



Diploma Programme subject in which this extended essay is registered: Sports, exercise, & health

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: How does the technology in physical therapy affect shin splints, concussions, and ACL tears for teenage athletes?

Candidate's declaration

This declaration must be signed by the candidate; otherwise a grade may not be issued.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Supervisor's report and declaration

The supervisor must complete this report, sign the declaration and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator.

Name of supervisor (CAPITAL letters)

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

- Did an excellent job using all of her resources; herself, teammates, coaches, teachers, physical therapists, doctors & parents.
- She did a great job researching each topic that was identified in the paper.
- She proved to have great understanding of the material & knew exactly what she wanted to research from the start.
- displayed great passion for this assignment & kept me informed the entire process.

This declaration must be signed by the supervisor; otherwise a grade may not be issued.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent hours with the candidate discussing the progress of the extended essay.

Assessment form (for examiner use only)

Criteria	Achievement level					
	Examiner 1	maximum	Examiner 2	maximum	Examiner 3	
A research question	1	2		2		
B introduction	1	2		2		
C investigation	2	4		4		
D knowledge and understanding	4	4		4		
E reasoned argument	1	4		4		
F analysis and evaluation	1	4		4		
G use of subject language	4	4		4		
H conclusion	1	2		2		
I formal presentation	2	4		4		
J abstract	1	2		2		
K holistic judgment	2	4		4		
Total out of 36	20					

How does the technology in physical therapy affect shin splints, concussions, and ACL tears for teenage athletes?

Extended Essay

Sports, Exercise and Health Science

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Word Count: 3,218

Abstract:

This essay studies the different effects of technology in physical therapy on three common injuries in the average teenage athlete. The research that will be conducted focuses on the opinions of physical therapists and scientists involved with sport medicine. Focusing on Anterior Cruciate Ligament (ACL) tears, shin splints, and concussions in teenage athletes helped find specific information on testing, while also focusing on the modalities used while in the physical therapy office. From the simplest tools to the use of Ultrasound, Iontophoresis, and other advanced machines to get deep into the muscle tissue. The research conducted also helped find ways to prevent further injury and protect from worsening the injury at hand. Although not all have been proven to work there is research being done to prevent more injuries from occurring in the future.

Because of the increase of technology the seriousness of injuries has become more than the “run through it approach”. Other than the idea of using physical therapy and specific modalities, rest is give especially with the three injuries that have been focused on. Technology is being improved, especially in the teenage athletic world. People are becoming more focused on healing the athletes now so there won’t be any long term issues. The technology used is also helping the athlete heal faster and get back on the field. Without the developed technology, ACL tears would take almost a year and a half to heal, there would be significant damages in memory due to concussions, and many track athletes out due to shin splints.

Word Count: 256

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Sport specific injuries often plague the lives of teenage athletes. With the daily practices, and rigorous game schedule the risk of injury increases drastically. The dedication of teenage athletes has become ten times more rigorous than it used to be. High school athletes become more competitive every year, and the training pushes them harder and harder. Sometimes, the amount of work put in overwhelms the body and causes potential career ending injuries. After diagnosing the issue the number of steps to take from that point varies. The possibility of surgery, the rehabilitation time, leaves many athletes in a panic. Although rehabilitation time is needed with any injury, technology and research has not only improved but lessened the amount of time spent off the field. Extensive parts of rehabilitation are the physical therapy office, with the modalities and research the therapists are able to “rehab” and get the patients on the field faster than before. With three common sport injuries, Concussion, the Anterior Cruciate Ligament (ACL) Tear, and Shin Splints, technology has improved the analysis and diagnosis of said injury, the overall understanding of the injury, and the modalities used to speed up rehabilitation time.

