Osseointegration as a Way to Improve the Quality of Life for Lower-Limb Amputees

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Title: Osseointegration methods as a way to improve lower-limb amputees' quality of life.*

Speaker: Mimi Overbaugh

Image: A picture of an x-ray that shows the titanium fixture implanted into the bone.

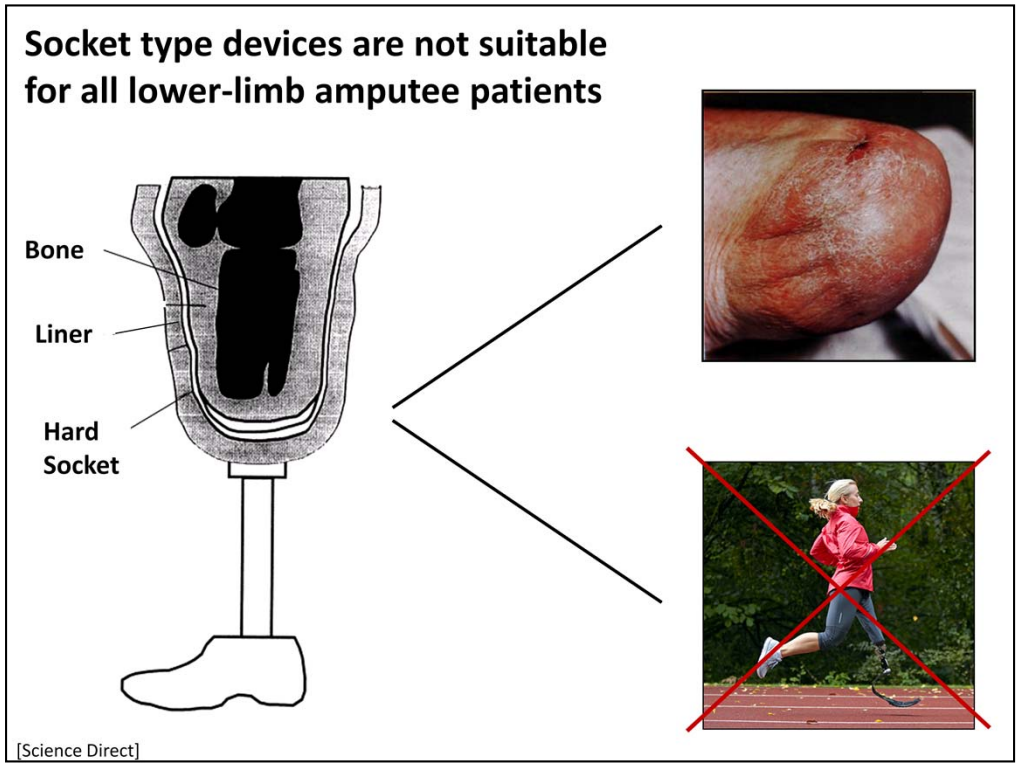
*This slide is for the handout only and was not projected during presentation.

Introduction:

Establish Importance: In 2010, Phill Coulson of New Zealand was riding his motorcycle when he was in a very unfortunate accident that caused doctors to amputate his right leg. For almost two years, Phill used a socket type prosthetic device, and he couldn't do all of the things that he used to be able to do before his amputation. He reported a lot of inflammation, skin issues and discomfort, as well as a lack of energy. Overall, Phil was dissatisfied with his quality of life.

Transition: If you recall from my problem speech, a great deal of patients using the socket type prosthetic device reported similar problems.

http://www.stuff.co.nz/nelson-mail/news/7608658/New-prosthesis-a-leap-in-right-direction (photo)



