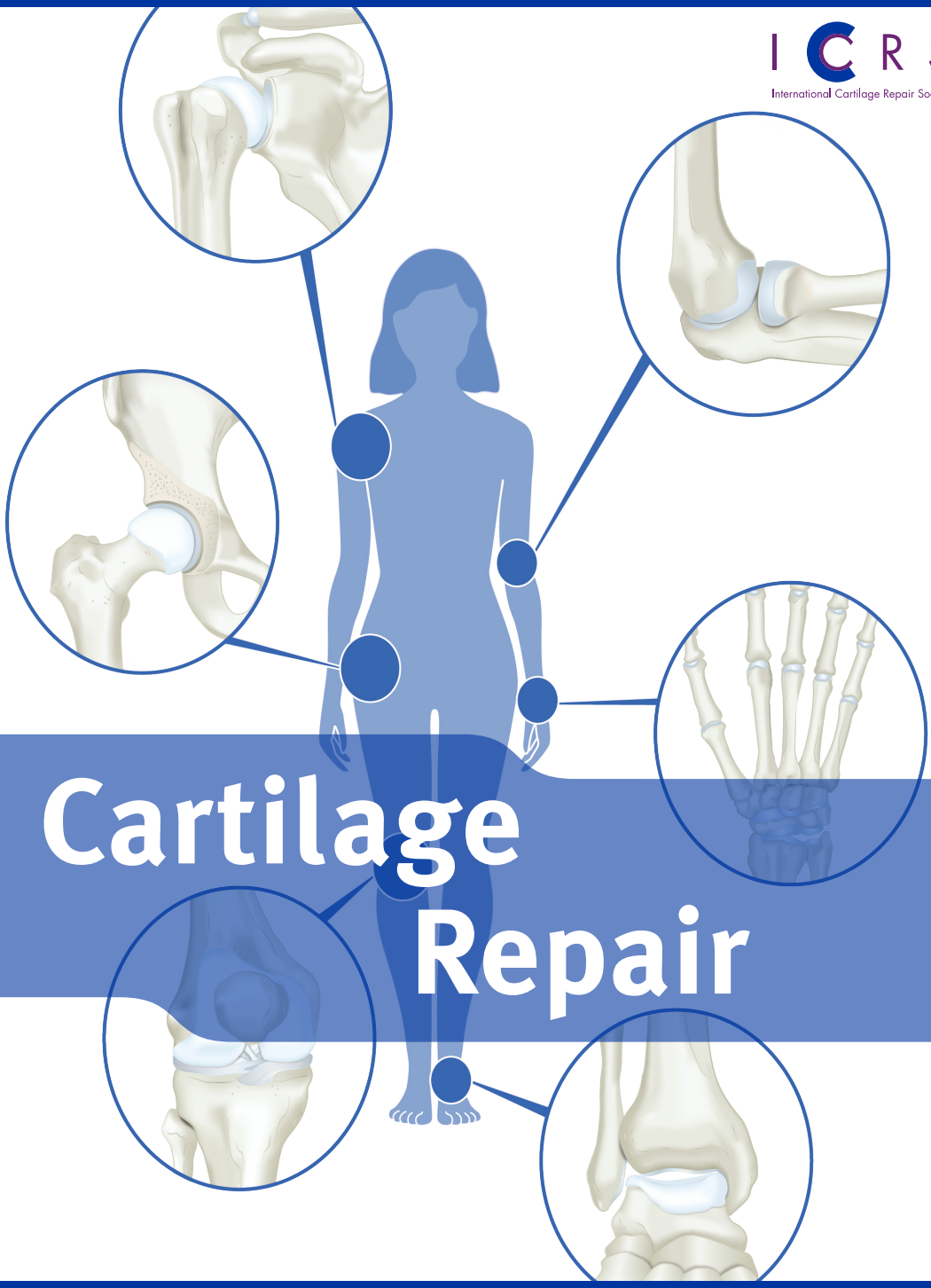
ICRS

International Cartilage Repair Society



Cartilage Repair

Introduction

If you suffer from joint pain, you are not alone. Each year, more than 50 million people visit their doctors because of joint pain — half of them with a damage of the articular cartilage. In this brochure, you can find useful, updated information on specific cartilage-related conditions and possible treatments options, written by world-renowned experts in this field.