When an athlete that is a part of a contact sport steps on a field there is always a chance of a concussion. "A concussion is a clinical syndrome characterized by the immediate and transient impairment of neural function. This includes alteration of consciousness, disturbance of vision, and loss of equilibrium owing to mechanical injury" (Brotzman, and Wilk). Now, athletic trainers and coaches take extreme precaution when there is a suspected concussion. Trainers must look for symptoms like headaches, nausea, vomiting, dizziness, poor balance, sensitivity to

noise, ringing in ears, sensitivity to light, blurred vision, poor concentration, memory problems, trouble sleeping, drowsiness, fatigue, sadness/ depression, irritability, and neck pain. If a trainer was asked to look at a concussion twenty years ago, Matthew Greene PT, DPT, CSCS said “there was no rehab time you'd go back into the game, no testing. Now, it's much more strict, athletes must pass guidelines and must wait a certain amount of time to be cleared to play. Other tests for concussions include “ABCs (Airway, Breathing and Circulation), Evaluate for loss of consciousness, cervical spine assessment, cranial nerves, coordination, and motor function, assesses cognitive function, short term and long-term memory, and frequent reassessments of the injured player”(Brotzman, and Wilk). "What field are we playing on? Which team scored last? What quarter is it? Did our team win last week? What team did we play last week"(Brotzman, and Wilk)? “Recovery now, as far as I know is ‘wait and see’ type of thing” (Greene). If the trainers do not follow the guidelines there is a possibility of Second Impact Syndrome. Second Impact Syndrome is where an athlete’s returns to play before being cleared, and obtains a second concussion. Vascular engorgement leads to massive increase in intracranial pressure. This can be followed by death. With the various symptoms that have occurred, doctors, trainers, coaches, and physical therapists, have become more involved in concussion awareness and making sure the players are one hundred percent clear before taking another step on the field. The understanding of concussions has also skyrocketed in the past years because the increase in MRI machines and research on the swelling of the brain. In the past, the guidelines for concussions were very vague and useless. In the NFL, trainers would send in the player back in by the next quarter. Research has indicated that former NFL players have suffered from diseases like Alzheimer’s, Amyotrophic lateral sclerosis (ALS), and significant memory loss. But with the help of research and understanding the brain, doctors have come up with “a systematic approach to management

of concussion requires that all sports medicine personnel involved in treating athletes must be familiar with instruments, procedures, and recommendations for evaluation, follow-up care, and return-to-play decisions” (Anderson, Oliaro, and Hooker). With the numerous effects over the years that concussions have had on teenage athletes even Washington Legislature has passed the following law "The first of its kind, it requires young athletes playing or practicing on public property to be removed from practice or competition if they are suspected of sustaining a concussion or head injury. The athletes must then be evaluated and cleared by a licensed health care provider trained to evaluate head injuries a definition that includes certified athletic trainers- before returning to play"(Foreman). With the medical advancement, more cautionary measures have been available to the teenage athlete. Although it is a watch and see process, doctors have prevented a number of serious consequences from increasing. Trainers and coaches now know what to look for and are very precautious for the athletes on the field. Before the season starts in high school,” The law also requires coaches, student athletes and their parents to be educated about head injuries, ranging from courses for coaches to flyers for parents and students. Athletes and their parents must sign a concussion and head injury information sheet before beginning practice each season"(Foreman). The athlete normally goes through a series of different tests including a post-concussion scale (See Diagram A), cranial nerve testing (eye tracking, pupil reactivity, etc.), balance error scoring system (See Diagram B), and the Standardized Assessment of Concussion (See Diagram C). From the advancement made in research towards concussions, people have begun to take concussions very seriously. The research collected has caused varying opinions on how to assess and send a player back on the field, which is better than not enough information given and endangering the athlete.