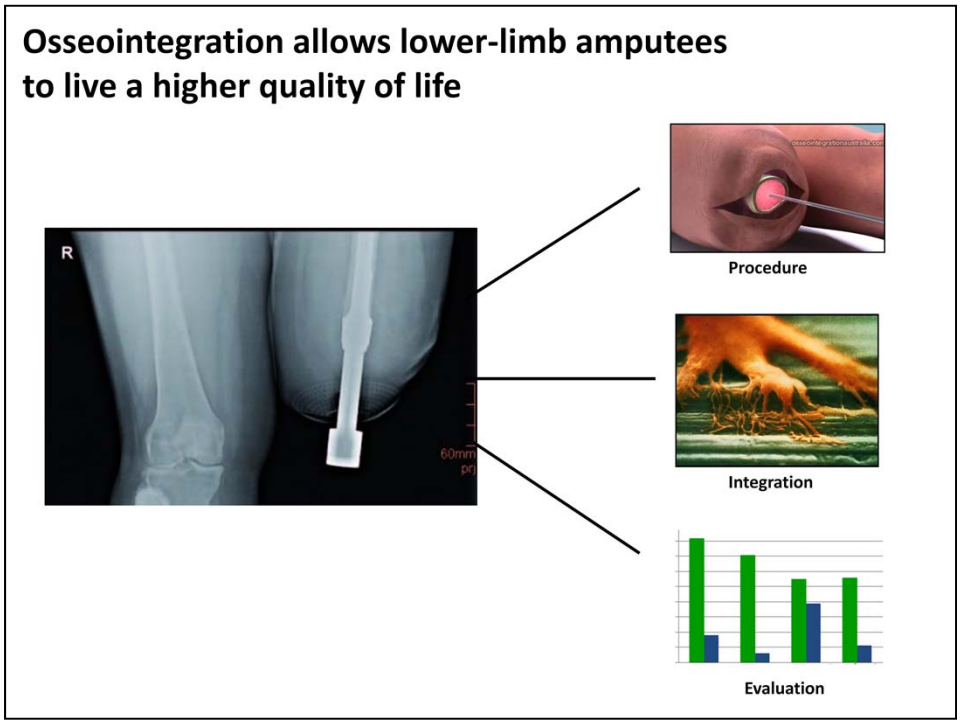
Summary of problem speech: The socket prosthesis is basically a plastic shell that the residual limb is placed in. The lack of air circulation and flexibility in the device often leads to many problems. For instance, numerous skin issues are reported amongst these patients, which affects their daily levels of physical activity. A study done by the US Department of Veteran Affairs showed that over 40% of patients still want to participate in higher levels of physical activity which might not be possible with this device.

Transition: These amputee patients truly deserve a better life than what they are living now. Therefore, a new method of prosthetic devices is available that could very well be a solution to this growing problem.

http://www.sciencedirect.com/science/article/pii/S0021929008001656 (photo)

http://www.oandplibrary.org/alp/chap26-01.asp (photo)

http://www.thecoolist.com/nike-sole-prosthetic-running-shoe/ (photo)



Thesis: Osseointegration methods allow lower-limb amputees to live a higher quality of life.

Credibility and Audience Relation: The reason that this method is so relevant today, is that in the past, only 250 reported patients have undergone the treatment in the European Union and Australia. However, the University of Utah just recently found out that DJO, a global leader and manufacturer of medical devices, is helping to fund research and development in the area. The FDA also is allowing the university to run a human early feasibility study, in which 10 patients will undergo the treatment so that we can start implementing it in the United States. As future engineers, it is our job to ensure the safety and comfort of our peers using these devices, and osseointegration shows a great deal of promise (University of Utah, 2012).

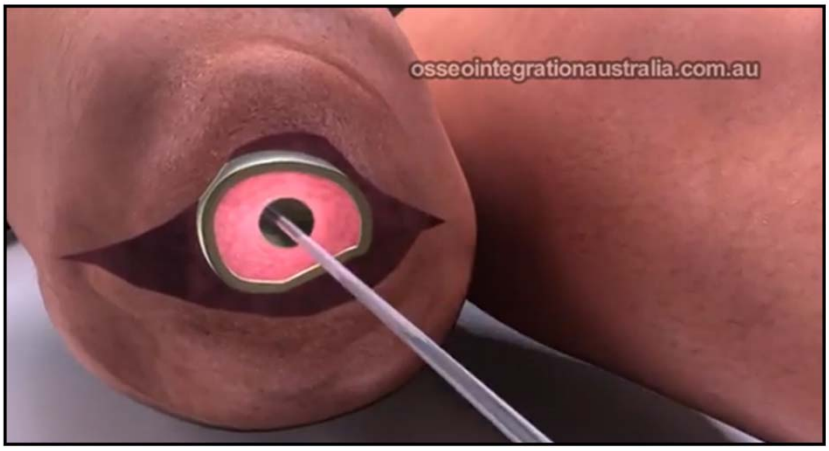
Assumptions: An underlying assumption about what constitutes a higher quality of life is that patients can rely on a long-lasting device that provides stability and comfort in daily use.