Intended Audience

People of all ages can suffer from cartilage complications, whether due to 'wear and tear' or injury. While the former is much more common in middle-aged patients, and even more so in women, injuries to the joints, such as trauma or accidents during active sports, can affect any age group or gender. Careers requiring repetitive or intense motion can increase the risk of developing cartilage problems, but there are several other risk factors, including age, weight and genetic predisposition.

Acknowledgement to the Mäxi Foundation

This brochure would not have been possible without the substantial support of the Swiss "Mäxi Foundation". The ICRS would like to express a deep gratitude for this very generous contribution to the International Cartilage Repair Society, making it possible to provide updated information about cartilage damage and cartilage repair technologies free of charge to interested persons.

Acknowledgement to the Authors

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Disclaimer

The information in this brochure is not intended to treat, diagnose, cure or prevent any cartilage related issues. Always seek the advice of a physician or other qualified health care provider with any questions you have regarding your medical condition.

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Dear Patient

The human body is a complex and fascinating structure that allows us to perform all the actions of daily life that we take for granted.

Alongside many systems that are crucial for existence, the musculoskeletal system, which consists of bones, joints, muscles, tendons and cartilage structures, allows us to move. It also provides form, support and stability to the body.

Cartilage repair and regeneration are treatments for joints that have damaged cartilage but are otherwise healthy.

The treatment is recommended for patients with cartilage damage or deterioration caused by:

- **Injury or trauma**, including sports injuries
- **Repetitive use** of the joint
- **Congenital abnormalities**, abnormalities a person is born with, that affect normal joint structure
- **Hormonal disorders** that affect bone and joint development, such as osteochondritis dissecans (OCD)

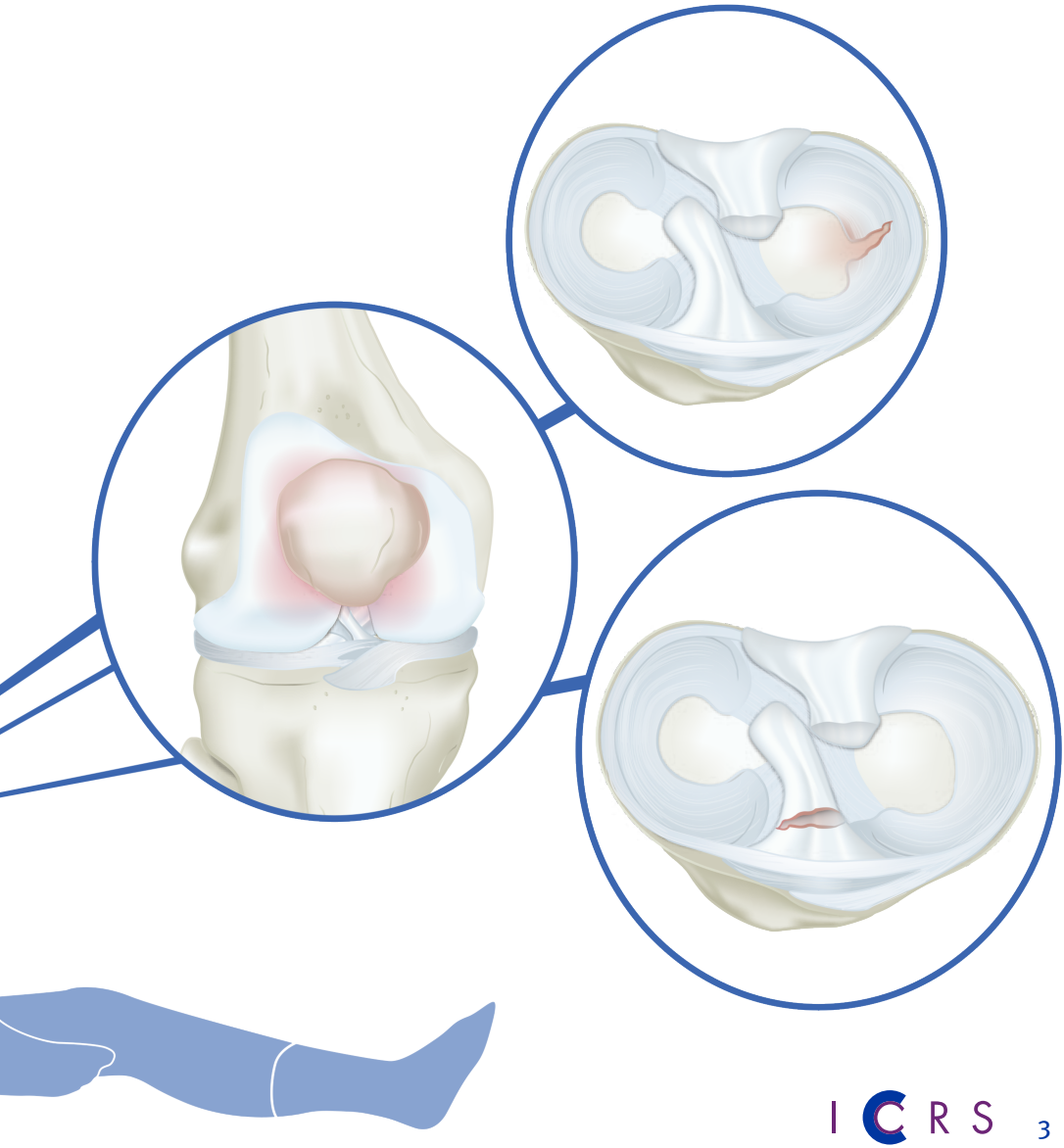
In this brochure, we focus on articular cartilage repair treatment, which means the restoration of damaged hyaline cartilage in the joints.