Concussions vary on a vast level unlike other injuries. Depending on the strength of the hit and the intensity of the swelling of the brain the symptoms and rehabilitation varies. When cervical concussions occur, caused from whiplash, therapists recommend “Mostly soft tissues massage to cervical spine, around the upper trap area and a little traction (pulling on head to stretch the ligaments) Light stretches upper trap stretch, cervical rotations stretches and isometric exercises” (Greene). When utilizing modalities Greene said “electrics stem, electric massage to sooth the pain and muscles in the cervical spine.” Concussions, especially for physical therapists, really seem to be a touch and go process; there is not really a correct way to treat concussed athletes. Many athletes are told to stay away from bright light and not to perform any mentally draining activities. When getting back into the sport of choice athletes can now choose to wear concussion headgear such as Full 90 Sports. Jeff Skeen, creator of Full 90 headgear wrote “The benefit of wearing our head gear is that it significantly reduces the impact forces reaching your head” (“Rock Center: With Brian Williams”). The headgear not only protects soccer players but there have been other options for other athletes, not only getting back on the field but giving a sense of stability when they play. With the increased importance of preventing concussions other companies have come out with similar products like, ForceField Protective Headband, Brain-Pad, Head Blast, and DonJoy Hat Trick. Physical Therapy modalities have not been as effective on concussions as they would be on other injuries but with the increased importance can only increase the number of tasks people to prevent, protect, and safely recover. Instead of going back in quicker, the precautions taken have made it slower to get back into the game, but the time lost on the field will only benefit the athlete in the long run. Without the research that has been done today, there would be a lot more concussions on the field with more extreme consequences, leading to an even bigger risk for all contact sports.

Track runners and teams that play on Astroturf fields often suffer from shin splints. Shin splints or Medial Tibial Stress Syndrome has become an increasing problem with high school athletes. “Anterior shin splints are treated with aggressive warm-up stretching, with particular attention to gastro soleus-Achilles tendon complex. Anterior symptoms may also respond to decreased shoe weight and level running surfaces” (Brotzman, and Wilk). Another very symptomatic injury, dealing with the anterior tibialis. Greene says it often comes from “dorsiflexion of the foot. The anterior tibialis pulls the shin and the periosteal (outer layer) of the tibia and causes it to become inflamed. When you run your heel strikes first, the anterior tibialis slowly lowers the foot and causes inflammation.” Mayo Clinic wrote that the following symptoms would be prevalent for shin splints “Tenderness, soreness or pain along the inner part of your lower leg, Mild swelling in your lower leg” (Staff). Shin splints in teenage athletes is normally taken lightly between but if ignored there could be possibilities of stress fractures and breaking of the bone. With the advancement of technology doctors are able to see the shin splints through the X-Ray and MRI.

From the understanding of shin splints doctors have been able to diagnose the problem easier and change their opinion from “work through the pain” to “rest more”. Shin splints has become a rest based injury in the past 20 years. People have developed shin sleeves that are designed to angle the pull of the muscle. There is also kinesio tape which is used to aid the muscle in its entirety. Unlike the previous KT tape, kinesio tape is more advanced and better lasting than the basic “off brand” KT tape, which from personal experience never sticks on, and never helps with the aiding of muscles. The good thing about kinesio tape is used to work on the deeper tissues in the area of pain. It pushes more fluid throughout the entire muscle, with hopeful results of stronger performances. Increasing the range of motion the muscle it is supposed to

reduce fatigue throughout the muscle and create a better range of motion. The small steps towards shin splints have resulted in vast improvements in performance, and with the addition to turf fields in many high schools the small steps are helping out the teenage athletes.

Therapy for the injury is simple. Green recommends “A lot of stretching, a lot of icing. Regular ice packs and ice massages because you have to get the inflammation out. After that you want to strengthen the anterior tibial muscle, a lot of eccentric exercises, lowering the weight slowly and control, getting longer but still working.” Thera Band exercises, resistance and eccentric exercises are recommended as well as walking on the heel. Ultrasound is also used. Ultrasound, sends sound waves into the body to vibrate the cells and heats them up and with that there is more blood flow to promote healing” (Greene). With the use of electric e stim it can speed up the recovery if there is a lot of pain the tibial muscle area. And also a newer process called Ionto phoresis. Ionto phoresis is a process where “put anti-inflammatory on a pad and it will go right over top of the bone where it is painful. The meds we use have a negative charge and we send negative electricity, so it repels the medication away from the pad and through the skin and into the body which decreases the inflammation in the area of the body”(Greene). From the new braces being introduced and anti- inflammatories have helped with athletes that suffer with shin splints. There is also the new introduction of toe-heel running not heel-toe running has also prevented the introduction of shin splints in many athletes’ lives. With the many modalities utilized to rehabilitate it is still most important to rest and ice to prevent stress fractures and longer recovery times.