Limitations: Once again, I will only be discussing lower-limb amputations, osseointegration techniques using titanium fixtures, and I will not discuss the cost of the procedure. Also, because of time, I will not be discussing complications that might arise from the surgery.

Mapping: In my speech, I will first give you an overview of the surgical procedure as well as recovery process in order to better understand the method. Then I will talk about osseointegration and how this provides a stable fit as well as more sensation for the patient. Finally, I will end my talk by discussing some physical improvements that patients experience when they use the osseointegrated method rather than the socket device.

Transition: Let's start with some information on the procedure itself.

The prosthesis process begins when titanium components are implanted in a patient's limb during two surgeries



[Osseointegration Group of Australia, 2012]

Body

Main Point 1: The prosthesis process begins when titanium components are implanted in a patient's limb during two surgeries.

A. The Osseointegration Group of Australia, which is comprised of many orthopaedic surgeons, bioengineers, and prosthesis specialists, created this 1 minute long video to describe and animate the surgical procedure that must be performed (Muderis, 2012).

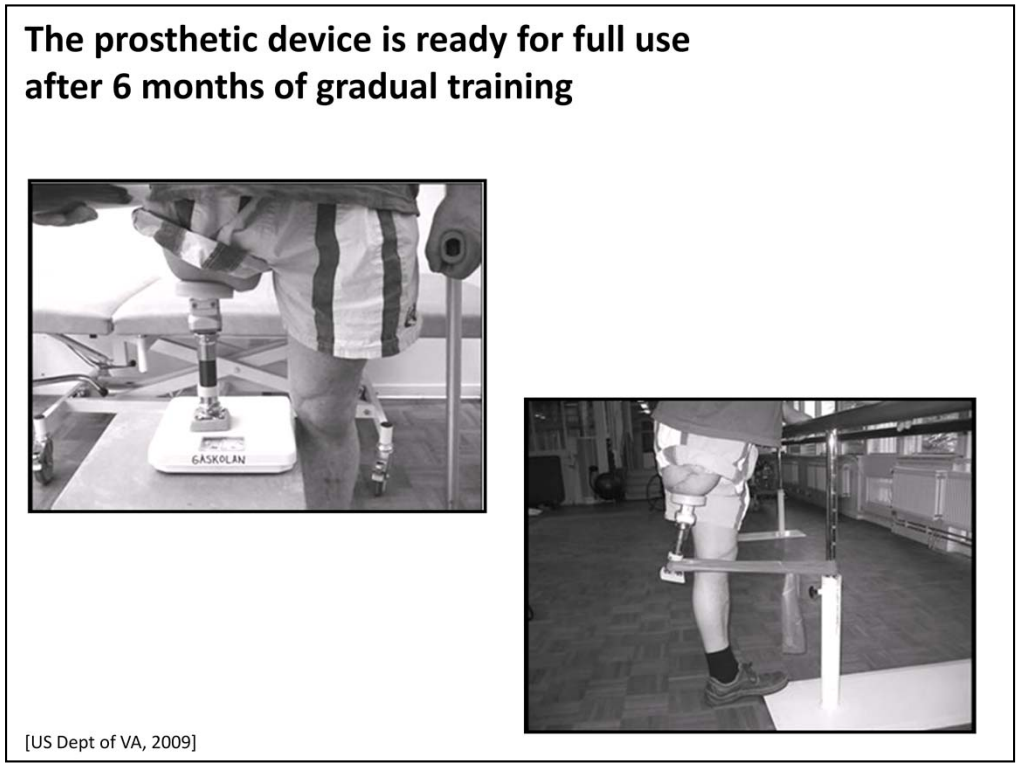
B. The procedure is a combination of 2 surgeries.

C. During the first surgery, the limb is cut open , and reshaped if needed. Then, a titanium fixture, much like a screw, is placed entirely into the bone.

