort to ensure that the modality is used properly, the equipment must be calibrated by a certified medical technologist and the staff must be trained regarding proper usage, indications and contraindications, and the physiological effects of ultrasound.

Ultrasound is generated through the conversion of electrical energy into mechanical waves. Modern ultrasound machines generally consist of a high-frequency generator joined to a handheld applicator containing the transducer head. The transducer heads can come in varying sizes (Klafs & Arnheim, 1981). It contains a crystal that vibrates when the current is applied. Changing the size of the head directly affects the amount of divergence in the tissues. Today's machines allow you to set the intensity of the treatment, whether or not the treatment will be pulsed or continuous, the duty cycle (amount of time that ultrasound is present during a pulsed cycle), and the treatment time. If a pulsed setting is chosen, the "on" time is generally one or two microseconds followed by an "off" time of one, two, or eight microseconds. Generally the transducer head effectively radiates within a $5cm^2$ area of the target tissue. However, this is dependent on the size of the transducer (Gann, 1991).

The use of gel to ultrasound a body part is called direct coupling. The gel is needed to decrease the air bubbles between the skin and the transducer head. A liberal coat should be applied to cover the skin to reduce the reflection of energy with the air. When applying ultrasound to an irregularly shaped body part or an area covered with body hair, the efficacy of the ultrasound is decreased leading to a decline in the amount of ultrasound energy transferred (Dyson, 1987). Since there is considerable reflection of the mechanical waves at the air tissue interface, it is necessary to use a coupling agent to combat the reflection. A water-based gel is the most commonly used. This decreases the amount of energy lost as well as facilitating the ease of moving the head over the tissue due to the lubrication. In an effort to reduce attentuation – a decrease in energy as radiation passes through a material (Cameron, 1999), the therapist must ensure that the head is in contact with the skin at all times. It is recommended that the head forms an angle of no greater than 15° with the surface of the skin to prevent loss of energy. However, the head must not remain stationary. It can be moved either in a circular or longitudinal pattern slowly yet continuously with each stroke overlapping the last. The movement of the transducer head should ideally cover 2 - 4 cm per second to deliver an adequate amount of energy (Dyson, 1987). Figure 10 on the following page exhibits the difference in depths of penetration between two transducer heads of different frequencies.

Figure 10: Penetrating Ability of 1MHz head compared to 3 MHz head (Starkey, 1993).



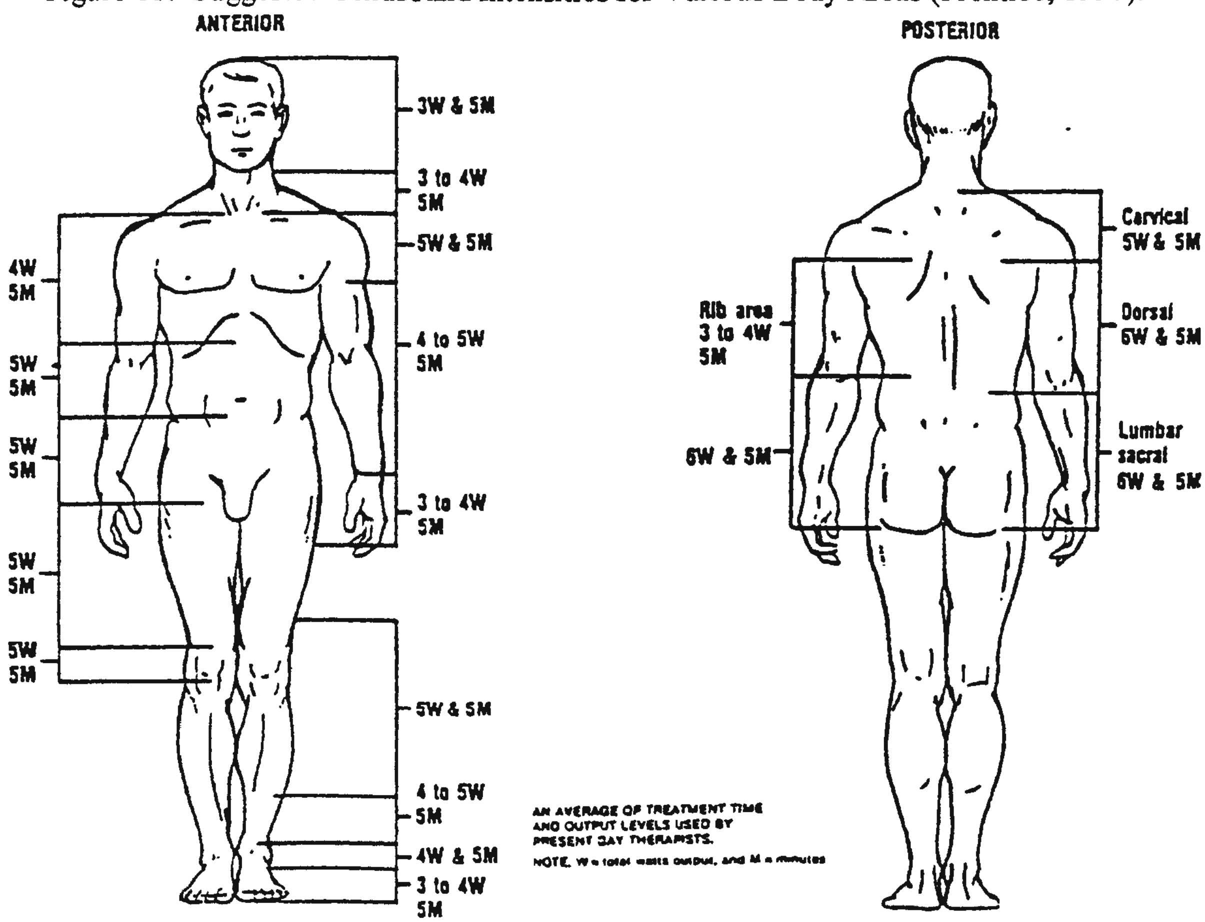
If the above circumstances are not met, reflection occurs at the tissue. This can occur in one of three ways (Gann, 1991). First, it may occur at the periosteum or surface of the bone. This often causes pain especially at higher intensities. Secondly, if reflection occurs at the tissue-air interface, the mechanical waves are reflected back to the skin by the air causing heating. A third way of obtaining these areas of excessive heating is through improper use of the transducer head. Refraction of the waves occurs when the transducer is not held at an adequate angle. Furthermore, it must be assured that the stationary technique of treatment is not used even when the ultrasound is pulsed. Due to the formation of standing waves, blood cell aggregates may form in small blood vessels resulting in a reduction or halt of blood flow. Moreover, the endolethial linings of venous cells can suffer damage possibly leading to the formation of blood clots (Dyson, 1987). Additionally, an excessive heating of one small area can cause pain (Kottke et al., 1982). When deciding on the appropriate intensity of ultrasound application, Prentice (1990), recommends considering the following factors: desired amount of tissue temperature elevation, the tissue that you want to treat, and the size of the injury. The body's tissues exhibit different cellular make-up. For this reason, some tissue absorbs more of the energy than others. For example, fat does not absorb much of the energy from ultrasound, however, tendons absorb a great deal due to their high protein content (Starkey, 1993). Additionally, surrounding structures need to be considered when deciding on an appropriate intensity. Superficial areas in the vicinity of bone may be susceptible to periosteal heating. When this occurs, pain will be experienced before heat can be transferred into surrounding tissues. It is recommended that a treatment time of five minutes for an area of 5 to 6 square inches is sufficient to elicit desired results (Dyson, 1987).

The choice to use a pulsed or continuous mode of ultrasound has been highly debated. Unfortunately, there is no standard protocol outlining clear-cut instances when one should be used over another. The therapist should base their choice depending on the physiological effects of the tissue that they want to achieve. As a general rule, pulsed ultrasound is used when thermal effects are not desired. Yet both pulsed and continuous methods can produce nonthermal effects. Pulsed ultrasound produces a lower average intensity throughout the treatment time. This type of application relies on the duty-cycle parameter. Ultrasound machines usually have a 20% or 50%, duty cycle. This equals the proportion of time that the waves are actually oscillating.

The nonthermal effects of ultrasound are generally indicative of pain relief. Therefore, it is generally used in the acute phase of an injury when additional heat would be hazardous. The nonthermal effects of ultrasound have been attributed to two principles: cavitation and acoustic streaming (Prentice, 1990). The compression and expansion of gas bubbles, known as cavitation, alters the mechanical and chemical properties of the cells. This causes the diffusion of ions across the cellular membrane. Like all sound waves, the longitudinal waves of energy experience reflection, refraction, penetration, and absorption. As the wave travels through the medium, the wave comes into contact with the bone. At this point, some of the energy is converted into transverse waves while some is reflected. This transfer of energy causes the cell to acquire kinetic motion causing the cell to vibrate. Standing waves may result when the incident wave meets the reflective wave (Starkey, 1993). A standing wave would create areas of high and low pressure. Air bubbles agglomerate in areas of low pressure; whereas freely moving cells migrate to the areas of high pressure. This causes an area of high energy confined to a small space, increasing the stress on the tissue (Starkey, 1993).

Energy that is not reflected or absorbed by the tissues is transferred to deeper structures. Some of the intensity of the ultrasound is lost as it travels through the tissue. This is called attentuation. Therefore, when deeper structures are injured, energy is lost through each layer of tissue as the wave finally reaches the desired location. Energy is absorbed by surrounding tissues and converted from mechanical energy into thermal energy (Prentice, 1990). Figure 11 outlines suggested ultrasound intensities relative to various body areas (Prentice, 1990).

Figure 11: Suggested Ultrasound Intensities for Various Body Areas (Prentice, 1990).



An ideal coupling agent transmits a large proportion of the energy reflecting very little. Williams (1993) states that distilled water is the ideal coupling agent. It has been found to reflect only 0.2% of the energy. Many modern ultrasound machines will shut off automatically if the coupling agent is unsuitable. Utilizing an ultrasound with a nonconductive medium can damage the transducer head.

There are several contraindications for the use of ultrasound. The modality should not be applied over areas of decreased sensitivity or poor circulation. The application of heat to this area may cause excessive heating which may go unnoticed, ultimately causing damage to the skin. Due to the principal of cavitation, ultrasound should not be used over fluid-filled cavities such as the eyes and spinal cord due to the possible unstable formation and eruption of the bubbles. Finally, ultrasound should not be applied over cancerous growths or undiagnosed lumps due to the resulting increase in cell metabolism (Starkey, 1993).

The nonthermal effects of ultrasound are generally indicative of pain relief. Therefore, it is generally used in the acute phase of an injury when additional heat would be hazardous. The nonthermal effects of ultrasound have been attributed to two principles: cavitation and acoustic streaming (Prentice, 1990). The compression and expansion of gas bubbles, known as cavitation, alters the mechanical and chemical properties of the cells. This causes the diffusion of ions across the cellular membrane. In turn this alters the metabolism of the cell. The actual vibrations of the cell aids in the destruction of scar tissue and fibrous adhesions. Acoustic streaming can be defined as the movement of fluids along the cell membrane. Such movement is thought to be enhanced by the mechanical pressures on the cell. This too increases the metabolism of the cell and reduces the amount of waste products in the cell (Starkey, 1993).

Conversely, the thermal effects of ultrasound are desired when treating overuse, chronic or sub-acute injuries. These injuries desire a large amount of heat and respond well to its application. Continuous ultrasound is effective in increasing the extensability of collagen fibres, increasing blood flow to the area, and increasing the activity of enzymes (Starkey, 1993). In order to attain the thermal effects of ultrasound, the temperature needs to reach 40-45°C within the tissue, and needs to be applied for at least five minutes to be effective. Dyson (1987) has proposed the following non-thermal and thermal effects of ultrasound:

Non-thermal:

- promotes tissue regeneration
- soft tissue and bone repair
- increased blood flow
- decreased pain
- promotes cell metabolism

Thermal :

- increased extensibility of collagen

- decreased joint stiffness
- decreased pain/spasm
- increased velocity of nerve conduction
- produce mild inflammation reaction, which increases blood flow to the area helping to resolve inflammatory problems
- protein synthesis (High frequency 3 MHz)

Table 8 outlines the physiological effects of ultrasound according to Starkey, (1993).

Table 8: Physiological Effects of Ultrasound (Starkey, 1993).

Nonthermal Effects	Thermal Effects
Increased cell membrane permeability	Increased sensory/motor nerve conduction
Increased vascular permeability	Increased extensability in collagen-rich structures
Increased blood flow	Reduction of muscle spasm
Synthesis of protein	Increased blood flow
Reduction of edema	Reduction of pain
Tissue regeneration	

Ultrasound is a method of deep heat application. This modality raises the temperatures of tissues 2-5 cm beneath the skin through the process of conversion. Secondary to this, is the transfer of heat to nearby structures through conduction. Once again, it cannot be stressed enough that the therapist must consider the effects that ultrasound can have on the surrounding structures. This modality remains a separate entity from other therapeutic modalities because of two aspects (Gann, 1991). First, there is no use of electromagnetic radiation. Secondly, the penetration of the treatment is not affected by the attentuation of fat. Its' ability to offer both thermal and nonthermal effects sets it aside from other modalities. Ultrasound is a well-respected modality among sport medicine professionals. However, when used incorrectly, it can be more of a liability than a benefit.

Neuromuscular Electrical Stimulation

Neuromuscular Electrical Stimulation (EMS) is used primarily to re-educate muscle fibres, prevent muscle atrophy or to increase the strength of muscle contractions (Prentice, 1994). Usually such instances are likely after a muscle has incurred a large trauma such as immobilization for a cast, or nerve damage as a secondary complication to an injury. The use of such a device rearranges the normal recruitment order of muscle fibres (Arnheim & Prentice, 1993). Normally small diameter type I fibres are recruited first. Although they do not generate a large amount of force, they are easily fatigued. Type II fibres, the larger of the two, are recruited last. These fibres are easily fatigued yet can generate a lot of torque. With the use of an electrical muscle stimulating unit, the above order is reversed. Type II fibres, because of their ability to generate a lot of force, will strengthen the contraction elicited by the muscular unit (Arnheim & Prentice, 1993).

It is known that the reversal of the recruitment order is due to the cross-sectional area of the nerve fibres as well as the depth of their location beneath the skin. EMS preferentially stimulates type II fibres because their large cross-sectional area offers less resistance to the flow of current (Starkey, 1993). Likewise, due to the fact that type I fibres lie much deeper than type II fibres, the latter are stimulated first. Due to the impedance to electrical flow offered by the body's tissues, the deeper the current travels, the less effect it has on deep tissues.

Neuromuscular stimulation offers the strongest electrical current and is often the most uncomfortable for the athlete. The increased pain is primarily due to the increased pulse duration. Lake (1992) has found that when EMS is being used to elicit a stronger contraction, the intensity should be maximized according to the patient's pain threshold. However for the purpose of muscle re-education, the intensity need only be enough to stimulate the nerve fibres.

EMS also increases the amount of blood flow to the area primarily when the modality is used to elicit muscle contractions. The contraction produces a "pump" bringing new blood to the area and removing cellular waste. A second explanation for the increased blood flow is the increased metabolic rate that results from the muscle contraction. The pumping action is also a contributing factor to the role of EMS in the reduction of edema (Starkey, 1993). A frequency of 1-10 pps is suitable to attain these contractions. It should only be strong enough to achieve a visible contraction. It should not be strong enough to move the corresponding joints.

