Project Affordable Spring Ankle Brace

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Project number 3-47

Problem finding

In our group, 3 of us are in a sports cca. We find that we often have soreness and pains in our legs after a tiring day of training. Some of the pain goes away, however some of them are more permanent. While we thankfully have not had any ankle sprains, our seniors are often seen wearing assorted leg braces or guards. Our interest peaked and we wondered how effective a piece of cloth could really be. After further research, we found that there are many different kinds of braces, and decided to do a project on knee and ankle braces.

Defining the problem

According to a survey in 2014 and 2015, the most common injuries in sports like Track & Field are knee and ankle injuries, followed by hamstring tears and hairline fractures. The most common knee injuries are Runner's knee and Jumper's knee, and the most common ankle injuries are Achilles Tendonitis or Tear Ankle Sprain. Knee and ankle pains are also common in the elderly, they are a combination of inflexibility of the spine, also including hip joints and weak core muscles and compensation to the knee and ankle which leads to shifting of body biomechanics from the hip joints to the knees and ankles. This leads to them having to wear an ankle/knee brace. As most of us are in sports CCAs, our aim is to reduce the suffering of our young and aspiring fellow athletes, as well as the elderly suffering from knee/ankle pains or other conditions such as osteoporosis. (Target audience: Athletes and Elderly)

The BIG idea

We thought about how the existing ankle and knee braces are all made for one purpose: to help users recover from injuries. However, the braces work by stabilizing and immobilising the joint while providing heat and compression to the bones and muscle to stimulate recovery, which heavily restricts the movement available to your ankle or knee, and will affect daily activities such as walking up stairs or sitting down. Also, many existing ankle and knee braces are expensive and difficult to take care of, because they are made of non-washable materials. So, we thought about how we could create an ankle brace that serves to both help recover from injuries, and makes daily activities easier (especially for the elderly), by adding springs to the braces to reduce the load the ankle takes, and allows daily activities to continue with no hindrance, as well as making it more affordable and washable. Also, the brace would also not necessarily have to be worn with an injury. Thus, we came up with our idea for a Spring-Loaded affordable ankle brace.

Construction process

There are four types of braces. They include rehabilitative, functional, prophylactic and unloader braces.

Rehabilitative braces are used during or after an injury or surgery. They keep the knee stable but still allow limited movement while it is healing.

Functional braces are used to support knees which have previously sustained injuries in the past so as to decrease the chances of the injury happening again.

Prophylactic braces are used to prevent and reduce the severity of ligamentous injuries to the knee. They protect the knee joints from being injured again and are mostly used by athletes that play high contact/intensity sports at high risk for knee injury, or who previously suffered an injury.

Unloader braces are designed to relieve pain in people who have arthritis in their knee. It works by shifting the weight, or in other words, “unload it” from the damaged area of the knee to a stronger area. This is the type of brace our invention falls under.

After some research, we found that there are similar products on the market, such as the ALIMED Comfy Spring-loaded Ankle-Foot. However, it weighs 2.3 pounds (1.04 kg), meaning that it is slightly heavy. It’s price is also very expensive at USD$156.75 (SGD$227.18 as of 24/3).

Also, one of our group members has an older model of an ankle brace from a past injury. It weighs 0.74 kg, and has a price of $200. The inside is made of memory foam, which helps improve comfort but is very expensive, but it has no springs. Many reviews that we found complain about things that we found to be similar in both these braces.
Both these braces are similar in being:
Non washable - Springs are prone to rusting/ Memory foam is non-washable. Brace will get dirty.
Heavy - Springs are heavy/ Frame is big and outside is reinforced plastic. Both these objects/materials are heavy. Causes inconvenience.

Expensive - Springs will be expensive to design and manufacture/ Memory foam is very expensive. Makes brace expensive.
These all come with many disadvantages, for example, when the brace is not able to be washed properly, this results in hygiene issues, and in the long term lead to bacterial growth on the brace, or on the ankle and heel itself, which could potentially cause bacterial skin infections such as rashes and impetigo and cause discomfort for the user. Also, some may decide not to buy the product due to the expensive prices or heavy weight, and will instead resort to cheaper and more convenient options which could impact the speed and effectiveness of recovery.

With this information, we decided that our brace would be less expensive, lighter, and washable. We would do so by using lighter and cheaper materials, making the design collapsible, and making it open-toed to allow for better ventilation and less feet sweating. We also plan to use stainless steel springs, as they are strong, waterproof, and do not rust.

- Materials:

1. Neoprene
Neoprene is durable and resistant to water and oil, as well as being able to resist a wide variety of weather conditions such as degradation from ozone, sunlight, oxidation, sand, snow, and dust, which would allow the wearer to use it while training without damaging it. It is also machine washable so the wearer will not have to worry about hygiene issues. Neoprene is also light and stretchy to ensure comfort and convenience for the user.

2. Stainless Steel
The springs will be made out of stainless steel. This prevents the springs from rusting or breaking because stainless steel is strong and does not rust.

3. Rubber
Rubber will be used to make the soles of the brace to provide cushioning and grip for the user. The straps used on the brace will be made out of rubber as it is elastic and will allow the wearer to tighten or loosen the brace.

4. Nylon
Nylon is used for the velcro on the straps to fasten the straps in place.

5. Foam
Foam will be used to cushion the wearers ankle to provide stability and comfort.

All of these materials are easily accessible and affordable. The current material on most knee braces is neoprene and we will be sticking to this material as it is the most suitable.