D. The patient then recovers for about 6 weeks, and during this point, osseointegration takes place, which I will discuss soon.

E. Then, during the next surgery, an external abutment is attached to the internal fixture. This abutment acts as the connector to the bone and the prosthetic device. Note that there are also a sort of cover that goes over the stoma, which is the skin abutment interface it protect it from infection and other problems.

F. Finally, the prosthetic device can be attached.



Main Point 1 (Continued)

The patient is able to start gradually using the prosthetic device in only a matter of weeks. They use a shorter attachment to train on a bathroom scale. By gradually applying different weights, they can increase the load that the device experiences. They also must strengthen their hips and other muscles, so they will do activities with elastic bands. After they successfully complete training, they are ready to fully use their prosthesis (Hagberg & Branemark, 2009).

Transition: The strength of the patient not only comes from the physical training, but also from an internal transformation within the body.

http://www.rehab.research.va.gov/jour/09/46/3/Hagberg.html (photo)

Once the first surgery is completed, bone cells attach to the titanium fixture in a process called osseointegration

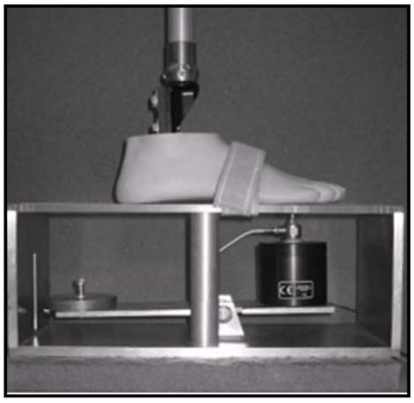
[Branemark Osseointegration Center]

Main Point 2: Once the first surgery is completed, bone cells attach to the titanium fixture in a process called osseointegration.

A. Recall from the video that there is a 6 week break between the two surgeries. That is because time must be provided for osseointegration to occur.
B. Osseointegration is when a device is anchored in the body due to the growth of bone around it.
C. The picture above is provided by the Branemark Osseointegration Center in Sweden, and its mission is to provide treatment for orthopeadic impediments.
D. Picture of a bone cell attaching to the titanium from a microscopic view (Barbo, 2010)
E. The reason that titanium is used, is because it is completely inert to bodily fluids, so therefore the body does not reject it as foreign material.
F. Shows that the titanium fixture truly becomes a part of the body, per say, which provides extra stability and control, because it acts as if it's an actual limb.

http://www.branemark.com/default.htm (photo)

Because of the integrated prosthesis, these patients can detect stimuli faster than those using socket device



[Psychoprosthetics, 2008 ; Center of Orthopaedic Osseointegration]

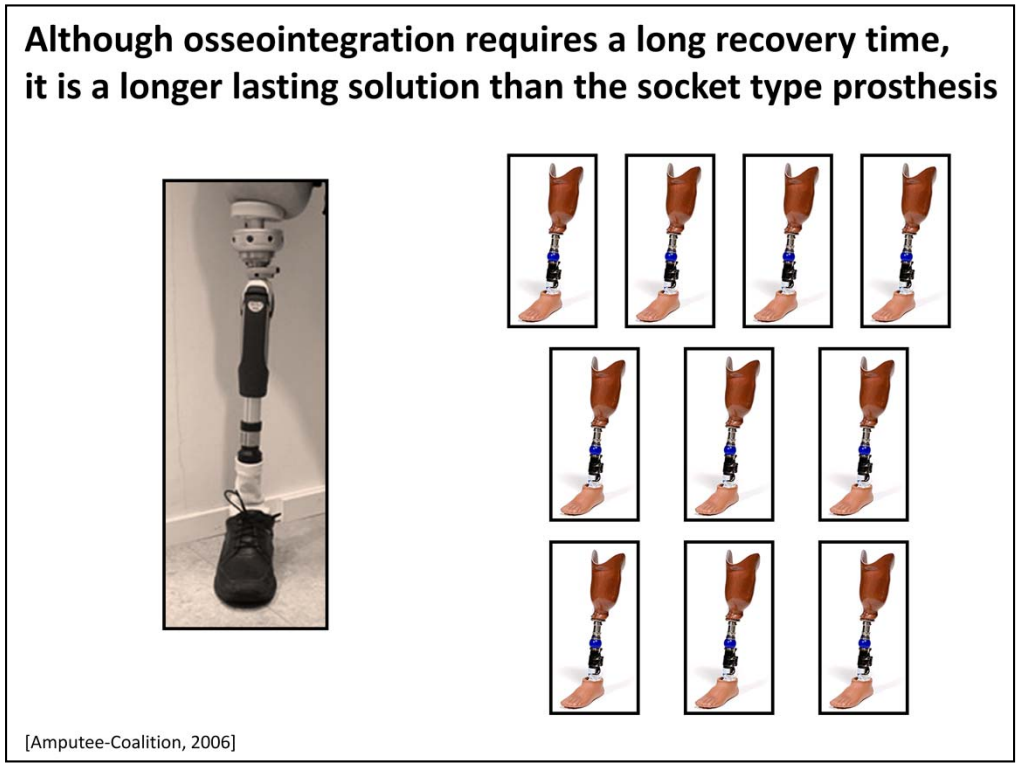
Main Point 2 (Continued)