A bipolar electrode placement is generally used for EMS. The electrodes can be placed at the insertion and origin of a large muscle group. This promotes a much generalized contraction. When smaller electrodes are used and placed closer together, a more localized contraction is achieved. However, as the electrodes are placed closer together, the effects of the stimulation are increasingly superficial and the intensity of the contraction decreased (Prentice, 1994).

Treatment for muscle atrophy can be given constantly through the use of a portable stimulator much like the TENS unit. EMS for the purpose of strengthening muscle contractions can be administered daily. However, such treatments should be monitored for pain and/or tissue state decrements.

The application of the electrodes on the belly of the muscle allows the patient to experience a passive contraction without any voluntary effort. Although maximum benefit comes from a ramp time of 2-3 seconds, a longer ramp time will allow maximal levels of comfort for the patient. The rest period serves two functions: first it serves to counteract the development of a muscle spasm by allowing the muscle to rest between contractions. Second, it allows the muscle to sustain a longer contraction before fatigue sets in. Furthermore, electrical muscle stimulation allows a muscle contraction even when the athlete has a pain inhibition response resulting from joint diffusion or disuse (Prentice, 1999). This response would prevent the athlete from eliciting a voluntary response. Ultimately, it aids to progress a rehabilitation protocol that would otherwise be delayed. The following table describes some common uses of neuromuscular stimulation (Prentice, 1990).

Table 9: Common Uses of Electrical Modalities (Mellion, 1999).

Used For:	NMS	TENS	IFC	High Voltage	Medium Frequency
Acute/Chronic Pain	No	Yes	Yes	Yes	No
Acute Edema Reduction	No	No	Yes	Yes	No
Enhancement of Bone Healing	No	No	Yes	Yes	No
Muscle Strengthening	Yes	No	No	No	Yes
Muscle Reduction	Yes	No	Yes	No	No
Reduction of Muscle Spasm	Yes	Yes	Yes	Yes	Yes
Increase/Maintain ROM	Yes	No	No	No	No

Modalites are a widely used treatment option by Athletic Therapists. It is the mainstay of the rehabilitation protocol when manual therapy is not an option. The diversity that these modalities posess, offer alternative options for all types of injuries. The following table summarizes the effects of some commonly used electrical stimulation modalities.

Table 10: Indications and Contraindications of Electrical Modalities (Mellion, 1999).

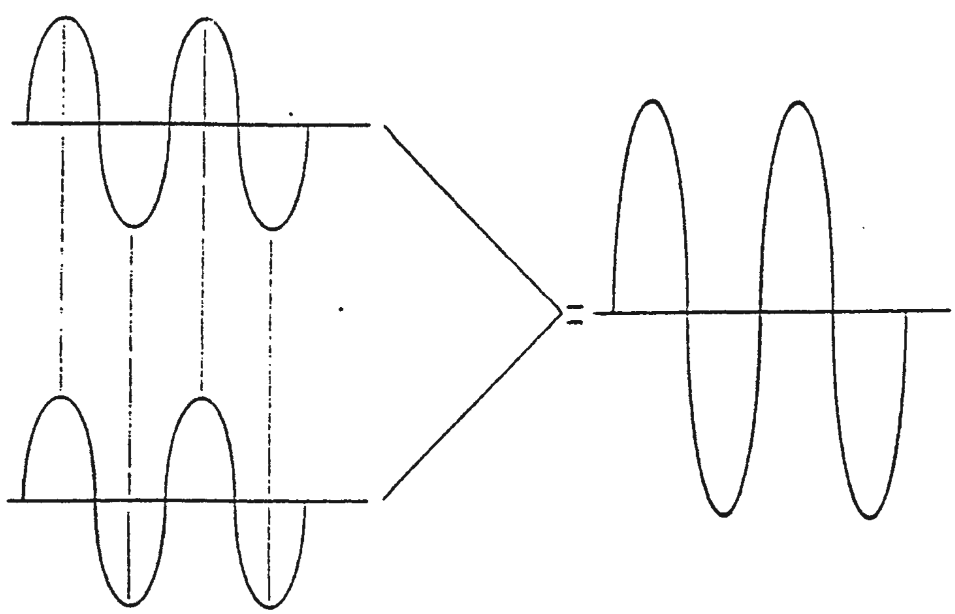
Modality	Indications	Contraindications
High Voltage EMS	Increase circulation & ROM Decrease pain & edema Decrease muscle spasm Delay disuse atrophy Muscle strengthening & re-education	Pacemakers Pain of unknown origin Pregnancy Thrombophlebitis Cancerous lesions Suspected fracture sites Superficial skin lesions
Low Voltage EMS	Facilitate nonunion wound healing Facilitate fracture healing Iontophoresis	Malignancy Hypersensitive skin Allergies to common drugs
TENS	Reduce chronic pain Manage postsurgical pain Analgesia	Pacemakers Pregnancy Pain of unknown origin
Interferential	Chronic edema Acute/chronic pain Increase circulation Reduce muscle spasm	Pacemakers Pregnancy Pain of unknown origin Prolonged use may increase muscle spasm or soreness

Interferential Current

Interferential Current (IFC) is a form of transcutaneous electrical nerve stimulation that is commonly used for pain relief, to increase circulation, and for minimal muscle stimulation. It generates two medium frequency, alternating currents on two separate channels. Medium frequency current is useful in overcoming the skin impedence which low frequency currents cannot overcome (Prentice & Bell, 1999). The current from each channel intersects each other to form a single frequency ranging from 1 to 100 Hz. Recalling basic wave principles from physics, the therapist must understand constructive and destructive interference to comprehend how IFC works. Constructive interference occurs when the waves are in perfect phase, with each wave crossing the baseline at the same point. Figure 12 on the following page depicts constructive interference.

Destructive interference occurs as the positive peak and negative peak meet at the same point on the baseline thus cancelling each other out. A combination of constructive and destructive interference is called a continuous interference pattern. This current which can be superimposed in the patient's body is called the quadripolar technique (Starkey, 1993). Alternatively, the bipolar technique superimposes the current in the machine. One current is generated at 4000 Hz. This high frequency current reduces the skin impedence, shortens the pulse width and makes the treatment more comfortable for the patient. The other current is variable. If for example, current A was set at 35 Hz, current B would be 4035 Hz. The resultant wave form, a pattern of interference, is referred to as beat frequency (Anderson & Hall, 1995).

Figure 12: Constructive Interference (Starkey, 1993).



The beat frequency can be varied in only one of the two carrier currents. This alteration can either be constant or sweeping. The sweeping frequency "sweeps" through a range of beat frequencies. This helps to reduce accomodation - an adaptation to an applied stimulus. The decision to select an appropriate beat frequency in beats per second (bps) should be placed on the following parameters (Starkey, 1993):

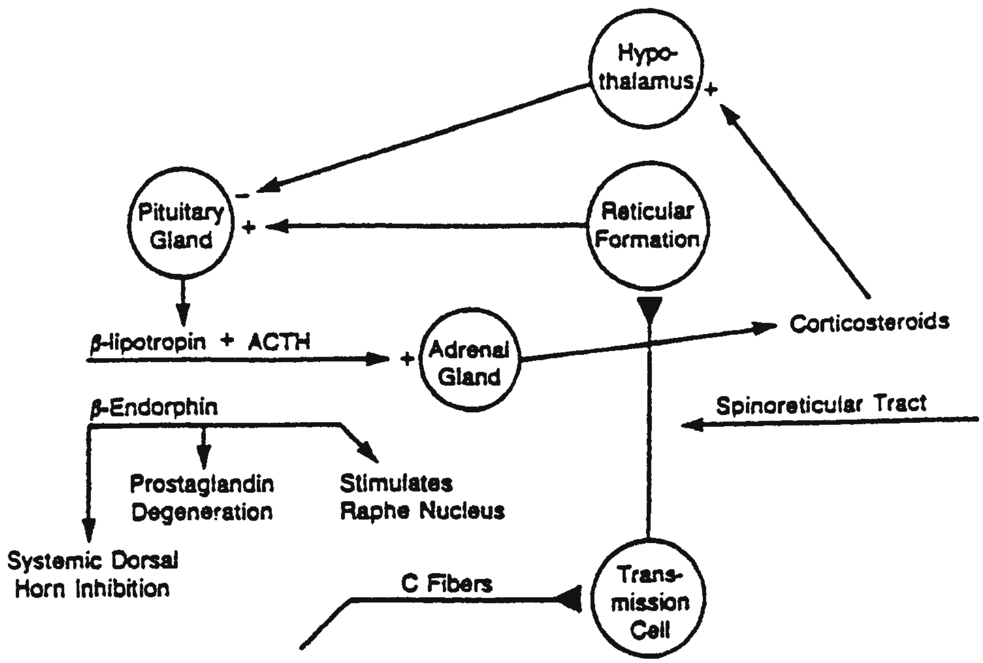
- 100 bps - pain management
- 50-60 bps - tetanic muscle contractions
- 1-50 bps - venous return (pumping action)

Traditionally, IFC has been used to control pain and to stimulate muscle contractions creating a pumping action. This "pump" promotes an increased blood flow to the area which serves to carry waste from the area (Starkey, 1993).

Pain Control

A high beat frequency, usually approximately 100 Hz, in combination with sensory nerve stimulation contributes to the gate control theory of pain. This theory proposed by Melzack and Wall in 1965 states that "a nonpainful stimulus can block the transmission of a noxious stimulus." Although many studies dispute the efficacy of this theory, there are alternate theories which are substantiated along the premise of the original theory. Figures 21a on the following page outlines the gate control pathway. IFC channels the current through the electrodes activating sensory nerves that reduce pain at the trauma site. The pain is transmitted along nociceptors receptors and nerves that carry pain impulses. Conversely, low beat frequencies, 2 to 10 Hz, in combination with electrical current is used to elicit motor changes such as muscle contractions (Wells, Frampton & Bowsher, 1988). This leads to a release of opiates – the body's natural way of obtaining pain relief. Figure 13 below outlines this theory.

Figure 13: The Opiate Pain Control Theory (Prentice, 1990).



Electrode Placement

The quadripolar technique involves placing the four electrodes (two for each channel) perpendicular to each other crossing the injured area. Such placement allows the current to cross the area at the lesion site. Ultimately, the current is re-directed at a 45 degree angle from the central point in four directions. A four-leaf clover pattern should be formed. Tissues lying within this area receive the maximal effects of the treatment (Starkey, 1993). It was originally thought that the maximal current concentration was found in the center of the electrode placement. The effects of the IFC should only be felt within the area encompassed by the electrodes and not under the actual electrode. Figure 14 outlines the four-leaf clover pattern that is produced by the IFC unit.

Figure 14: Four Leaf Clover Pattern (Starkey, 1993).

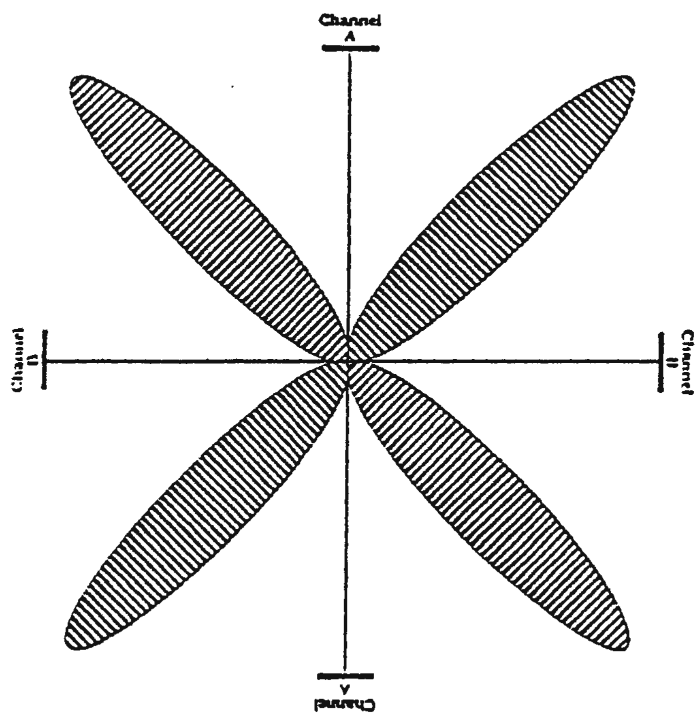
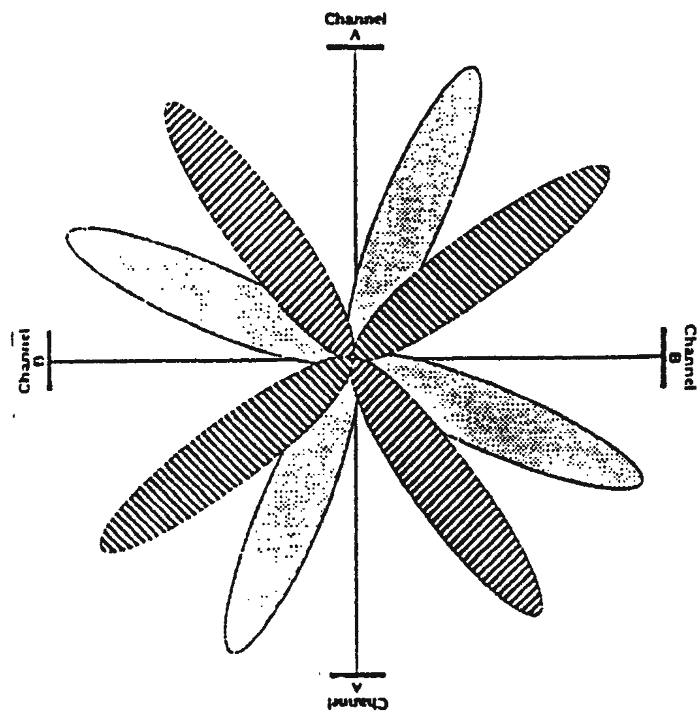


Figure 15 depicts the dynamic vectoring pattern that rotates the current throughout the treatment area to ensure that the total lesion site is elicited.

Figure 15: Four Leaf Clover Pattern With Rotating Current (Starkey, 1993).



The Bipolar technique of electrode placement mixes the current produced by the two channels in the IFC generator rather than in the body of the patient. Both channels are utilized, yet only one channel is applied to the body. This technique is used primarily to elicit muscle contractions. Unlike the quadripolar technique, the current does not penetrate tissues to the same depth. Instead, subcutaneous nerves are preferentially stimulated (Prentice, 1990).

