

# HOW DOES OSSEOINTEGRATION IN LIMB RECONSTRUCTION WORK?

## Authors:

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*Osseointegration is a surgical method which introduces metal into bone with the purpose of achieving permanent bonding between them.*

It has been shown in experiments that bone and some metals can bond if certain criteria are fulfilled. This method is widely used in dentistry for implanting/replacing missing teeth, joint replacement surgeries (so called uncemented hip, knee, or shoulder replacements) and recently in amputees as well.

To improve the chances for success, the metal surface should be coated. Experiments have shown that HydroxyApatite (HA) coating - which is itself one of the bone building blocks - is optimal, enabling long term intimate bone-metal contact. In healthy bone, HA will represent half or even more of the bone. This proportion can change if the bone is affected either by inactivity or a condition of some form.

### **Bone changes due to inactivity**

Inactivity will cause the bone to become softer and thinner (disuse osteopenia). The main reason this happens is that the bone notices lower loading, which triggers a lower replenishing rate for bone. This is because bone is a living tissue and - as with many other tissues in the human body - it responds to increased use with strengthening and to disuse with weakening.

### **Bone changes due to conditions**

It is clearly going to be dependent on the condition, but while the bone quality can change in different ways, in the majority of the conditions the bone will get weaker or more brittle, and in some conditions it will get considerably harder. None of these are good in the long term.



Client with Daryl Robinson, Catastrophic Personal Injury Lawyer, Barr Ellison

## Growing new bone

The time it takes for a new bone to grow on HA implants varies, but on average it is between 6 weeks and 3 months, and is the main reason for delaying loading of osseointegrated implants - time is needed to allow osseointegration to take place. All osseointegrated implants (whether surgical or dental) are inserted into a predrilled hole in the bone. The hole has to be of an exact diameter to allow for press-fit insertion of the implant. This enables the initial stability required for osseointegration to take place. If there is movement present between bone and implant, the new bone will not be able to adhere to the implant irrespective of the coating.

The initial response of the bone is to move away from the implant (so called bone reabsorption) and then to lay a layer of new bone in place, thus achieving full contact by obliterating the space completely. When the process is completed, the implants can be loaded as there will be no movement between bone and implant. The implant has become a part of the body.

## Complexities of amputation surgery

In joint replacement surgery there is no requirement to get the implant through the skin, as the whole implant is safely buried underneath the skin with no outside world contact. However, in amputation surgery there is a need to attach the external prosthesis or similar to the implant in the bone and at the same time breach the surface protection layer i.e. the skin in the case of amputees.

In dentistry, bringing the implant through the gum does not represent a major problem due to the very limited mobility of the gum around the osseointegrated implant, which permits the gum to adhere to the implant quickly and securely.

Unfortunately this is not the case for amputees because the skin and muscles on the stump will move during movement of the stump (walking, exercising, ...) causing irritation in the transition zone or stoma (the opening of the skin where the implant comes through).

## Alleviating the issue

Adjustments of that part of the implant in contact with the skin can certainly decrease the issue but will not alleviate it completely. Surgically the stoma can be shaped differently to minimise the soft tissue in the vicinity of the implant, but this is not a clearcut decision. The less soft tissue around the stoma, the less irritation it can cause; however it is still not clear if it results in less infection of the bone.

## Prerequisites for OI to work

It not just the bone quality which is relevant for the OI to function properly. Muscles control the joints and movements of the limbs and, in the case of an amputation, certain muscles will be lost. In the case of a very short bone stump, it is likely that few muscles will be left to control the joint, whether the hip, knee, shoulder or elbow.

Unfortunately it is almost impossible to get a good assessment of the muscle power of a short stump prior to the OI process, because the stump cannot be controlled sufficiently. From this perspective, it is reasonable to expect that - despite the successful OI implant and procedure - the function of the prosthetic limb will be less than that of the non-injured one. The limb will be weaker and it is very likely that, despite vigorous exercising, the muscle remnants will never regain the strength to perform at the level

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Dr Matija Krkovic, Limb Reconstruction Specialist

of the non-injured limb. The volume of muscles has been depleted and even after building up the existing muscles they are unlikely to ever achieve the same strength as the non-injured limb.

### **Managing expectation**

So, if the stump is very short we have to anticipate that the function of the limb post OI will be decreased, though certainly better than before the OI. It is important that we do not raise false hopes.

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### **Other potential issues**

As in any surgery, the risk of infection is the biggest threat. Indeed, infection is likely to be the main reason why the procedure may fail.

Another potential problem is fracture. The bone is usually weakened by disuse over a long period of time, because of the injury. When loaded through the OI - despite the fact that failsafe connectors are used (these are intended to break before the bone does) - the bone can still break. Fixing this type of fracture can be challenging because the majority of the bone is likely to be covered by the OI stem, leaving few options for repair of the fracture. Fortunately, modern surgical implants do offer some solutions, but this nevertheless is a difficult position for a patient to be in.

Additionally, there are significant risk of issues related to the stoma, which can cause a lot of pain and discomfort. Usually they can be treated with antibiotics, and regular stoma care alleviating the symptoms can reduce them to a bearable level.

### **Funding options**

While modern medicine will continue to make steps in the provision of OI options within the NHS, private funding will be the most likely option for the foreseeable future.

As a result of a civil claim for compensation, an applicant for OI is likely from the outset to have a rehabilitation package overseen by a clinically trained Case Manager with experience in amputation claims. During this process many options are available in terms of support, including accommodation along

*It is a surprise to many that, outside the provisions of the NHS, a private rehabilitation package can be made available*

with aids and equipment. While traditional socket-based prosthetics are available through a number of capable providers throughout the country, the option of OI has become more popular. The Case Manager will report to the instructed lawyer if OI is a viable option.

Once it becomes the client's preferred option, steps will be taken for them to attend an OI provider for a full assessment, including costs. On the basis of this information, the lawyer will

produce costings to the Defendant in order to secure funding. It is possible that the Defendant will resist this option and if so, then an interim payment to cover these costs can be secured on a 'general' rather than 'specific' basis. This will help to secure the funds to proceed with the client's wishes.

Generally, Defendants are not averse to a client opting for OI; but they will need to see evidence that it is the right and appropriate option. There can in fact be savings when compared to socket-base mouldings which sometimes have to be altered every few years.

### **What are the costs?**

Costs will include the fees for the surgeon, the anaesthetist and the hospital as well as equipment costs and a programme of anatomical and psychological consultations before and after the osseointegration. It is imperative that all these costs are covered in the initial assessment.

It is also essential to cover the costs of a full rehabilitation support programme post-osseointegration. The programme will be prepared by the Case Manager and will include education in order to identify the onset of infections and a programme of physiotherapy, generally working with the client on an ongoing basis.

### **Dealing with contingency events**

Cost estimates will also need to include contingency for a failed osseointegration or some form of revision not just within a short period of OI but also over the long-term.

Clients have had to return for further osseointegration several years after the initial surgery to deal with unanticipated complications. Costings will therefore need to cover this risk and the need for a further rehabilitation programme following revision osseointegration surgery. This may require the reinstatement of a Case Manager and other professionals, such as a physiotherapist.

There is also a need for allowance to be made for the client's own losses that may arise such as loss of earnings, etc.

It would be prudent therefore to obtain a further prosthetist and, if required, dermatologist report some 12 months or so after the initial osseointegration. This will report on progress and enable the assessment of future risk and will also be relevant to assessing future aids and equipment needed, should the applicant have to resort to socket use in place of osseointegration.

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