Compared to the two previous injuries, ACL tears have become one of the leading injuries in teenage athletes today. The Anterior Cruciate Ligament (ACL) stops an athlete’s shin from sliding in front of the large bone in the thigh. Harpreet S. Basran wrote, "Anterior cruciate

ligament (ACL) injuries are devastating sports injuries with a rate reaching 300,000 injuries per year in the United States alone" (ACL Injuries, a Growing 22). Before the official diagnosis doctors have developed on field diagnosis techniques. The Lachman technique and the anterior drawer, "if the tibia goes too far it means it's torn" (Greene), are both used by athletic trainers to make preliminary diagnosis before the player goes for an MRI. Early symptoms also include a popping sound at the time of injury, swelling around the area within six hours, and harsh pain when putting weight on the injured leg. The understanding of the ACL tear has helped improved the repairing and rehabilitation. When the ACL tears it cannot repair on its own, Greene says "There are three grafts the doctor can pick from patella, hamstring, or cadaver. The patellar graft they'll move the patella into your ACL. Same with hamstring and last one is a cadaver graft. The doctor determines what they want to use. Using a tendon into a ligament the body turns it into a ligament. Through its healing time it will turn the cells around" Unlike twenty years ago doctors have switched to a less invasive surgery. Arthroscopic surgery, only involves three holes in the knee. Twenty years ago doctors would open up the whole knee to operate on their patients. With the improvement of understanding the injury doctors have made faster decisions to diagnose and operate on the problem.

From new research, doctors have found many different aspects that help with the understanding of the injury. From the surgery required, research has developed a faster reconstruction and rehabilitation time. "A prolonged period of rehabilitation for restoring the strength of the muscles around the joint and proprioception is needed after surgery. Particular emphasis should be placed on the hamstrings as these muscles have a similar function to the ACL, preventing forward displacement of the tibia with respect to the femur (Ekstrand, 1995)." (Reilly, Howe, and Hanchard 141). Research has already improved the understanding of how

Doctors operate. Switching from opening the full knee to just having three holes to operate on as previously stated. The rehabilitation has been split up into five stages to gradually increase the strength of the healing ACL. Physical Therapists have been given strict guidelines on “goals, braces, how much weight the knee can bear, exercises, muscle stimulation, continuous passive motion, ice and elevation, and different tests that can take place throughout rehabilitation time”(Clinical Orthopaedic Rehabilitation 287). Not only has the research increased but the seriousness of the ACL tear has also increased immensely. Focus on the ACL has become a wide trend in both female high school soccer and NCAA play. The innovation of braces and exercises has shown the lengths of research being done, for the injured player. And it only continues to become more and more powerful, including faster rehab times and easier surgeries for the problem.

Modalities, by far been the biggest part of the decreasing ACL rehabilitation time. One machine being used is the Biodex machine. Greene explains, “It’s a big massive chair that you can do any exercise. You can do passive, eccentric, isometric, etc. This machine will also measure the force you can put through it. Basically if it's stuck in one position, you can push against and it will measure the strength you're progressing with.. You can make better goals for reaching full rehab time. Better range of motion.” The Biodex is classified as a computer-controlled dynamometer, “are used to test muscle performance and for training purposes during rehabilitation programmes” (Howe and Hanchard 14). Greene also states that during rehab, “We'll use a lot of ice and heat, some e-stem if they're in a lot of pain, if they need stretching sometimes they'll do ultrasound a muscles that isn't stretching well” Through the different phases, light stretching and range of motion will be in the beginning, the move into heavier strengthening (lunges and squats), moving into straight-line walking and running as well as