IFC treatment times generally range from fifteen to thirty minutes and may be used once or twice daily. Patients who suffer from both acute and chronic pain as well as those suffering from muscle spasm make excellent candidates for IFC. However there are several contraindications which the therapist should be aware of (Starkey, 1993):

1) pacemakers

2) pregnancy (if treatment area is in the abdominal or pelvic region)

3) infection

4) cancerous areas

5) the carotid sinus

Most research notes that interferential current provides a greater depth of penetration accompanied by a larger surface area for penetration than most modalities. The modality offers the opportunity to customize many parameters making it suitable to treat a wide variety of injuries. It is a versatile modality which can be used on a large lesion area such as the quadriceps or a smaller area such as the wrist. Its'current is perhaps the most comfortable treatment option, and the modality acts to prevent accomodation so the patient receives the full effect of their treatment. Additionally, IFC is suitable for all injuries whether acute or chronic. The most noticeable effect of the IFC is the tingling sensation produced as the nerves respond to the current. This in turn increases the circulation to the area, delivers essential nutrients, and decreases the inflammatory response (Starkey, 1993). Ultimately, the modality helps reduce the irritation experienced by the nerves, and slows down the transmission of pain signals. With the addition of heat, the surrounding musculature can relax, thereby relieving spasm and contracture.

High-Voltage Pulsed Stimulation

High-Voltage Pulsed Stimulation (HVPS) is often used to complement other forms of therapy in an effort to control pain. This transcutaneous nerve stimulating current works to relieve pain, reduce edema, reduce muscle spasms, increase blood flow, and promote tissue healing (Anderson & Hall, 1995). The current delivered is a twin-peak monophasic form. It possesses a high peak but a medium current. The resultant waveform is monophasic with short pulse widths. Because of its' average current, HVPS cannot be used to stimulate denervated muscles (Starkey, 1993).

This treatment utilizes a direct current with a known polarity or direction. This particular current allows optimal penetration into the tissues. However, the conductivity of the tissues will affect the treatment parameters and success (Prentice,1990). The HVPS modality must utilize a voltage between 300-500 volts. The high voltage is combined with a short pulse width and a long interval between pulses to reduce the current to a level that is tolerable to the human body. This modality has a very short pulse duration that usually hovers around 100 microseconds. This duration permits the stimulation of both motor and sensory nerve fibres (Starkey, 1993).

HVPS is proposed to work through both the gate-control mechanism and the opiate release theory. The gate control theory states that electrically stimulating large sensory nerves when there is pain forces the central nervous system to acknowledge the electrical stimuli (Prentice, 1990). Therefore, for the duration of the electrical stimulus, the perception of pain is decreased. The stimulation causes the sensory nerves to fire, closing the gate to pain. However, if the patient develops accommodation to the stimulus, the gate is no longer closed, and the transmission of the pain signal will commence. Conversely, the opiate pain control theory states that the electrical stimulation of sensory nerves causes the central nervous system to release enkephalin accompanied by the release of beta-endorphins from the pituitary gland. These newly released chemicals are now free to bind to nerve cells to inhibit pain. Yet, the mechanism governing this theory is unclear.

High voltage stimulation allows a dual polarity of current. The treatment electrode should only be as large as the area being treated. A dispersal electrode is placed over a nearby large muscle along with a wet sponge to prompt the generator to transmit either positive or negative current. The dispersal electrode is always larger than the active electrode. Consequently, this electrode is usually placed proximally to the active electrode (Prentice, 1994). This electrode arrangement pattern is referred to as monopolar application. A positive current is used to solidify hydrous edema. That is, this application hardens edema which contains a lot of cellular exudate and promotes its reabsorption into the surrounding tissues. A vasodilation response occurs increasing the permeability of the cell thereby engulfing the surrounding fluid environment. Conversely, a negative current is often used to soften or break down hard or thickened scar tissue.

HVPS's implications for the control and reduction of edema can be explained through the electrical field model. When an electrical current passes through tissue, an electrical potential results. The combination of this potential and the normal rhythms of the human tissue are said to create a pumping action. When used in this capacity, a continuous mode should be used with a frequency of 80-120 pps for at least twenty minutes (Starkey, 1993). Conversely, when the aim of the treatment is to reduce the spasm cycle in the muscle, the muscle must be fatigued to produce a stronger than normal contraction. Furthermore, this protocol will interrupt the pain-spasm cycle. The same parameters for edema reduction can be used with the addition of the stimulation of motor nerves.

The following is a list of conditions for which HVPS may be indicated:

1) denervated muscle

2) to retard tissue atrophy

3) to decrease or control edema

4) to decrease spasm

5) to maintain ROM

6) to re-educate muscle fibers

7) to increase blood circulation (Prentice, 1994)

Conversely, there a few conditions for which HVPS are contraindicated:

- pacemakers
- pregnancy

- areas of increased sensitivity (Prentice, 1994)

Other contraindications which apply to electrical modalities in general will also apply to HVPS.

In summary, HVPS is an effective modality that elicits the same effect as trans cutaneous neuromuscular stimulation (TENS). Although useful for acute injuries, it also shows promise in the treatment of chronic or overuse conditions. Consequently, it has the ability to stimulate motor nerve fibres although this is not its' primary role. There is some debate as to its' effectiveness when used on large muscle groups as there must be enough intensity to move the limb against the forces of gravity (Starkey, 1993). This modality provides analgesic pain reduction much like that attained through the use of a TENS machine. It is fully operational without any effort of the patient. This attribute makes it a popular modality of choice.

In summary, the following table (Table 11) originally published in the The Professional Journal for Athletes in 1998.

Table 11: Summary of the Efficacy of HVPS (Professional Journal for Athletes, 1998)

Effect	Current Type	Intensity	Frequency	Pulse Duration	Electrodes	Mode
Edema	Monophasic	Sensory	80-120 pps	20-200 usec	Negative over	Continuous
reduction					area of edema	
Neuromuscular	Monophasic	Motor	<15 pps twitch	300-500 usec	Negative over	Alternate duty
stimulation			>40 pps tetany		ends of muscle	cycle
Pain Management						
- Gate Control	Monophasic	Sensory	100-150 pps	100-200 usec	Positive over	Continuous
					pain site	
- Opiate Release	Monophasic	Motor	1-5 pps	300-500 usec	Positive for acute,	Continuous
					negative for chronic	
					over pain site	

Trans Cutaneous Electrical Nerve Stimulation

Trans Cutaneous Electrical Nerve Stimulation (TENS) was initially developed as a screening device to assess the sensory response of patients and to determine the proper placement of electrodes implanted along the spinal cord to control pain (Starkey, 1993). The popularity of the modality grew when patients were experiencing success from the surface electrodes applied to the skin. Moreover, the risk of complications arising from implanted electrodes along the spinal cord warranted the implementation of a new method of pain control (Starkey, 1993). TENS is used primarily for pain control. Nonetheless it may be used to elicit muscle contractions. Ultimately, through the use of TENS, an athlete's perception of pain is modified due to the electrical current. This altered level of pain can be achieved through the gate control theory or the opiate release theory as explained earlier in the IFC section. The variable parameters of the TENS treatment will determine the path through which the patient's pain is alleviated. These parameters include amplitude, frequency, and pulse durations (Prentice, 1994).

The first documented success of TENS was recorded by Melzack and Wall in the 1960's. As mentioned previously, it was these individuals who proposed the gate control theory of pain. Much success has been found regarding the use of TENS for both chronic and acute musculoskeletal pain. However, TENS proves to have little effect on the reduction of pain from visceral or psychogenic sources (Prentice, 1994).

As the parameters for TENS treatment are varied, the outcome is also variant. In addition to the nature of the parameters, there are many external elements which contribute to the effectiveness of the treatment. Jette (1986) proposes the following variables:

1) the nature of the pain. Is it acute, or chronic?

2) the placement of the electrodes

3) the intensity of the stimulation

4) the pain threshold of the individual

There are three forms of TENS treatment. Each has a different pulse rate, pulse duration, intensity. Table 12 summarizes the three.

Table 12: Summary of the three forms of TENS Treatment (Starkey, 1993)

Parameter	High TENS	Low TENS	Brief-Intense
Intensity	Sensory	Motor	Noxious
Pulse frequency	50-100 pps	1-5 pps	100-150 pps
Pulse duration	30-200 μsec	200-500 μsec	250-500 μsec
Mode	Modulated rate	Burst	Modulated
Duration	As needed	30 minutes	15-30 minutes
Onset of relief	<10 minutes	20-40 minutes	<15 minutes
Duration of relief	Minutes to hours	Hours to days	<30 minutes

High Frequency TENS

This mode of TENS treatment is used primarily to achieve pain relief from acute conditions. Patients often state that they feel a "pins and needles" sensation. This mode of TENS provides the fastest relief from pain; although this relief is very short lived (Jette, 1986). According to the opiate release theory, the relief will only last as long as the pain inhibitor exists. Enkephalin only has a half-life of 45 seconds (Starkey, 1993). However, the relief is achieved from disrupting the pain-spasm cycle allowing the muscles to relax. It has been proven effective in relief from myofascial pain, inflammatory conditions, and post-operative pain. The therapist should be vigilant for the presence of muscle contractions as this would be a contraindication when treating an acute soft tissue injury.

High TENS works at the sensory level. Such treatment activates the “gate” at the spinal cord to modify the patient’s pain. The painful impulses travel along small-diameter nerve fibres at a slow rate. Conversely, other sensory information travels at a much quicker speed along large-diameter fibres. Because of the short pulse duration and high frequency normally used with TENS treatment, sensory A fibres are preferentially stimulated (Starkey, 1993). The increased activity in these fibres activates the T-cells in the dorsal horn of the spinal cord closing the gate. The closed gate prohibits the transmission of pain fibres along the C-fibres (Starkey, 1993).

Mannheimer & Lampe, (1984) have found the following parameters to work effectively with the use of high TENS:

- Pulse Rate - between 75-150 pulses per second
- Pulse Width - narrow, usually around 60 microseconds
- Amplitude - increase slowly until discomfort is felt or a slight muscle contraction is achieved, and then decreases it slightly.

With the use of these parameters, a decrease in pain should be felt within ten to fifteen minutes.

One of the major concerns with using High TENS is the patient becoming accustomed to the current. If the parameters are not changed, it is plausible that the athlete will adapt to the current and the desired effects will not be achieved. In an effort to diminish this, most modern generators have built in cycles to modify the parameters. The athlete should be instructed on how to adjust the amplitude level to contend with the accommodation factor (Prentice, 1994).

Low Frequency TENS

Pain-relief achieved from Low TENS is achieved through the release of beta-endorphins from the pituitary gland into the central nervous system (Starkey, 1993). These hormones relieve pain similar to the use of narcotics. The primary pain relief occurs through a negative feedback loop within the central nervous system. First the athlete is made aware of the painful stimulus. When travelling through the midbrain, the release of endogenous opiates is stimulated. From here, the impulse travels down the motor pathways to the spinal cord. It is at this point that the opiates inhibit the release of substance P, which is a neurotransmitter that causes pain. This loop effectively blocks the transmission of pain (Jette, 1986).

Low rate TENS elicits a motor response rather than sensory fibre recruitment. The duration of the treatment is shorter than high TENS, with treatment usually lasting only thirty to sixty minutes. Patients do not experience immediate pain relief with Low-

Rate TENS. Pain relief is felt thirty to sixty minutes after treatment. However, the duration of pain-relief is longer (Ottoson & Lundeberg, 1993) due to the four hour half-life of beta endorphins. For this reason, this mode of TENS is usually used to treat chronic pain conditions resulting from deep tissue or myofascial damage.

Mannheimer & Lampe, (1984) have found the following parameters to work effectively with the use of low rate TENS:

- Pulse Rate - 1-5 pulses per second
- Pulse Width - 200-300 microseconds
- Amplitude - adjusted to elicit a strong, regular contraction within the tolerable limits of the athlete.

It is proposed in some literary sources that the application of high TENS before low TENS will offer both immediate and prolonged relief from pain. The high TENS should be applied for at least twenty minutes before it is switched to the low TENS mode. It is found that there is less accommodation to this method of treatment. However, this theory has not been substantiated.

Brief Intense TENS

Often called noxious-level TENS, this mode diminishes pain impulses at the brain stem. A noxious stimulus is applied briefly to trigger the release of opiates. Although treatment times generally last from seconds to several minutes, immediate pain relief is evident (Starkey, 1993). Due to the transitory effects of this treatment, brief intense

TENS may not be indicated for acute or chronic pain. Instead Bechtel and Fan (1985) state that brief- intense TENS should be included in the treatment regime before rehabilitation exercises. Dulling the patient's pain for a short period of time will permit them to complete their exercises which are an integral part of their recovery. The intention of this mode is to provide a strong contraction at a low current to make the treatment more comfortable for the athlete. There is a great variance in the literature with regards to the parameters of treatment. However, it is of general consensus that the treatment should last from twenty to sixty minutes.

Electrode Placement

There are many ways of placing electrodes for use with TENS treatment. Most TENS machines use four electrodes, two from each channel, similar to IFC machines. When used with four electrodes, the placement is much like that of the IFC. The crossing electrode placement is logical, yet so is the parallel placement (Starkey, 1993). The latter involves the electrodes from each channel placed parallel to the lesion area on one side of the injury.

Likewise, the therapist can choose direct or contiguous placement. Direct placement positions the electrodes directly over the injury area with each channel running parallel to the body's midline. Contiguous placement is ideal when TENS is used to treat pain from lacerations or surgical incisions. It involves electrode placement in the surrounding area but not over the exact lesion where electrical current is contraindicated (Prentice, 1994). This mode may use parallel or crossed electrode placement as explained above.

Conventional TENS can be used daily or as needed for pain relief. Therapists often give patients a portable TENS machine to carry around throughout the day. However, the athlete should be instructed on how to adjust the intensity of the unit as well as how to disconnect the unit before going to bed. It should be noted that TENS units are symptomatic ways of pain relief and therefore existing pain is often masked underneath its effects. Alternatively, Low Frequency TENS may be applied as usual, with treatment times not to exceed thirty minutes. Additionally, Intense Burst TENS should be applied no more than once daily for no more than half of an hour (Ottoson & Lundeberg, 1988).

TENS units have evolved into a wide variety of machines that offer additional parameter settings. Some of these modifications are confusing and offer no additional benefit to the patient; while others have been exercised in an effort to afford more comfort and relief for the patient. The general contraindications that apply to the other modalities apply to TENS as well. The ease of mobility of the TENS unit allows the patient to continue the use of the modality throughout the day while at work or at home. This ensures longer lasting relief and a speedier return to activity.

Massage

Swedish massage involves a group of techniques which are designed to relax the muscles. It accomplishes this effect through the application of pressure against other structures or by rubbing into the direction of the lymphatic system. Stroking the tissue in this manner will assist venous return from the limbs back to the heart and circulatory system (Mellion, 1999).

This increased circulation is imposed without any stress or overload on the heart. It also serves as a means of relieving muscular stress and strain from a build-up of metabolic wastes. The metabolic wastes, such as lactic acid and uric acid, when accumulated at high levels, will cause fatigue, soreness and or/stiffness (Arnheim & Prentice, 1999).

Swedish massage was developed by Ling who believed that vigorous massage increased circulation of blood and lymph. This is turn was thought to promote a state of optimal healing. Everyone can benefit from massage, yet massage therapy has proven to be instrumental in therapeutic advances in the field of sports. Sports massage has proven to be of key benefit to athletes before, during, and after competition. This type of massage, a sub-discipline of Swedish massage, has been shown to be of benefit to athletes in preparation for their competition. Likewise it helps the body rejuvenate from the stress that exercise places on the body. Stress resulting from exercise can cause fatigue, sore, over-stretched tendons and ligaments, and a build up of metabolic wastes in the muscles. All of these stressors can be detrimental to an athlete's performance. Hence, sports massage has been seen as a mode through which to combat these training adjustments (Anderson & Hall, 1995).