A. In addition to added stability, osseointegration also increases sensation in the prosthesis
B. There is a physical way to test sensation, by using vibrametry, which uses the device shown on the left
C. The device is placed on a machine that contains a vibrating pin.
D. The device starts vibrating at a low amplitude, and gradually increases, until the patient can detect the vibrations by pressing a button, as shown in the right (Kerstin, 2008).
E. The threshold is determined and studies have shown that patients with osseointegrated devices can better detect both vibrations and pressure than those with socket type devices.

Transition: So, while osseointregration techniques enable a firm and stable fit, I'm sure many of you are still wary the long recovery process and its actual improvement over the socket type device.

http://www.springerlink.com/content/l82025032g78g063/fulltext.pdf (photo)(source)

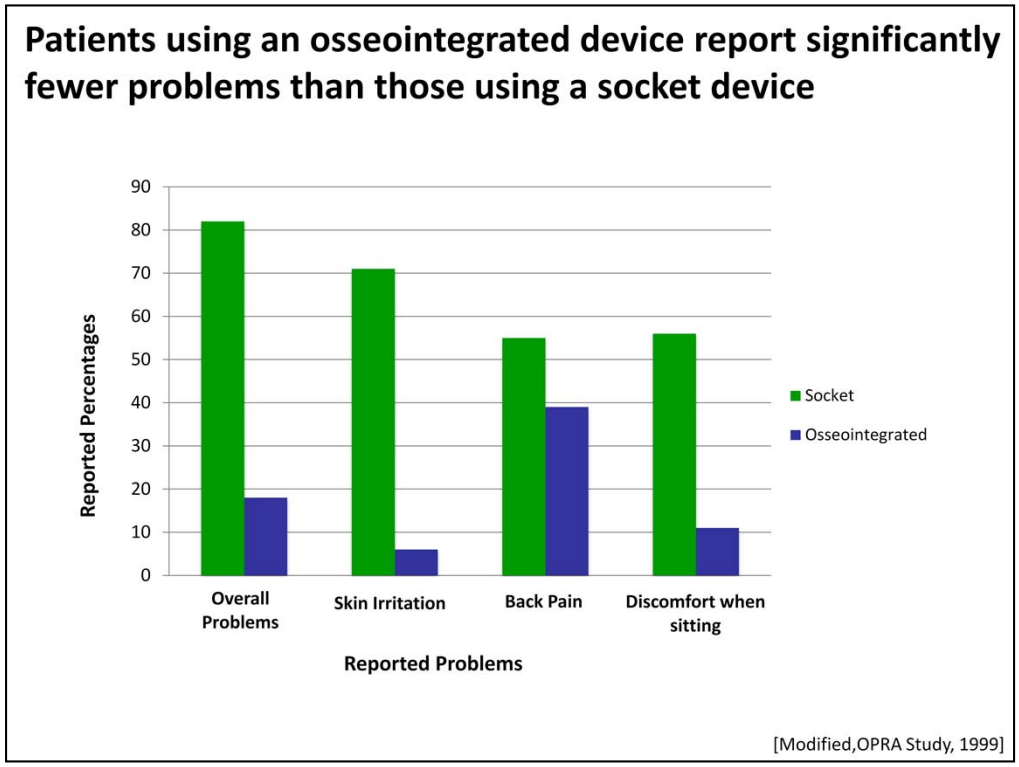
http://www.rehab.research.va.gov/meet/osseointegration.pdf (photo)



Main Point 3: Rebuttal Approach (First admit that it is a long recovery, but the device is long lasting. Then go into the main point that due to its longer life and a decrease in reported problems, it shows promise over the socket device.)