agility into sports specific exercises. The focus on braces has also become a huge part of the healing process and has become an essential modality for athletes today. As the phases and days change so do the braces used to hold the knee in place. In the preoperative phase it is suggested to use elastic wrap or a knee sleeve to reduce the swelling. As the patient progresses to the immediate postoperative phases (Day One through Seven) the brace goes from a transitional hinged braced locking in fully extension to an EZ wrap brace/immobilizer. When entering the early rehabilitation phases (Weeks two through four) the brace is taken off for week two through three. In the controlled ambulation phase (week's four through ten) there is no brace or immobilizer recommended but a knee sleeve is acceptable. The Advance Activity phase which is weeks ten through sixteen has no recommended braces, which is when the athlete should slowly start moving back onto the field. Greene states that modalities have "Probably [impacted] more than any injury. It's significant. As far as from day one to what is going on to all the machines out there to rehab with and all the surgeries are much better than they were twenty years ago." Modalities have made this crossroad a lot easier to get through than before. With the new understanding of the ACL tear, doctors, researchers, and physical therapists, have developed many modalities like the Biodex machine and the knee braces to help the recovery of a teenage athlete.

All three injuries, concussions, shin splints, and ACL tears, have been drastic injuries to teenage athletes lives. Concussions have become an increasing problem, and with the more information research finds the more doctors will do to prevent serious concussions from happening. The shin splints have become a rest based injury, which should be for any injury; instead of the "suck it up" approach research has given data that has proven otherwise. With possible breaking of the bone and discomfort, trainers and coaches have become more aware of

the problems a lot of track athletes face. ACL tears have also become an increasing problem in the athletic spectrum, specifically in soccer and basketball. With the new surgeries and modalities that are offered ACL tears have gone down from a year of rehabilitation to eight months of rehabilitation. From the lengths of research that has been made in the past two decades there have been great advancements in the rehabilitation of patients. Through the first diagnoses made on the field, to the understanding of the injury all together, and the modalities that are used to speed up the process. Injuries are unavoidable but with the right techniques and the right modalities the rehabilitation will fly by. Technology has paved a way for the rehabilitation era, there has been a huge decrease in downtime, with an exception to concussions, and athletes have gotten back on the field within a year of their specific injury. It can only increase from this point and athletes can only rehabilitate faster with the new advancements being made. With the hard work and dedication the teenage athlete injuries will eventually become minimal and easier to rehabilitate from. With the possibility of health, there is possibility that more injuries could emerge. Technology will somehow find a way to fix the new injuries for teenage athletes everywhere, and enhance the treatment for the future.

Appendix:

Diagram A:

Symptom	Preseason Baseline	Time of Injury	2 to 3 Hours Postinjury
Headache			
Nausea			
Vomiting			
Dizziness			
Poor balance			
Sensitivity to noise			
Ringing in ears			
Sensitivity to light			
Blurred vision			
Poor concentration			
Memory problems			
Trouble sleeping			
Drowsiness			
Fatigue			
Sadness/depression			
Irritability			
Neck pain			
Total score			

*0 = none, 6 = severe.

Diagram B:

Scorecard (No. of errors)	Firm Surface	Foam Surface
Double-leg stance		
Single-leg stance		
Tandem stance		
Total errors		
Total score		

Diagram C:

Grade	Level of Consciousness	Cranial Nerves, Cognition,* and Coordination (3 Cs)	Headache
0 (mild)	No LOC†	Mild confusion but asymptomatic in 10 minutes; passes functional tests without recurrence of signs and symptoms	Possibly develops later
1 (mild)	No LOC	At least 1 of the following is present: 1. Abnormal cranial nerve function lasting <1 hour 2. Abnormal cognition lasting <1 hour 3. Abnormal coordination lasting < 3 days	Probable; lasts from 10 minutes to as long as 2 days
2 (moderate)	Brief LOC from 10 seconds to 1 minute or altered consciousness lasting <2 minutes	At least 1 of the following is present: 1. Abnormal cranial nerve function lasting >1 hour 2. Abnormal cognition lasting >1 hour 3. Abnormal coordination lasting longer than 3 days	Probable; lasts 24 hours to 4 days
3 (severe)	LOC >1 minute or altered consciousness lasting >2 minutes	2 of 3 Cs are abnormal for more than 24 hours	Likely; lasts longer than 4 days

*Cognition includes orientation, memory, concentration, and attention.

†LOC indicates loss of consciousness.

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