Sports massage enhances circulation, loosens fibrous adhesions, loosens muscles, and removes toxins from within the muscle (Hungerford, 1999). Sports massage *does not* provide a quick fix to the damage occurred from high-intensity training. However, it does help the body restore its natural healing processes.

At the 1984 Olympics, sports massage was made available to athletes for the first time. However at that time, sports massage consisted only of compression and cross-fibre friction. Today, sports massage can be classified as follows (Hungerford, 1999):

1) Pre-race - usually given the day of, or the night preceding the event

2) Pre-competition - usually given 15 to 45 minutes before the competition

3) Post-event - given after the race is over

4) Post-competition - given days after the event is completed

5) Inter-competition - given during competition such as during time outs

6) Intra-competition - massage during a several day competition

7) Rehabilitation - used to rehabilitate the athlete from injury

8) Training/conditioning - usually involves the techniques of pre-event, post-event, and rehabilitation. Such a method is often used during peak competition times

Although sports massage stems from the art of ancient massage, its goals are independent. Massage therapy aims to promote relaxation and inner peace. Aromatherapy oils and music are often used to foster a peaceful environment.

Conversely, sports massage does not aim to relax the participant in the same manner. Generally, the goals of sports massage are (Soderquist & Cobelli, 1996):

Pre-event - used to prepare the athlete for the upcoming competition. The athlete's flexibility should be optimized. The therapist will strive to increase tissue pliability to optimize metabolic exchange.

Post-event - focuses on relieving the stress and tensions built up in the muscles after intense competition. According to the aforementioned authors, when performed effectively post-event massage can help prevent delayed onset muscle soreness (DOMS). It also helps maintain an adequate oxygen supply to the muscles.

Rehabilitation - this form of massage is used to treat an acute problem such as a muscle strain. It can also be used to prevent a chronic problem from becoming more troublesome. The ultimate goal of this form of sports massage is to return the athlete to competition with less pain and discomfort.

It is important for athletes and therapists to remember that pain is not necessary to achieve the best results. Inflicting pain on the athlete will not speed up the healing process. In fact this may set the athlete back even further. The athlete first has to recover from the damage incurred from working too deep, too fast. Then they have to recover form the original injury itself.

For the purpose of a brief overview, the following four techniques (explanations and illustrations) were introduced by Nadine Currie (BPE, R.M.T.) during the annual Sports Massage Seminar offered to U.N.B. Athletic Therapy Practicum students:

1. Effleurage - direction of flow is upwards towards the heart and lymph system. Its primary purpose is to promote venous return. Consequently, it aids in the removal of waste from the cell thereby facilitating the exchange of nutrients at the cellular level. This is due in part to the increased blood flow to the area which causes vasodilation of the cells. Furthermore, cell permeability is increased. The application of light pressure aids drainage of lymph vessels and promotes good muscle tone. Effleurage is commonly used to begin the massage or as a transition between strokes. Moreover, effleurage is beneficial when deeper strokes are contraindicated. Local and absolute contraindications to massage are discussed below.

2. Petrissage - this stroke functions similar to a pump. The therapist alternates pressure and relaxation to promote a "milking action" within the muscle. Due to its superficial involvement, petrissage is used to treat muscular or subcutaneous ailments. In addition to improved circulation and muscle tone, this stroke can loosen or stretch tissue adhesions, muscle fibres, and fascia. Generally therapists using petrissage will lift the muscle away from the periosteum of the bone allowing fluid to escape. The muscle is then squeezed before allowing it to fall back into place. Alternatively, the therapist may use a wringing stroke across the width of a muscle. This functions to compress the tissues against one another. The rate of these strokes will depend on the results that the therapist desires.

3. Tapotement - this stroke involves using the fingers, the borders of the hand, or a fist to bang the muscles. This stroke relies on the hands "springing" off the tissue. Tapotement can be fast or slow and can use heavy or light pressure. It is important for

the therapist to be familiar with the anatomy of the body in order to decide when heavy pressure is or is not appropriate. This stroke also increases circulation and promotes blood flow to the active area. Moreover, it has been shown to be effective in breaking down fibrous adhesions. Tapotement is particularly beneficial for muscles that need to be stimulated.

4. Shakings - the massage therapist grasps the muscle and shakes it to provide stimulation. Of course, the amount of shaking will depend on the amount of stimulation desired. Again this component of sports massage promotes venous return, increases circulation and loosens tight structures or adhesions. For this reason, shakings are often used where an increased ROM is desired.

Massage therapy, like other forms of treatment, has contraindications which may worsen the pre-existing condition or cause a new problem. The following is a list of general contraindications to massage therapy:

- local edema
- hemophilia
- myocardial infarction
- high or unstable blood pressure
- fever
- infectious skin disorders
- frostbite
- irritable skin conditions such as eczema or psoriasis
- burns

- unknown/undiagnosed lump
- a hernia or herniated discs
- contusion - especially a Charley House or myositis ossificans
- any area of active inflammation

Massage therapy manipulates the soft tissues in such a way to benefit athletes therapeutically, physiologically, and psychologically. The resultant vasodilation response "warms" the extremities, reduces muscle spasm, and reduces soreness. In addition to promoting a feeling of relaxation, it aids in the recovery of sore or injured muscles. Subjectively, massage therapy relieves discomfort, increases an athlete's pain threshold, and can contribute to an improved performance. Objectively, massage increases blood flow to the area, breaks down scar tissue or fibrous adhesions and reduces the spasm in the muscle (Soderquist & Cobelli, 1996). The concept of sports massage remains a relatively new addition to the field of sports medicine. Surely, it will continue to hold a greater place in the rehabilitation program as more athletes attest to its' benefits.

Flexibility

Flexibility is defined by Blanke (1999) as "the ability to move the joints of the body through the range of motion (ROM) for which they are intended." Each of the body's joints is designed to allow a specific amount of movement. An individual is considered inflexible, when the normal degree of movement cannot be produced.

The type of joint (saddle, plane, and hinge), the connective tissue surrounding the joint as well as the associated musculature are all factors which affect the amount of ROM at the joint. As we stretch the connective tissue, we achieve both plastic and elastic deformation (Blanke, 1999). That is, the connective tissue which returns to its normal length after being stretched exhibits elastic properties. Conversely, those fibres which retain their elongated position after stretching are said to be plastic. In order to become more flexible, plastic deformation is desired. Blanke (1999) notes that maintaining a low-tension stretch for a longer period of time achieves a greater amount of plastic deformation. Moreover, tissues with elevated tissue temperatures respond better to plastic deformation.

As there is considerable variation in the amount of ROM at each joint, a table for the purpose of illustration can be found at the end of this section.

The ideal level of flexibility depends on the athlete. Each athlete will require more movement from some joints due to the demands of their sport. For example, runners will require greater hip flexibility than will a swimmer whereas the swimmer will need more ROM at the shoulder than will the runner. Therefore, it is the therapists' role to assess which joints are hypermobile and hypomobile and to adjust the athlete's flexibility training accordingly. A hypermobile joint can be equally as troublesome as a hypomobile joint. Joints which have excessive motion are often unstable. This makes the joint particularly susceptible to sprains usually because of the elongated position of the tissue. A hypomobile joint is more prone to suffering muscular damage. The applied force is transmitted through the surrounding musculature due to the rigidity and stability of the joint itself (Anderson & Hall, 1995). The following table (Table 13) published by the American Academy of Orthopaedic Surgeons states the average range of motion found at the joints of the body.

Table 13: Average Range of Motion of the Body's Joints (American Academy of Orthopaedic Surgeons.)

Average Range of Joint Motion

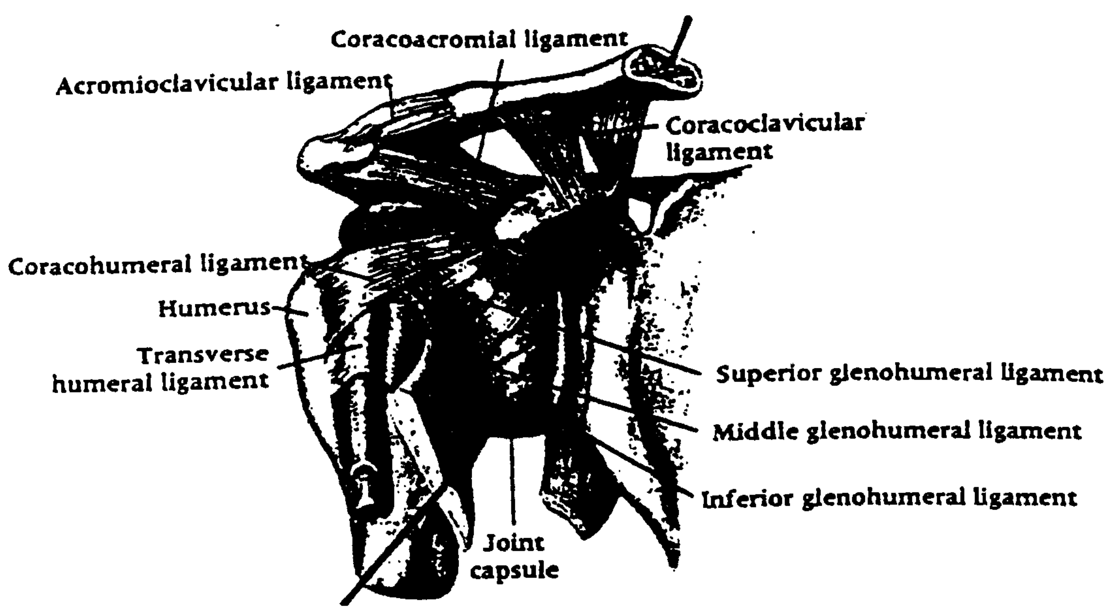
JOINT	ROM IN DEGREES	JOINT	ROM IN DEGREES
Shoulder		**Hip**	
Flexion	158	Flexion	113
Extension	53	Extension	28
Abduction	170	Abduction	48
Adduction	50	Adduction	31
Horizontal flexion	135	Horizontal flexion	60
Arm at side		Hip in flexion	
Internal rotation	68	Internal rotation	45
External rotation	68	External rotation	45
Arm in 90° abduction		Hip in extension	
Internal rotation	70	Internal rotation	35
External rotation	90	External rotation	48
Elbow		**Knee**	
Flexion	146	Flexion	134
Hyperextension	0	Hyperextension	10
Forearm		**Ankle**	
Pronation	71	Plantar flexion	48
Supination	84	Dorsiflexion	18
Wrist		**Hind foot**	
Extension	71	Inversion	5
Flexion	73	Eversion	5
Ulnar deviation	33	**Fore foot**	
Radial deviation	19	Inversion	33
Thumb		Eversion	18
Abduction	58	**Great toe**	
I-P flexion	81	I-P flexion	60
M-P flexion	53	I-P extension	0
M-C flexion	15	M-P flexion	37
I-P extension	17	M-P extension	63
M-P extension	8	**2nd to 5th toes**	
M-C extension	20	Distal I-P flexion	55
Fingers		Middle I-P flexion	38
Distal I-P flexion	80	M-P flexion	35
Middle I-P flexion	100	Extension	40
M-P flexion	90	**Cervical spine**	
Distal I-P extension	0	Flexion	38
Middle I-P extension	0	Extension	38
M-P extension	45	Lateral bending	43
		Rotation	45
		Thoracic and lumbar spine	
		Flexion	85
		Extension	30
		Lateral bending	28
		Rotation	38

Common Injuries

Acromioclavicular Sprains

Acromioclavicular Sprains are what is commonly referred to as "separated shoulders". The usual mechanism of this injury is direct contact to the superior aspect of the acromion. Common examples of this injury are falling on an outstretched hand, or through direct contact with the boards, or falling hard on the playing surface. The resultant force drives the scapula inferiorly away from the clavicle. The integrity of the coracoclavicular ligaments, which acts to stabilize the acriomioclavicular joint, may be compromised (Arnheim & Prentice, 1993). Figure 16 shows the associated ligaments in the shoulder complex.

Figure 16: The ligamentous structures of the shoulder (Arnheim & Prentice, 1993).



The extent of the sprain depends on the amount of force applied and the extent of damage to the coracoclavicular ligaments. Most classification systems are based on the degree of distal clavicular displacement, the integrity of the coracolclavicular and acriomioclavicular ligaments as well as the integrity of the fascia covering the deltoid and trapezius muscles (Levine, Flatow, & Bigilani, 1998). Rockwood et al. (1994) have recently classified acromioclavicular sprains as grades 1-5.

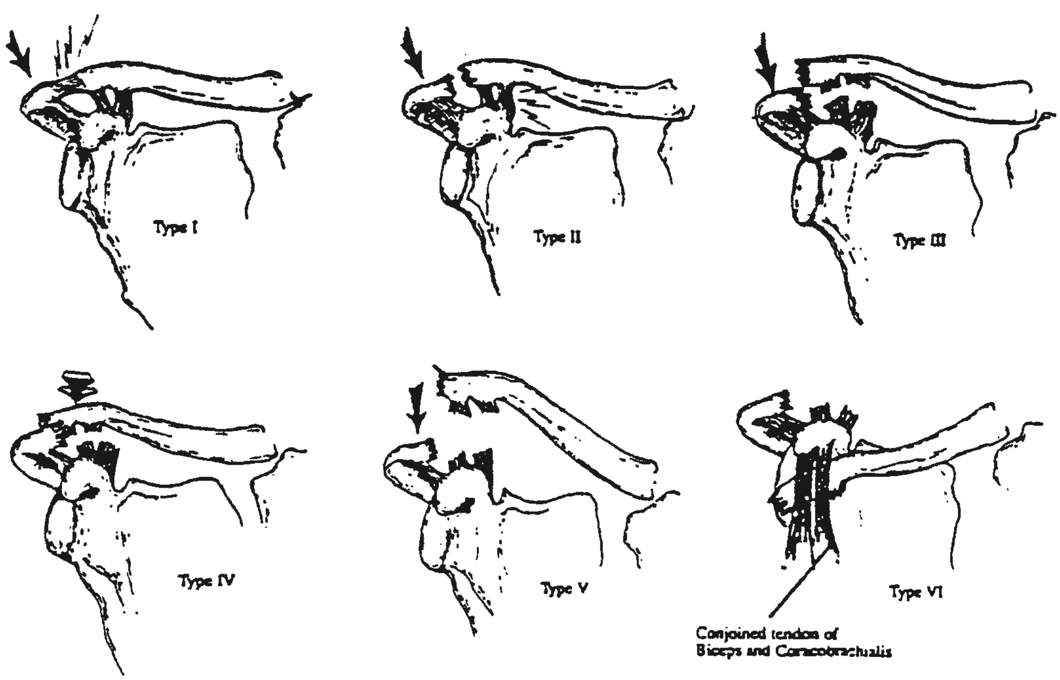
- Grade 1 - normal x-ray, no visible disruption
- Grade 2 - integrity of the acriomioclavicular (AC) ligament is damaged with no associated damage to the coracoclavicular (CC) ligament
- Grade 3 - damage to both the AC and CC ligaments
- Grade 4 - a type 3 sprain with posterior displacement of the clavicle
- Grade 5 - a type 3 sprain as well as damage to the fascia of the deltoid and trapezius; accompanied by superior displacement of the clavicle. Figure 17 on the following page offers a visual guide to the above descriptions.