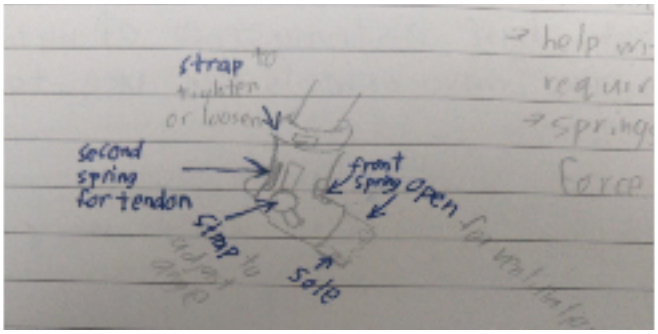
- Design:

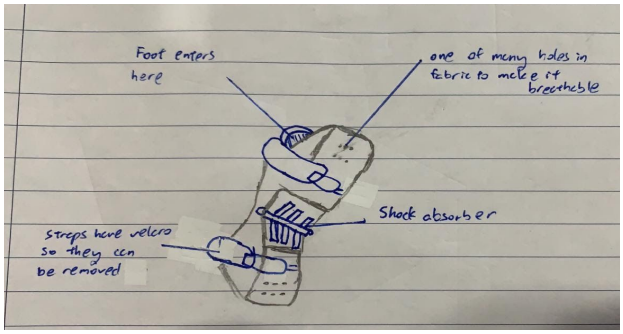
1. Collapsible design
We plan to make the brace collapsible to ensure convenience when packing, travelling, etc. It also allows parts that are hard to reach to be washed, and makes it easier to wear or remove it.

2. Ventilation
Outer covering for the brace such as the neoprene will have gill-like patterns along the top and sides to ensure proper ventilation, and will help users with sweaty feet and prevent bad smells.

3. Adjustable straps
Adjustable straps will decrease the need for constantly buying a new brace due to its one size fits all capability. This reduces the cost of manufacturing as we will not need to make multiple sizes

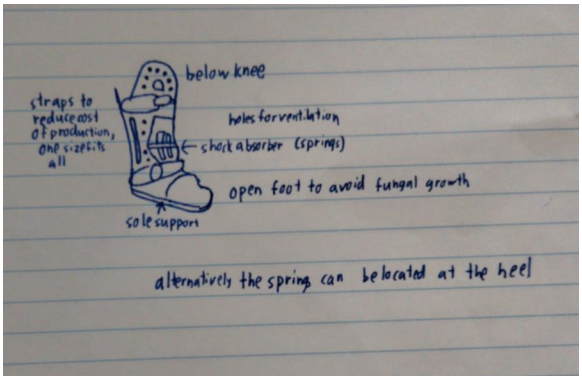
Modelling process



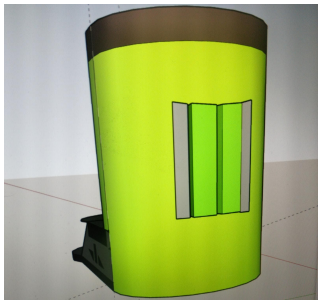


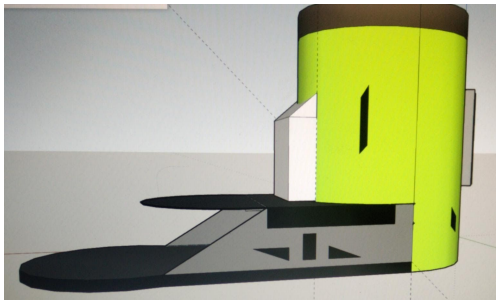
After deciding on the materials and designs for the brace, we started to make some sketches.

After this, we made a few minor tweaks and adjustments before finalizing the design that we would start to build.



Unfortunately, due to restrictions and an inability to work together from different classes, we could not build the brace in makerspace, and instead made an online design that was more detailed and to scale.





Some of the features of our brace include adjustable straps which will decrease the need for constantly buying a new brace due to its one size fits all capability. This reduces the cost of manufacturing as we will not need to make multiple sizes. There are also multiple holes in the fabric to enhance ventilation. Our brace also features an open-toe design to avoid fungal growth which is a huge hygiene issue especially for people who wear shoes for an extended period of time. The bilateral design further reduces manufacturing costs as it does not require different moulds for different feet. The white box-like object located at the front of the model is rubber covering 2 springs.The compact design will make it portable and easy to carry around. As stated before, it has adjustable straps so we will only need to make one size and thus reduces the cost as compared to making multiple sizes. An important factor that we will make sure of is that our product will not compromise on the quality and functionality of a brace.

References

Braceability, United States (April 25, 2018). The Four Types of Knee Braces
https://www.braceability.com/blogs/articles/the-four-types-of-knee-braces

Dorfner, Micah (January 20, 2017). Mayo Clinic. Brace for it: When to use an ankle brace
https://newsnetwork.mayoclinic.org/discussion/brace-for-it-when-to-use-an-ankle-brace/

Family Doctor, United States (May 11, 2017). Knee Bracing: What Works?
https://familydoctor.org/knee-bracing-what-works/

Ossur, Singapore. Unloader One advertisement
https://www.ossur.sg/oa-solutions/oa-products/oa-knee/oa-knee-braces/unloader-one

Technavio Blog, Europe (June 16, 2016). Top 5 benefits of using Neoprene in Industrial Products
https://blog.technavio.com/blog/top-5-benefits-neoprene