A. Also, some of you might be questioning the long recovery. After all, it does take 12 months to fully recovery and be able to use the prosthetic device comfortably every day.
B. However, when you compare it to the socket type prosthetic device, it is worth the wait
C. Although the recovery is longer for the osseointegration technique, the device should last you a lifetime. If there is a problem, it's typically with the wearing of the abutment, and this can easily be replaced.
D. According to the Amputee Coalition, a patient using a prosthetic device will have to replace the device approximately every 2-4 years, and possibly even more if swelling and discomfort occurs (Sabolich).
E. So, over a course of 20 years, a patient might have to have 10 different replacement devices.

So, because of its longer lifespan, the osseointegration method has promise. Additionally, patients are reporting less problems while using an osseointegrated device.



Main Point 3: Patients using an osseointegrated device report significantly fewer physical problems than those using a socket type device.

A. Finally, a study done by the OPRA, which is the Osseointegrated Prosthesis for Rehabilitation of Amputees, shows that osseointegration patients are generally experience less problems than patients using socket devices.

B. They gave out a questionnaire to socket and osseointegration patients to ask if they experience physical problems such as skin irritation, back pain, and discomfort while sitting (Kerstin, 2008)

C. The results are displayed in the graph above. On the y-axis is the reported percentage of problems, while the x-axis contains the actual problems. The light blue color represents the socket patients and the dark blue represents the osseointegrated patients.

D. The results are clear that the osseointegrated patients experience less problems than the socket patients, which means that they live an overall more comfortable life that is not burdened by these physical problems.

Transition: So, if you think back to Phil Coulson, who used both a socket type attachment as well as the osseointegrated device, he reported very similar problems to the ones presented on this graph. So, instead of living a life of pain, he took control of his future and decided to undergo the osseointegration surgeries.

In conclusion, osseointregration allows lower limb amputation patients to live a better life

[Phil Coulson]

Conclusion: After a fantastic recovery, Phill is living the life that he never could have imagined with the osseointegrated device. In fact, just 4 months after the second surgery, he already has gone snorkeling in Fiji and visited a hot thermal spring in New Zealand. He even bought a snowscoot to use, which is similar to skis. He has already noticed a significant increase in energy, and a decrease in skin problems (Coulson, 2012).

Restate Thesis and Emphasize: In conclusion, osseointegrated prosthetic devices provide lower limb amputee patients with the opportunity to live a better life. This success is due to the two part surgery that has an excellent rehabilitation program, as well as the osseointegration that occurs between the bone cells and the titanium fixture. Finally, patients report a drastic decrease in problems using the osseointegrated device over the socket type device.

Phill is just one example of a patient who was unhappy with his socket type device, so he changed his life by using an osseointegrated device instead. He is extremely pleased with his decision, and hopefully other amputee patients will someday be as happy as he is with this promising prosthetic device.

http://www.google.com/imgres?q=phil+coulson+prosthetic&um=1&hl=en&sa=N&biw=1280&bih=709&tbm=isch&tbnid=sWIxzbtVALA6SM:&imgrefurl=http://www.stuff.co.nz/nelson-mail/news/5691677/Crash-victim-thanks-helpers&docid=gREBn7RK7Z7YWM&imgurl=http://static.stuff.co.nz/1317081775/990/5691990.jpg&w=360&h=433&ei=1CuPUOihBuXV0gGRz4Aw&zoom=1&iact=rc&dur=408&sig=111432059155061707915&page=1&tbnh=146&tbnw=122&start=0&ndsp=20&ved=1t:429,i:98&tx=72&ty=72 (photo)

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