Most AC sprains (Grade 1&2) do not require operative treatment. However, there are a small percentage of those injuries that do not respond well to non-operative measures. Return to activities may take days or weeks and should not be initiated until the athlete possesses pain-free ROM. This return usually occurs within two to three weeks in the majority of athletes.

All AC sprains will present point tenderness of the acromion process. Grade 2 and 3 sprains will manifest pain over the coroclavicular space. When the coroclavicular ligaments are torn, there is usually deformation. This is commonly called a "step-deformity". The clavicle rides high creating a step. It is important to note that this deformity does not need to be present in order for the sprain to be of a serious nature. With an injury of this nature, the surrounding musculature goes into a protective spasm in an effort to minimize the damage sustained. This guarding often limits the appearance of the "step deformity" (Arnheim, 1995).

The initial treatment of AC sprains should be symptomatic. A sling should be used to immobilize the arm, with ice and anti-inflammatories used as needed. Once the initial symptoms subside, complete rehabilitation of the shoulder should follow.

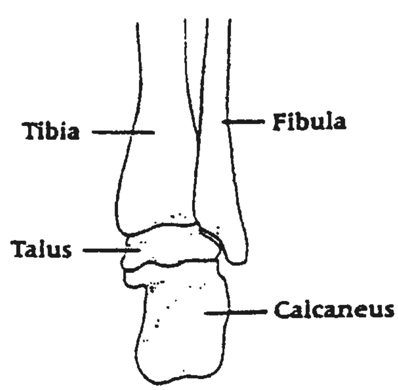
Figure 17: Classification of AC Sprains (Rockwood et al., 1996).



Lateral Ankle Sprains

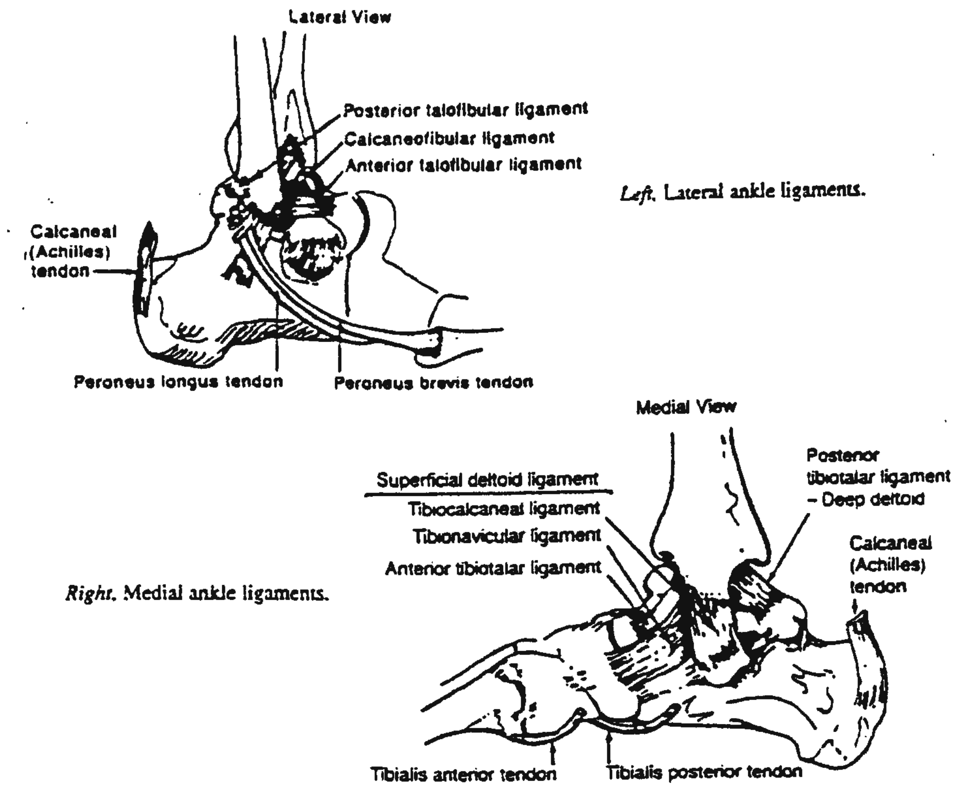
Inversion sprains are the most common acute ankle injury (Bunch et al., 1985). Sprains of the lateral ligament complex and the peroneal tendons account for 85% of all ankle injuries. Fortunately, such injuries respond well to rehabilitation alone (Garrick and Webb, 1999). Lateral ankle sprains can occur from running on uneven surfaces, landing from a jump, or cutting and weaving. Garrick and Webb (1999) state that approximately 25% of these injuries are reoccurring. Figure 18 outlines the structures that form the ankle joint.

Figure 18: The Ankle Mortise. (Reimer, 1999) in Mellion, (1999).



Early signs of injury will include localized edema around the anterior talofibular ligament and calcaneofibular ligament. Furthermore, there is usually discoloration or bruising in the associated area. The athlete will complain of pain localized to that area. Their ambulation will be limited to a limp and crutches may be required. Some athletes report hearing a crack or pop when the injury occurred. Figure 19 entails the ligaments of the ankle mortise.

Figure 19: The Ankle Ligaments (Reimer, 1999 cited in Mellion, 1999).



The initial treatment for an ankle sprain is RICE. When the elevation factor is ignored, the edema and ecchymosis moves downwards into the forefoot and toes. Diffuse pain and point tenderness usually accompany this (Anderson & Hall, 1995).

Differentiating between Grade 1, 2, and 3 sprains involves "stress-testing" of the ligaments. The degree of laxity and end feel found when testing the ligament will attest to its integrity. The following special tests are commonly employed:

1) anterior drawer - tests the anterior talofibular ligament

2) hyperdorsiflexion - tests the calcaneofibular and deltoid ligament

3) hyperdorsiflexion with external rotation - tests the anterior tibialfibular ligament.

4) percussion - tests for fractures of the calcaneus

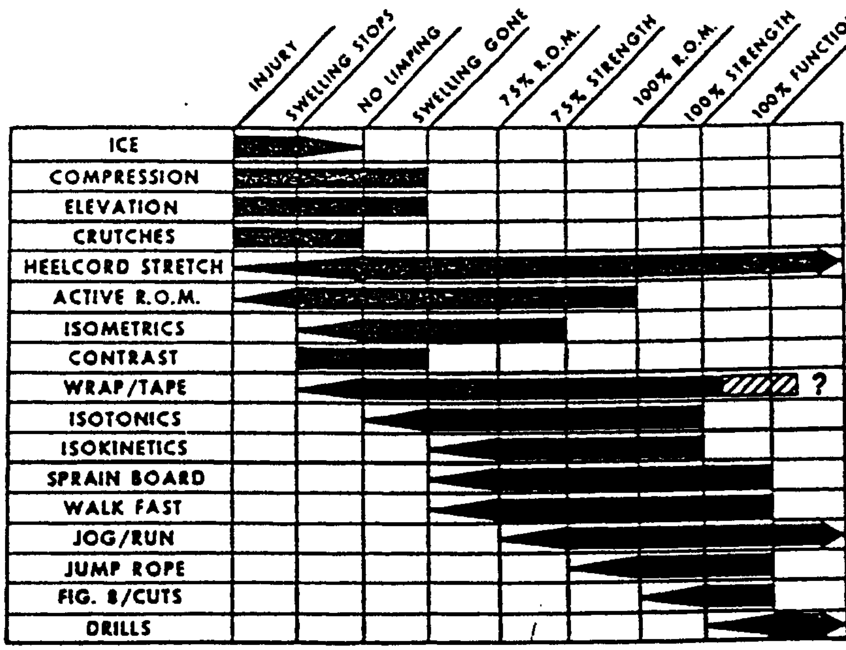
Table 14 outlines the common mechanisms of ankle sprains and ligament damage.

Table 14: Classification of Ankle Sprains (Anderson & Hall, 1995)

Mechanism	1st° (Mild)	2nd° (Moderate)	3rd° (Severe)
Inversion and plantar flexion	Anterior talofibular stretched	Partial tear of anterior talofibular with calcaneofibular stretched	Rupture of anterior talofibular and calcaneofibular with posterior talofibular and tibiofibular torn (severe)
Inversion	Calcaneofibular stretched	Calcaneofibular torn Anterior talofibular stretched	Rupture of calcaneofibular, anterior talofibular with posterior talofibular stretched
Dorsiflexion	Tibiofibular stretched	Partial tear tibiofibular	Rupture of tibiofibular
Eversion	Deltoid stretched or an avulsion fracture of medial malleolus	Partial tear of deltoid and tibiofibular	Rupture of deltoid, interosseous membrane with possible fibular fracture above syndesmosis

Following the initial treatment of the ankle sprain, rehabilitation should begin immediately. Figure 20 on the following page describes a progressive ankle sprain rehabilitation program proposed by Garrick, 1981 cited by Mellion, (1999).

Figure 20: Progressive Ankle Rehabilitation Program (Garrick, 1981 in Mellion, 1999)



Myositis Ossificans

The anterior thigh is the most common site for the development of myositis ossificans in athletes. Garrick and Webb (1999) define myositis ossificans as the growth of heterotopic bone within the quadriceps muscle. Unfortunately, the pre-cursor to this condition, a thigh contusion, often goes mistreated. Rigorous stretching, heat, and massage to the injured area all contribute to the development of myositis ossificans and should be avoided. Therefore the therapist should ensure that all contusions to the thigh are followed-up and appropriate treatment if needed is provided. Development of this condition can end an athlete's season and furthermore limit participation in sports for another 4-6 months.

The athlete normally sustains a direct blow to the rectus femoris muscle. A contusion results from the contact. An example of a situation in which an athlete may sustain a contusion is that of a soccer player. A typical scenario would involve two players running for the ball, as they collide, player A's knee connects with player B's thigh resulting in a contusion for player B. Usually, the athlete sustains a second injury, continues to play, or is treated with massage, heat, and stretching before myositis occificans develops (Arnheim & Prentice, 1999).

The athlete usually does not complain of injury until they have been inactive for a few minutes. Initially, they will complain of point tenderness and limited knee ROM. The knee ROM is limited by a protective spasm in the quadriceps and swelling may occur immediately. Garrick and Webb (1999) have observed that the hematoma that forms may contain as much as 1000 ml of blood. Ecchymosis, or bruising, may not appear until one to two days post-injury. The force of gravity acting upon the area may pull the edema distally into the lower quadriceps or knee.

The knee should be placed in full flexion with compression and ice in an effort to decrease the pain and spasm (Hartley, 1990). Additionally, the athlete's pain-free ROM should be measured to determine the severity of the injury. Garrick and Webb (1999) propose that the athlete should lie prone to allow the passive range of flexion to be evaluated. They have introduced the following guidelines:

1) passive knee flexion less than 45 and 90 - contusion is serious, there is a great chance of developing myositis ossificans.

2) passive knee flexion between 45 and 90 - treatment protocol should be employed and athletic activity restricted for four weeks.

3) passive knee flexion greater than 90 - athlete's activity need only be restricted for 7-10 days.

Once the initial stage of the injury is managed, the aim of rehabilitation is to regain strength and flexibility in the quadriceps muscle. The rehabilitation process should begin with range of motion exercises, followed by isometric exercises then followed by isotonic exercises.

Stress Fractures

Stress fractures are very common in sports. However, they are very sport-specific. Stress fractures present two particular problems to the athletic therapist. First, they are difficult to diagnose, and secondly, the athlete's training regime must be altered to prevent their reoccurrence (Garrick and Webb, 1999). A highly trained athlete will develop a greater bone density due to their training practices than their untrained counterparts. But before the bone becomes stronger, it first weakens (Garrick and Webb, 1999) . It is during this state of vulnerability that stress fractures occur. Consequently, stress fractures occur as a maladaption to increased demands of the sport. Thus, modifying the demands of the sport or adapting the training regime is the key to preventing stress fractures.

The most commonly elicited cause of stress fractures is an activity change (Garrick and Webb, 1999). For example, stress fractures may manifest in the wrestler who is running daily as part of pre-season training. Secondly, the ballerina who is learning a new routine may develop a stress fracture from the unfamiliar technique. When an athlete presents a stress fracture, it is important to delineate the mechanism of the injury. If the cause of the stress fracture cannot be specified, the athlete will continue the same training pattern making his/herself increasingly vulnerable to injury.

Usually, the only symptom that the athlete will present is pain. The pain appears late in the activity often as a dull ache. In the later stages of the injury, pain is more constant and performance becomes sacrificed. If swelling does occur, it is late in the injury and is usually only present in the anterior compartment of the leg or metatarsals. Point tenderness in the involved area generally precedes swelling (Hartley, 1990). Unfortunately, the athlete is used to discomfort and is reluctant to report tenderness to the athletic trainer.

When examining the athlete, the therapist should look for areas of point tenderness. Garrick and Webb (1999) note that this painful area is usually one inch in diameter. To test the integrity of the bone, a percussion test is used. A positive test will elicit pain and discomfort in the athlete. Percussion tests can be performed with a tuning fork or by tapping the fingers over the bone.

If the athlete has been symptomatic for less than three weeks, referring the athlete for x-rays will be futile. Radiographic film will present nothing abnormal at this stage of the injury. If re-examined in two to three weeks, a cloud over the tender area would be visible. Later, the callus formation would appear as the bone began to heal. It is very rare for a stress fracture to appear as a line or fissure.

The immediate treatment for stress fractures is rest. Most experts feel that a rest period of ten days should preclude the athlete's return to play. During this rest period, the athlete should be given anti-inflammatories while at the same time applying ice to alleviate the pain.

When returning to sport, the training pattern should be noted and appropriate changes made. For example, runners should train on trails and avoid concrete pathways when possible. The lack of shock absorption of the concrete is conducive to the formation of stress fractures. Additionally, sneakers should be changed frequently to ensure adequate shock absorption, and arch support. If the athlete experiences pain, the rest period of ten days should begin again.

Head and Skull Trauma

Introduction

Concussions, or any head trauma, can occur in any sport. Yet, sports such as football, hockey, gymnastics, and boxing tend to receive the most attention with regards to athletes sustaining, or being at risk of sustaining, head injuries. Rightly so, head trauma is one of the most controversial and dangerous injuries in sports.

Each year more than 250,000 head injuries occur in the sport of football alone (Cummings, 1998). This makes the most common head injury victim the teenage, male football player. There is an average of eight deaths annually as a result of this (Buckley, 1988). In ice hockey, it has been found that those players who suffer from head injuries were referred to a physician only 8% of the times in contrast to those who injured their knees and who were attended to by a physician 72 % of the time (Buckley, 1988). These statistics are supportive of the fact that head injuries are difficult to recognize unless the athlete is rendered unconscious. For this reason, many head injuries go unnoticed and untreated.

There are no universal definitions for perhaps the most common head trauma - the concussion. Many sport medicine professionals in different contexts have defined it. Similarly, the guidelines to diagnose and treat head trauma are as varied as the definitions. A lack of scientific evidence regarding head trauma contributes to these variations. For the purposes of this review, a concussion will be defined as a clinical syndrome characterized by immediate and transient post – traumatic impairment of neural function. This results in normal brain function being temporarily disrupted (Jaenicke, 1998). Concussions may or may not involve loss of consciousness.

The greatest detriment of the recognition and perception of the cerebral concussion is through the fault of society. Generally the public does not recognize that concussions, the most frequent injury incurred by the central nervous system, are not minor injuries. Yet the central nervous system is not capable of regeneration. Therefore, damage is accumulative and carries a significant morbidity and mortality rate. The key to decreasing the rate of head trauma injury is education and recognition. Although education may be the key to prevention, which is always the best measure, sometimes this is not enough. Some of the onus falls upon the sport medicine community. There is a dire need to become more efficient and effective at recognizing and treating head trauma. If both of these conditions are met, perhaps the incidence and severity of head injuries in sport will decline.

History

Concussion comes from the Latin word "concussus" which means to shake violently. In 1904, President Theodore Roosevelt threatened to ban American football because the sport was contributing more injuries and fatalities than any other sport. Because of this, it was receiving more media attention and medical concern than any other sport. (Kraus & Conroy, 1984). The National Collegiate Athletic Association (NCAA) was formed as a governing body in response for a need to establish rules and guidelines in an effort to reduce the number of injuries and fatalities in sport. Also in that year, nineteen athletes were killed or paralyzed while participating in the sport of football. This number peaked in 1964 to reach a total of thirty athletes (Schneider, 1987). Astoundingly, between 1931 and 1986, at least 819 deaths were attributed to football (Mueller & Schindler, 1987). Deaths resulting from football between 1973 and 1983 surpassed the death toll from all other sports combined (Kraus & Conroy, 1984). Although all of these deaths were not the direct result of concussions or head injuries, particular attention was given to their incidence.

In 1931, the American Football Coaches Association initiated the Football Fatality Report. This was put forth in an effort to keep track of the injuries in football. By 1962, the American Medical Association established the Committee on Medical Aspects of Sports. Through a series of conferences, football was the focus of many debates as proposed rule changes were being made. Despite these efforts, ironically these efforts were in vain. There was an upward trend in head trauma since the mid 1950's (Clarke, 1998).

It was agreed upon at a national sporting conference in 1962 that more protective headgear was necessary to protect the safety of the player. Moreover, coaching and officiating changes needed to be made so that players would stop thinking that they were invincible and sacrificing their bodies for the sake of the game. Instead, they need to realize the implications of their actions. For example, the action of spearing, using the head to "ram" another player for the purpose of a tackle, carries great risk of head and/or cervical trauma (Clarke, 1998). In the sport of football, the following statistics have been complied with regards to the total number of concussions sustained (Gerberich, Priest, Boen, et al., 1983):

- Making a tackle (43%)
- Being tackled (23%)
- Blocking (20%)
- Being blocked (10%)

Approximately nine out of ten head injuries are concussions, and athletes are twice as likely to sustain a head injury as they are to sustain a neck injury (Adams & Graham, 1972). Such a large number of head trauma cases are seen in the sport of football because of the sport's large number of participants. Approximately 1.5 million athletes play football each year at the high school and college level. Kelly & Rosenberg (1997) estimate that there are between 100,000 and 250,000 concussions in the sport of football each year. This computes to about one concussion in one of five football players.

While the National Operating Committee for Safety in Athletic Equipment Standards conducted research into protective head gear, it was determined that the guidelines in place for standard motorcycle helmets were not valid or safe for use in the sport of football because the former were designed for single impact situations. Their design was not appropriate for the multiple impact incidences that a football player is subjected to. When these results were made public in 1973, a decline in head and neck trauma in the sport of football was already evident.

The Brain

Over the past twenty years, there has been a marked decrease in the incidence of the most serious head injuries, especially subdural hematomas (Cantu, 1998). To understand completely the damage that the brain suffers, Cantu (1998) proposes that it is essential to understand the following: A blow to a resting head will produce injury below the point at which the cranium is contacted. This is called a coup injury. An example of this injury would occur from a football helmet. A moving head colliding with a nonmoving object produces maximal injury at the site opposite of cranial impact. This is referred to as a contra – coup injury. An individual who falls backwards and hits their head on the ground would be an example of this injury. When the skull is fractured, neither of the above applies. The fracture can either be linear in appearance or depressed at the point of impact. Either of which can directly injure the brain tissue. Anderson and Hall (1995) cite that skull fractures are dependent on the material properties of the skull, the varying thickness of the skull in certain area, the magnitude and direction of the impact, and the size of the impact area.

There are three different types of stress that can be generated by the force of impact: compressive, tensile (negative pressure), and sheraring (force is applied parallel to the surface). Of the three, shearing forces are poorly tolerated by neural tissue. The brain is surrounded by cerebrospinal fluid (CSF). Perhaps the most important function of the CSF is to absorb shock. The external pressure applied to the head is converted to compressive pressure as the CSF flows between the gyri and sulci - the folds and contours of the brain. This distribution in turn evenly distributes the force of impact. An athlete's head can withstand far greater amounts of force without injury if there is tension in the neck muscles. For example, when an athlete sees the collision coming, they tense up. Conversely, the athlete is at the greatest risk of injury when the neck is limp or when they are dazed or "stunned" and cannot maintain stiffness or rigidity in the muscles of the neck (Cantu, 1998). Concussions are usually the result of rotational forces. This causes the brain to shake within the skull. There are three places that these forces usually occur: dissipation of the cerebrospinal fluid between the skull and the brain, attachments between the dura matter and the brain itself, and irregular bony surfaces. Although there are no visible lesions, there is damage to the neural pathways (Leblanc, 1999).

Types of Head Injuries

Severe head injuries can lead to quadriplegia and even death. Today, neurologists and neurosurgeons state that there is no such thing as a minor head injury. Even the most minor collisions can cause a decrement in the ability to process new information (Gronwall & Wrightson, 1974). Moreover, the severity and duration of the impairment increases with repeated injuries (Gronwall & Wrightson, 1974). Studies have shown that the effects of minor head injuries are cumulative. In light of the above, it is easy to see that no minor head injury should ever be considered "minor". Head injuries in athletes parallel those occurred by nonathletes in car accidents or other mishaps. However head trauma in athletes is often preventable in some manner (Lehman, 1998).

Concussion Classification

As previously stated, the most common type of head trauma is the concussion. Concussions involve periods of neurologic dysfunction, which can take the form of confusion, or retrograde amnesia and even coma. Generally, concussions are classified along a three class grading system. Grade one being the mildest and Grade three being the most severe. There are no universal classifications for these grades. This is one of the major problems for sport medicine professionals when forming their diagnosis. Concussions may or may not involve a loss of consciousness. The confusion and memory disruptions may occur immediately or they may show a delayed onset. This is why it is imperative that the injured athlete is observed closely for at least for twenty – four hours post – injury. Athletes with concussions may stare blankly; exhibit delayed verbal responses or reactions, and can be easily distracted. Their speech is sometimes incomprehensible, and they are often emotionally unstable. Cantu (1998) proposes the following classifications:

Grade 1 – constitutes 90% of all concussions. The athlete is not rendered unconscious and the retrograde amnesia lasts less than thirty minutes. The athlete appears muddled and confused. Close observation should be made for the next twenty – four hours.

Grade 2 – the athlete usually loses consciousness for a period less than five minutes. The post - traumatic amnesia lasts less than twenty - four hours yet more than five minutes.

Grade 3 – the athlete is knocked unconscious for longer than five minutes. The period of amnesia lasts longer than twenty – four hours. Because the athlete undoubtedly loses consciousness, this is the easiest type of concussion to recognize. The following are some of the symptoms generally displayed by athletes with concussions (Cantu, 1997):

- headache
- dizziness or vertigo
- nausea and vomiting
- lightheadedness
- poor attention span
- memory dysfunction
- easily tired
- intolerance of bright lights
- irritable
- difficulty focusing vision
- intolerance of loud noises
- tinnitus
- anxiety and depression
- irregular sleep habits For the purposes of contrast, the American Academy of Neurology proposes the following classification system:

Grade 1 – temporary confusion, no loss of consciousness, periods of altered mental status which last no more than fifteen minutes.

Grade 2 – transient confusion, no loss of consciousness, altered mental status which lasts longer than fifteen minutes.

Grade 3 – loss of consciousness either briefly or for prolonged periods of time.

Second Impact Syndrome

Although there has been a decrease within the last twenty years in the incidence of the most serious head injuries, there has also been an increase in the prevalence of second impact syndrome (SIS). Cantu (1998) cites that seventeen of the last twenty-four citations in the literature regarding SIS occurred between 1992 and 1998. This averages almost three per year.

Cantu (1998) notes that second impact syndrome was first thought to be described by Schneider in 1973. This syndrome occurs when an athlete sustains a head trauma and sustains a second injury before the symptoms associated with the first injury have subsided (Cantu, 1992). Before these symptoms resolve, the player returns to play and sustains another injury. This second impact does not have to impact the head. A blow to the chest, side, or back that snaps the athlete's head (as in whiplash) can deliver sufficient force to the brain. Although the second blow may seem relatively minor, its' effects accumulate a top of the first. The athlete usually does not lose consciousness but may appear "stunned" or dazed. They often complete the play and walk off the field without any assistance. They next few moments are crucial and differentiate the SIS from a concussion. The athlete usually collapses, their pupils rapidly dilate with no eye movement, and their respiratory system begins to fail (Cantu, 1998).

The brain of an athlete with SIS loses the ability to control its blood supply. The cranium becomes overwhelmed with blood, which increases intracranial pressure to dangerous levels. This pressure results in a hernia either at the foramen magnum or the medial surface of the temporal lobe. At this point, it takes only two to five minutes to progress from SIS to brainstem failure. This inevitably involves respiratory failure.

Between 1980 and 1993, the National Center for Catastrophic Sports Injury Research identified 35 probable cases of SIS among American football players. Although the incidence per 100,000 is not known, SIS is not confined to the sport of football alone – it is apparent in other sports. Second Impact Syndrome has a mortality rate near 50% and a morbidity rate at approximately 100%.

The Team Physician and Concussive Athletes

The team physician is generally responsible for examining athletes and evaluating their medical status. Consequently, the decision as to whether or not an athlete is able to continue, or return to, playing is at the discretion of the physician. It is the responsibility of this individual to protect the health of their athletes while at the same time avoiding unnecessary restriction of activity (Mitten, 1993). Because team physicians often establish medical guidelines for participation, it is important that they understand the legal ramifications of their actions.

Ideally, the decision to abstain from athletic activity would be made in agreement between the athlete, coaching staff, game officials, and the team physician. Unfortunately, this is not always the case because of pressures to perform and "work through the pain". Team physicians who allow an athlete's strong will and desire to play to interfere with their sound judgement in making a return to play decision could be held liable for malpractice (Mitten, 1993). Even if an athlete offers to sign a waiver, releasing the organization from any responsibility if injury should occur, the physician should still not be persuaded to change his/her mind. No one will ever scold you for being too cautious, especially when dealing with scholarly athletes.

In the event that the physician does allow an athlete, who has medical complication, to participate the athlete should be fully informed of all the risks of participation and the possible consequences of his/her actions. At this point, if the athlete returns to play and endures further damage, the team physician cannot be held liable if he/she has adhered to accepted guidelines and practice while providing care and treatment to the athlete.

Return to Play (RTP)

When the athlete does not lose consciousness but does indeed suffer a head injury then the diagnosis becomes difficult. When an athlete sustains a serious injury and loses consciousness, a cervical spine injury should be suspected, and immobilization techniques should be employed. The medical staff should also be alert to the possibility of a skull fracture. Bruising around the eyes (raccoon eyes), behind the ears (Battle's sign), or a leakage of CSF or blood from the nose or ears (Jaenicke, 1998).

Team physicians and athletic therapists have a responsibility to evaluate the injured athlete who has sustained a head injury. This means recognizing that a conscious athlete may develop a hematoma within minutes which has the potential of a life-threatening emergency.

The Glasgow Coma Scale is often used to predict the athlete's chances for recovery and assessing levels of improvement or deterioration. An initial score of eleven equates to a 90% chance of recovery and a score of less than five usually means a 80% chance of death or a vegetative state (Cantu, 1998). The Glasgow Coma Scale assesses eye opening, motor response, and verbal response.

In general the following conditions contraindicate return to contact sports:

- persistive postconcussive symptoms
- paralysis (partial or full) on one side of the body
- loss of vision
- hydrocephalus
- sudden hemorrhage in the subarachnoid area of the brain

Prior to 1981, it was a firmly held belief that mild head injuries were "benign" and athlete would recover naturally within a relatively short period of time. Barth et al. (1989) were among the first to discover that some cognitive symptoms, when measured by neuropyschological tests, often persisted for considerable periods of time after the injury is experienced.

RTP Guidelines for Concussions

Grade one concussion – if asymptomatic at both rest and exertion with no signs of retrograde amnesia (no recollection of events before the injury) the athlete may return to play later in the game at the discretion of the medical staff. Return to play would normally not occur before fifteen minutes of resting on the bench. Yet keeping in mind that no head injury is minor, sitting out the rest of the game is usually recommended. The athlete should be examined every five minutes to rule out post – concussive symptoms. For the athlete who is symptomatic, return to play may occur as soon as one week if the player remains asymptomatic. If the athlete suffers a second grade one concussion, the individual should not return until two weeks after.

Grade two concussion - an athlete must usually remain asymptomatic for at least a two-week period following a grade two concussion. Upon sustaining a second concussion, the athlete should sit out for a month and consideration should be given to not returning until next season.

Grade three concussion – the minimum amount of time to abstain from play is one month. They (the athletes) are able to return to play then if asymptomatic for one week. A second concussion would definitely warrant ending the season immediately. **Asymptomatic meaning no headache, dizziness, impaired mental functions or memory (Cantu, 1998).

Although CT and MRI scans are useful in detecting bleeding and swelling in the more severe head traumas, they are unable to detect the more subtle, tiny lesions that are typical of a minor head injury.

Universal criteria for return to play are constantly debated. All medical and coaching staff knows that an athlete who is still showing symptoms should not return to play. It is when athletes seemingly display no symptoms, yet are still suffering neurological problems or are lying about their rehabilitation status, that there are ambiguities about the return to play decision.

Prevention

Cantu (1992) has proposed five main areas where coaches and sport medicine professionals can strive to attain a decrease in the number of head injuries in sport:

- Improved medical care – this means better recognition on the field along with an effective treatment plan. Moreover, the use of sound judgement when deciding if an athlete is ready to return to play.
- Improved conditioning especially for the neck muscles. This does not guarantee that the athlete will not suffer head or neck trauma, but it lessens their chances for severe injury. Of course educating the athlete about proper use of the head is another important key to prevention.
- Improvements in equipment design and ability to withstand impact will offer greater protection to the athlete, making them less susceptible to injury. Also the equipment should fit properly and be replaced or repaired if broken.
- Rule changes, such as the prohibition of spearing in 1976, will help decrease

the incidence of accidents and trauma in sports. Cantu & Mueller (1990) cite that since this rule change in 1976, the incidence of serious head and neck trauma in sport has decreased by 50%.

- Coaching techniques – it is the responsibility of the coach to abandon teaching dangerous techniques and skills such as spearing and to advise and counsel the athletes about the dangers of using their head unwisely.

Perhaps the most challenging aspect of providing adequate treatment for head trauma survivors is that many of them do no present physical symptoms. Because of this, the injury sustained is often coined as mild when indeed there may be significant damage. This contributes to a widespread understanding of traumatic brain injury even within medical circles.

This leaves the sport medicine professional in the precarious position of determining the medical eligibility of the participant. Pressure from the athlete, parents, and coaching staff often interferes with the professional's decision regarding future participation. Yet it is the responsibility of these professionals to refrain from any situation, which may place the athlete at any undue risk. This is easier said than done. The physician or therapist who makes these unpopular decisions is often vulnerable to criticism for being too cautious. Yet it is imperative to remember that it is better to err on the side of caution. In the end, no one will ever be criticized for be too cautious with the health of a student athlete.

Technological advances, research, and the development of universal guidelines into the twenty-first century will enable the sport medicine community to improve its diagnosis, treatment, and rehabilitation efforts for athletes who suffer head injuries.

Additionally, as more research is conducted into the long term effects of repetitive blows to the head, perhaps the sporting community and society, will realize that the pleasure that is received from watching one player "cream" another may actually be contributing to their demise.

Ice Hockey

Ice hockey was first played by the Native Americans in the early 1600's (Mellion, 1999). The first recorded instance of the sport was in Montreal in 1875. Thorson (1999) reports that over 300,000 people participate in amateur hockey today.

Hockey is a sport of great speed. A study completed by Thorson found that professional hockey players skate at speeds of 30 mph. A player who slips and falls can reach speeds of 15 mph. Since its introduction, the sport has evolved in several ways. The players are bigger, faster, and stronger. The game can now be played all year round with the development of artificial ice. Equipment once used only for protective purposes is now designed to enhance athletic performance. For example, wooden sticks have been replaced by fibreglass, a lighter alternative. Likewise, the stick blades are now curved to allow maximal contact and manoeuverability of the puck.

The player is totally suited in protective equipment. Shin pads, elbow pads, and shoulder pads are only some of the required equipment. Helmets are suitable for full shields, half shields, or no shield, depending on level of play. Of course, with the increased incidence of violence in hockey, such protective equipment is necessary. However, some may argue that the presence of this protective equipment has in fact led to an increase in violence within the sport.

Hancock et al (1991), in a study cited in the Clinical Journal of Sports Medicine, have concluded that 60-90% of all injuries occur because of collisions. The stick contributes to 12-15% of all injuries, the puck in 10-15% of injuries and less than 5% of injuries involve the skates. Less than 15% of hockey injuries were due to overuse or repetitive strain.

The same author reported that contusions were the most prevalent injury, accounting for 70% of injuries. Fractures or dislocations were second to this with 14%, followed by sprains/strains at 10%. The remaining 10% were comprised of abrasions and lacerations, with 8% and 2% respectively.

With the mandatory use of protective equipment, the incidence of some once prevalent injuries has decreased. Mouth guards have decreased the dental injuries in the sport. Additionally, wearing a mouth guard helps to absorb some of the shock from collisions. Moreover, helmets have contributed most to the decrease in the severity of concussions. Yet, concussions are still a major problem in hockey. The mandatory use of helmets has been a step in the right direction, however further intervention in this area is still needed. The use of a face shield has prevented many facial lacerations and eye injuries. Unfortunately, the incidence of spinal injuries has not shown a declining trend (Bartolozzi et al. 1998).

A Canadian study by Tator cited by Thorson (1999) notes no incidence of any cervical spine injuries in the sport of hockey before 1972. Between 1974 and 1980, one such injury was reported. Five of these injuries were reported in 1980-1981. A research group led by Tator is currently investigating 117 spinal injuries occurring in the past two decades. The majority of the individuals were males between the ages of 15 and 25, with most injuries resulting from illegal checking.

The most common mechanism of these injuries is hyperflexion of the neck accompanied by straightening of the vertebral column (Thorson, 1999). An example of this would be going head first into the boards. Younger players are often more susceptible to these injuries as their neck muscles are weaker. This weaker musculature often promotes a "head down" posture when skating as they fatigue. It is important for coaches to teach proper checking techniques and for referees to enforce the rules governing checking stringently in an effort to reduce these injuries (Bartolozzi et al. 1998).

Acromioclavicular (AC) separations are the most prevalent injury to the upper extremity. Thorson (1999) notes that approximately 45% of all hockey players experience arthritic changes in this joint over the course of their career. AC Sprains are most common in adult hockey players. However, clavicular fractures are more common in the teenage population. A common mechanism of AC sprains is falling on an outstretched arm when the arm is abducted from the body. The force transmitted through the clavicle forces the clavicle forward away from the acromion. Please refer to Figure 16 for a graphic representation of the anatomy of the shoulder joint.

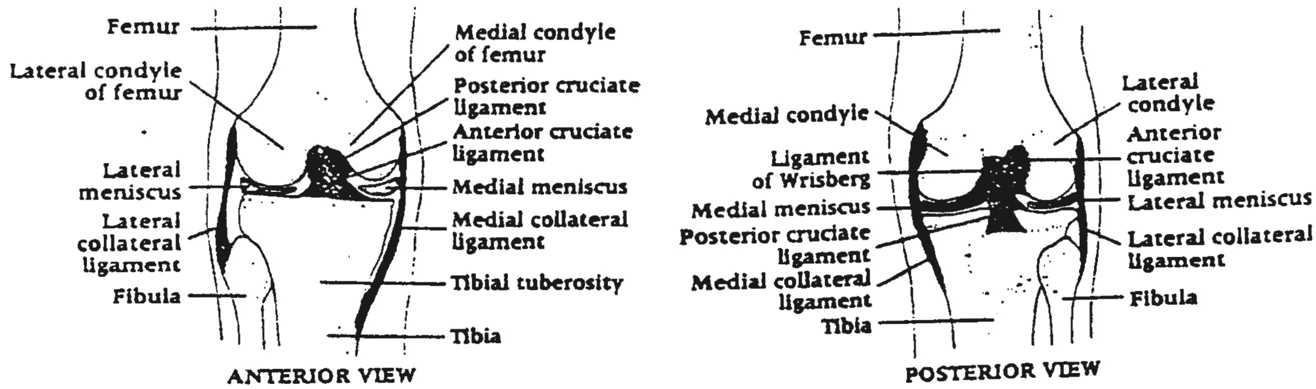
The integrity of the joint may also be sacrificed when colliding with the boards, ice, or another player. Players with AC sprains often have difficulty regaining cross-flexion or horizontal abduction (Mellion, 1999). This movement is of particular importance when struggling with opponents.

Less frequently, a player may injure the sternalclavicular joint by hitting the boards chest first. The impact causes the shoulders to retract when the opponent hits the player's back. Olecranon bursitis has also been reported as a frequent injury; although this is somewhat preventable with the use of good elbow pads.

Even though abdominal injuries are usually rare, the athletic therapist should be vigilant for damage to the spleen, liver, and kidneys from stick contact. The primary soft tissue injury in the lower extremity occurs in the groin or adductor muscles. These muscles are critical for a hockey player's skating speed and force. Bartolozzi et al. (1998) propose that such injuries can result from tight muscles, inadequate warm-up, fatigue, and/or muscular/postural imbalances. Contusions to the thigh, or a "charley horse", are prevalent in hockey. These injuries can cause a significant amount of bleeding causing a hematoma. If untreated, the hematoma ossifies depositing a bony fragment in the muscle. Signs of this will appear in an x-ray three weeks post injury as calcification. New bone formation will appear 6-8 weeks later. This is known as myositis ossificans. Once developed, the athlete is at risk of losing range of motion as well as strength in the affected limb (Castaldi et al., 1989). To offset this, the leg should be placed in full knee flexion and compressed with ice. Full ROM and strength should be comparable to the contralateral limb before returning to play.

Knee injuries in the sport can be both quite minor or serious with a mild stretching of the ACL, MCL or meniscal damage being the most prevalent structures involved. However, ankle sprains do occur despite the supportive bracing offered by the skate. Figures 21 a&b show the anatomical structures of the knee.

Figures 21 a&b: Anatomical Structures of the Knee (Mellion, 1999).



Fractures of the ankle or forefoot may also occur usually due to puck contact. The navicular bone on the medial side of the foot is the most common site of a fracture.

Castaldi and Hoerner (1989) have published the following statistics regarding the prevalence of injuries in the sport of hockey:

Proportion of injuries in relation to body parts:

Head and neck	20-30%
Upper body	15-20%
Trunk	15-25%
Arm	8-20%
Leg	20-30%

Injury rates versus position played:

Forward	49-60%
Defence	35-48%
Goalie	3- 8%

Ice hockey is not free from catastrophe. However, because hockey injuries are often not reported to injury surveillance systems, there is no true database of the incidence and severity of injuries in the sport. There is still much to be done to decrease the incidence of injuries in hockey. Player education is foremost on the list. Stiffer penalties need to be given to those who break the rules. As fans, we need to berate violence in the sport and not promote it. As a society, we should applaud skill and speed and antagonize the intentional violence.

Rugby

Rugby is a body-contact sport that is very similar to football. Due to the high incidence of body contact, there tends to be numerous injuries in the sport. Contributing further to this is the absence of protective equipment.

Brunkner (1998) has reported that despite the above conditions, the overall rate of severe injury in the sport is low. However, he notes that front-row forwards and centres tend to report more injuries due to the increased body contact involved with their position. The most serious injury documented in the sport is the cervical spine injury. The incidence of this injury was higher in front row forwards involved in the scrum. The hyperflexion of the cervical spine, with the additional load of opposing and fellow players, places the spine in a compromising position. Consequently, rule changes in the past twenty years have alleviated some of these injuries.

The head and face are still the most vulnerable to injury in the sport of rugby (Brukner, 1998). Lacerations are most common followed by minor concussions, usually grade one in nature. Similar to hockey, the most common injury of the upper extremity is the AC sprain. The mechanism of injury usually involves contact with another player or contact with the ground. Fractures and dislocations of the fingers are common when attempting to catch the ball; however the ball hits the fingertip. Fractured ribs or separation of the intercostal cartilage is common. Again this is due to direct contact with the ground or another player.

Brukner (1998) notes that quadriceps contusions are common in the sport of rugby, with the risk of developing myositic ossificans usually relatively minor. The most common knee injury is a sprain of the medial collateral ligament. A common example of such injury is the application of a valgus stress to the knee in a scrum or a tackle. With this injury, ACL injuries may also occur as a secondary complication. The most commonly injured joint is the ankle. Most sprains are inversion sprains involving ligaments on the lateral side of the ankle. Fractures of the ankle and eversion sprains do not occur very frequently. Conversely, Hillman (2000) states that the epidemiology of rugby injuries is poorly understood due to the lack of medical supervision provided to the sport. However, she does note that cervical spine injuries are the most significant source of morbidity in young males involved in the sport.

The absence of protective equipment has led to a steady level of injury reports in the sport. Examples of protective equipment regularly worn in the sport by a small proportion of players include mouth guards and scrum hats, a soft neoprene hat worn to protect the ears from cauliflower ear. Prophylactic taping for the ankle, wrist, and thumbs are is a relatively common practice in the sport of rugby.

Volleyball

The most common leg problem observed in volleyball athletes is patellar tendinitis. Rice and Steele (1999) define this as "inflammation and pain of the inferior pole of the patella at the patellar tendon attachment." Knee pain is quite common in these athletes, with patellar tendinitis being only one common source of pain. Osgood-Schlatters and patellarfemoral syndrome are also quite common complaints.

Pain caused by a dysfunctional iliotibial band (ITB) can manifest itself as knee pain in the lateral aspect of the knee. Point tenderness is usually felt over the lateral epicondyle of the femur or the lateral condyle of the tibia. These are the common sites of friction caused by a taut ITB rubbing over the bony prominence. The ITB usually tightens due to repetitive movements, muscle imbalances, or improper warm-up. The athlete normally notices progressive discomfort and no recollection of an acute injury (Hirshman, 1998). Treatment for ITB Friction Syndrome generally includes rest, ice, anti-inflammatories, and stretching.

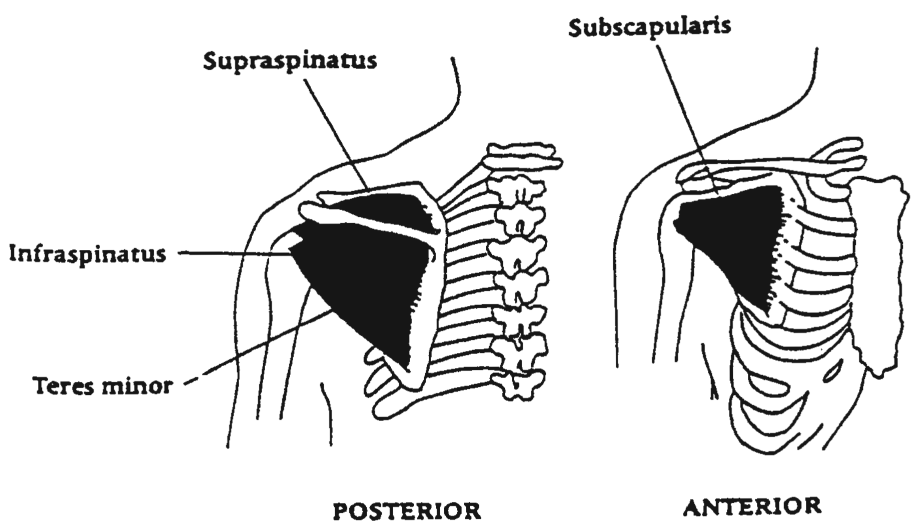
Ankle sprains are also common ailments for volleyball players, with 60% of these injuries occurring when blocking and the remaining 40% when attacking. The normal mechanism is the blocking player landing on the foot of the attacking player. Additionally, stress factures are often found in the shaft of the metatarsals of the third or fourth digits (Rice & Steele, 1999). This is often the result of poor shock absorption from playing surfaces. Wooden floors are the best choice for a playing surface with concrete floors being the worst. Another injury which is variable depending on the playing surface is shin splints. If unmanaged, more serious injuries such as stress fractures of the fibula or compartment syndrom may develop. Likewise, for all of the above, rest and ice are very important. Additionally, anti-inflammatories will help control the associated inflammation of shin splints. Stress fractures often go undiagnosed until 2-3 weeks post-examination when calcification will show up on a follow-up x-ray.

The shoulder is vulnerable to injury for a number of reasons (Hirshman, 1998). This is due to a number of factors. First, a volleyball player repetitively swings at different speeds and with multiple force levels. This repetitive force leads to microtrauma in the musculature of the shoulder. Secondly, when diving for a ball, the athlete often lands on an outstretched arm absorbing all of the impact force at the shoulder. Finally, the predominant use of one limb creates muscle imbalances that may lead to postural problems.

One of the more common ailments of a volleyball player is impingement syndrome. This typically involves the entrapment of a structure between two bones, usually a joint or other bony prominence. Rice and Steele (1999) note that the three common structures to be impinged are: subacromial bursa, supraspinatus tendon, or biceps tendon. Impingements are marked by excessive inflammation of the involved and associated structures. Its main mechanism of injury is repetitive motions. Treatment protocol usually involves ice, anti-inflammatories, pain control - through use of modalities or medication, and stretching of the surrounding musculature to alleviate the pinch. If such treatment is unsuccessful, surgical intervention may be needed.

A case of unresolved impingement can lead to progressive weakness of the rotator cuff (Arnheim & Prentice, 1999). This cuff is comprised of four muscles: supraspinatus, infraspinatus, subscapularis, and teres minor. Figure 22 shows the muscles of the rotator cuff.

Figure 22: The Musculature of the Rotator Cuff (Mellion, 1999).



An alternate cause of such an injury is an acute instance of trauma. An example may be a mis-hit attack with an untimed swing. Moreoever, repetitive mirco trauma may also result in tears in the rotator cuff.

Conclusion

The opportunites presented throughout this internship have been priceless. I have gained a wealth of practical experience that has prepared me to continue with the CATA certification process. As of March 31, 2001, I have collected 609 field hours and 720 clinical hours towards my certification. This total is well over the required 1200 hours to attempt the certification exam.

The knowledge and experience that I have attained has established a passion within me for my future career choice. Furthermore, I feel that it has prepared me enormously for my futures hopes of becoming a sports medicine physician. I cannot express enough my satisfaction with my choice to choose an internship over a thesis. I feel that I am ready to step into the work-place and contribute to the sporting community through the administration of a specialized level of health care.

Athletic therapy is a very rewarding profession. As a therapist, you have the fortuity of influencing the lives of others. Through the provision of rehabilitative interventions, you have the first hand opportunity of watching them climb their own personal road to success. I am truly happy with my career choice and look forward to practising in the field of athletic therapy in the very near future.

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Appendix 1
Sample Assessment Sheets

Courtesy of UNB Athletic Therapy Clinic

Wrist Assessment

Clear **elbow** using active movements & overpressure

flexion ____________________

extension ____________________

Clear **Hand** using active mvmts & overpressure

flexion digits ____________________

extension digits ____________________

adduction digits ____________________

abduction digits ____________________

opposition 5th ____________________

flexion pollux ____________________

extension pollux ____________________

adduction pollux ____________________

abduction pollux ____________________

opposition pollux ____________________

SPECIAL TESTS

Finklestein's test ________________

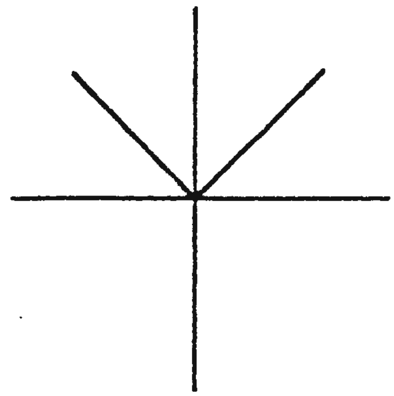
Phalen's test ________________

Tinel's test ________________

Allen test ________________

Pinch test ________________

FUNCTIONAL TESTS



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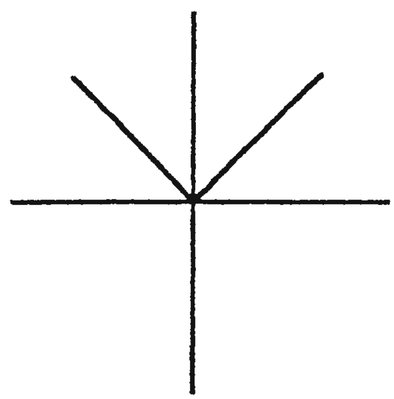

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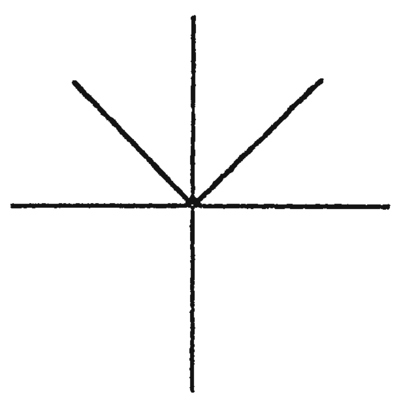


Resisted

Shoulder Assessment

Clear NECK using active movements & overpressure

flexion ____________________

extension ____________________

R rotation ____________________

L rotation ____________________

R flexion ____________________

L flexion ____________________

Clear ELBOW using active movements & overpressure

flexion ____________________

extension ____________________

supination ____________________

pronation ____________________

SPECIAL TESTS

Speed's test ____________________

Supraspinatus test ____________________

Impingement sign ____________________

Drop arm test ____________________

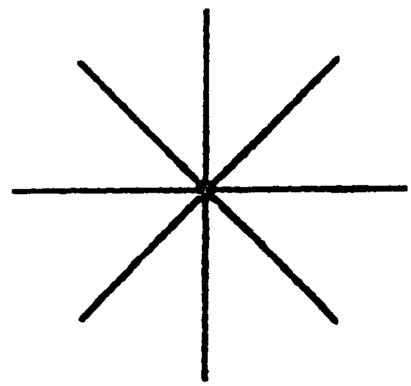
Apprehension test ____________________

Adson test ____________________

Yergeson's test ____________________

Scapular winging ____________________

FUNCTIONAL TESTS



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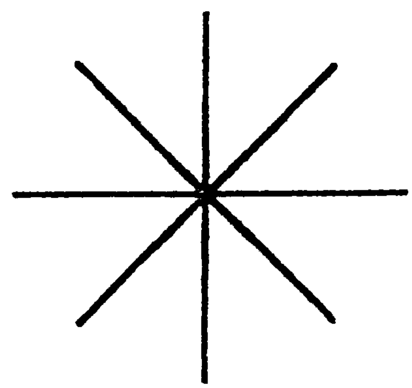

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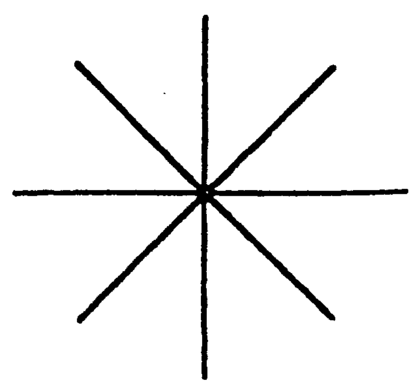


Resisted

Cervical Assessment

Clear cranial nerves

peripheral vision ____________________

tracking ____________________

focus (near, far) ____________________

facial ____________________

balance ____________________

vagus (diaphragm) ____________________

Clear **TMJ** using active movements & overpressure

open mouth ____________________

close mouth ____________________

shuttle jaw ____________________

SPECIAL TESTS

Vertebral Artery tests ________________

Adson's test ________________

Hyperabduction test ________________

Costoclavicular test ________________

Compression test ________________

Distraction test ________________

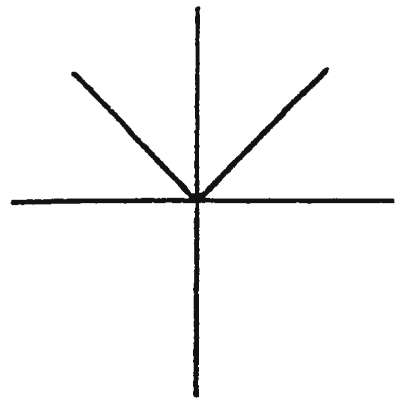
Quadrant test (upper) ________________

Quadrant test (lower) ________________

Valsalva test ________________

Swallowing ________________

FUNCTIONAL TESTS



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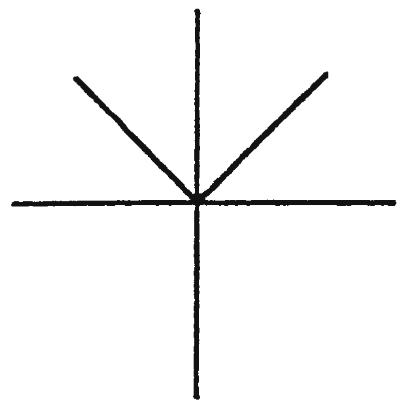

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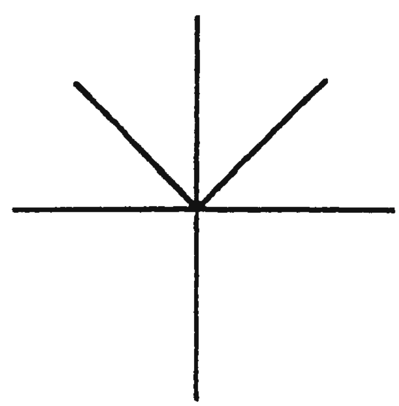

Resisted

Assessment of Lumbar Spine

Clear HIP using quick test (squat)	

standing tests

active trunk flexion	
active trunk extension	

	right	left
lateral trunk flexion		
SI jts (trunk flexion)		
SI jts (hip flexion)		
Trendelenberg test		
resist plantarflexion (S1)		
resist knee extension (L3)		

Sitting tests

resist trunk flexion	
resist trunk extension	

	right	left
trunk rotation		
resist trunk rotation		
resist lateral trunk flexion		
Sitting root test		
SI (trunk flexion)		
Thomas test		
Patellar reflex (L4)		

Side lying tests

Passive lumbar flexion	
Piriformis test	

	right	left
active lateral flexion		
res hip abduction		

KNEE ASSESSMENT

Clear HIP using the appropriate tests

quick test ____________________
  (squat clears lower extremity)

quadrant test ____________________

hip joint test ____________________

Clear ankle using active movements & overpressure

dorsiflexion ____________________

plantarflexion ____________________

inversion ____________________

eversion ____________________

SPECIAL TESTS

varus stress.(30° flexion) ____________________

arus stress.(ext) ____________________

valgus stress (30° flexion) ____________________

valgus stress (ext) ____________________

posterior sag ____________________

anterior drawer ____________________

Lachman's test ____________________

pivot shift ____________________

McMurray's test ____________________

Apley's test (distraction) ____________________

Apley's test (compression) ____________________

Clark's test ____________________

Apprehension ____________________

Patellar Mobility ____________________

ITB ____________________

FUNCTIONAL TESTS

Active

Passive

Resisted

ANKLE ASSESSMENT

Clear knee using active movements & overpressure

flexion ______________________

extension ______________________

Clear foot using active movements & overpressure

flexion ______________________

extension ______________________

adduction ______________________

abduction ______________________

SPECIAL TESTS

Superior Tib-fib jt. ______________________

Tib-fib mobility ______________________

Subtalar jt mobility ______________________

Inferior Tib-fib jt. ______________________

Anterior Drawer ______________________

Posterior Talo-fib Lig ______________________

Talar Tilt ______________________

Percussion Test ______________________

FUNCTIONAL TESTS

Active

Passive

Resisted

Appendix 2
Suggested Medical Supplies

Courtesy of Campus Physiotherapy Class Notes

Appendix 3
Sample Rehabilitation Programs

Knee Rehabilitation Program

Acute - (48-72 Hours)

- RICE
- Crutches to assist with weight-bearing
- NSAID's
- Referral to appropriate medical care if necessary

Goals:

5. Control inflammatory response
6. Decrease pain/spasm
7. Decrease edema/effusion

Sub-Acute

Goals:

1. Increase ROM
2. Progressive increase in weight-bearing

To achieve greater ROM, the following activities can be used:

- ***Wall-slides*** - the unaffected limb supports the affected limb as the heel slides down the wall. The contralateral limb then assists in recovery to the starting position. Gravity will assist the sliding motion.
- ***Heel-slides*** - a more advanced version of the same exercise. The athlete has total control over the sliding action as gravity is negligent. The patient lies supine while sliding the heel to the buttocks to obtain flexion and then extends.

Both of these exercises should be continued at home during the early stages of the injury.

Progressive weight-bearing should be made from crutches, to partial weight-bearing with crutches then to full weight-bearing. The emphasis should be placed on a normal heel-toe strike. It is important to note that at no time should one crutch be used. This would only result in compensation and stress on uninjured structures.

When rehabilitating athletes, it is important to continue some cardiovascular components to maintain the athlete's fitness level. Swimming or pool-jogging offers an excellent option as there is no load on the body's joints. Similarly, the water will help support the weight of the limb. When adequate flexion and extension is achieved (approximately 110 degrees of flexion and 160 degrees extension), the athlete should ride the stationary cycle with progressive use of tension.

All rehabilitation sessions during this stage should end with cold application; ice, cold pack, cold tub etc. Moreover, modalities such as IFC, TENS, ultrasound should be used as needed during this stage to promote an optimal healing environment and to control pain and swelling.

Rehabilitation Stage

Goals:

- Regain normal pain-free ROM
- Regain normal weight-bearing function
- Regain normal strength, power, and endurance
- Regain proprioception and coordination

Protective bracing or strapping may be indicated during the initial rehabilitation stages to provide extra physical as well as psychological support to the limb.

The exercises prescribed to the individual should be progressive and focus on bilateral strength. It is important not to ignore the joints above and below the affected area, in this case the hip and the ankle. The progression of exercises should appear in the following order:

- normal pain-free ROM
- manual resistance isometric exercises
- isotonic exercises throughout the whole ROM

Much focus should be centred on the quadriceps and hamstrings. For example, the initial stages of the program should include:

- step-ups
- wall-squats
- manual hamstrings

Progressively, the following list of exercises should be incorporated:

- lunges
- incline step-downs
- hip flexion/extension exercises
- core stability
- proprioceptive activities

When adequate strength is attained, the focus must then turn to agility. The patient should begin with light jogging, followed by lunges, cross-overs, circular patterns, "stop - and - go", zig-zags, and quick cutting actions. Once completed, the athlete is ready to begin sport-specific drills to progressively return them to play. There should be at least 80-85% attainment of pre-injury conditioning.

A weight program should be initiated that focuses on strengthening the whole shoulder complex, biceps, triceps, deltoids, etc. Moreover surrounding musculature should be examined for lengthening or contracture. A corresponding program to correct these postural abnormalities should accompany the rehabilitation program if warranted.

Ankle Rehabilitation

Acute Stage:
- RICE
- Crutches to assist with weight-bearing if necessary
- NSAID's
- Radiographic examination if necessary
- Compression sock or horseshoe
- Protective bracing

Goals:
- Decrease pain/spasm
- Decrease edema
- Control inflammation

Sub-Acute Stage:
- Restore ROM
- Increase weightbearing
- Use of modalities as needed. IFC/HVPC for pain control/edema. Ultrasound to increase cell metabolism, re-align fibres, increase protein synthesis. Ultrasound should be used only when there is no local inflammation.

Increases in ROM can be obtained through the following exercises:
- Towel exercises (dorsiflexion/plantarflexion)
- Alphabet exercises - drawing the alphabet with the ankle. Can also be done on with the foot on a Theraball.

Proprioception can be increased through the following:
- Stork-stand (assisted if necessary). To make the task more difficult, the athlete can close their eyes.
- Balance on wobble-boards (square or circular)
- Foam roller
- Trampoline

Each exercise should be held for thirty to sixty seconds.

The rehabilitation program should then move from general to specific principles and from balanced to unbalanced. Sport - specific activities should be incorporated into the athlete's routine according to a daily progressive routine. It is important to remember that the ankle bears the body's weight and should be strengthened accordingly.