Cartilage damage to your joints can be painful and if damage is left untreated, it will most likely increase over time until all the surrounding cartilage is worn away.

It is therefore very important that you talk to your doctor if you are experiencing pain in any of your joints.

We hope that this information will be useful. For more information, please visit our website www.cartilage.org.

Yours faithfully,
ICRS Board



1. Introduction

What is Cartilage?

Cartilage is a tough but flexible tissue that is the main type of connective tissue in the body. Around 65–80% of cartilage is water, although this decreases in older people, and the rest is a gel-like substance called the 'matrix' that gives it its form and function.

The matrix is highly organised and consists of several types of specialist proteins, called:

- Collagens;
- Proteoglycans; and
- Non-collagenous proteins

The proteoglycan and noncollagenous proteins bind, or stick to the collagen, which forms a mesh. Water is attracted to the mesh by negatively charged proteins. Together, these give the matrix its consistency.

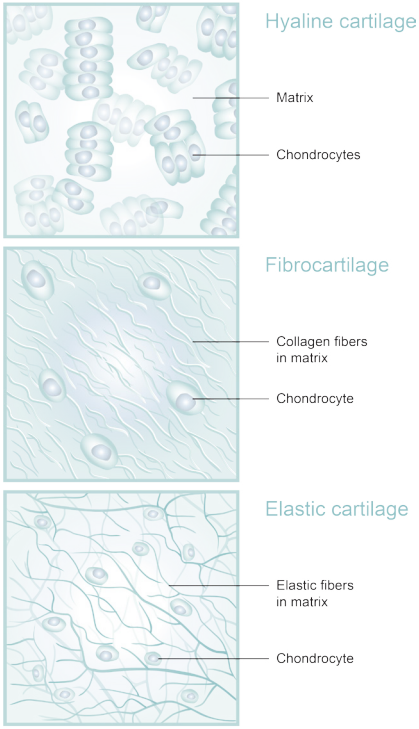
There are three main types of cartilage:

- Hyaline
- Elastic
- Fibrous

They have different properties that correspond to their specific functions in the body and make it the most appropriate type of cartilage at that particular site.

Hyaline, also called **articular cartilage**, is found in the joints, in the septum of the nose (which separates the nostrils), and the trachea (windpipe).

Elastic cartilage, which has elastic fibres that make the cartilage more flexible, is found in the ear, part of the nose and the trachea.



Fibrous cartilage occurs in special cartilage pads called menisci that help to disperse body weight and reduce friction, such as in the knee.

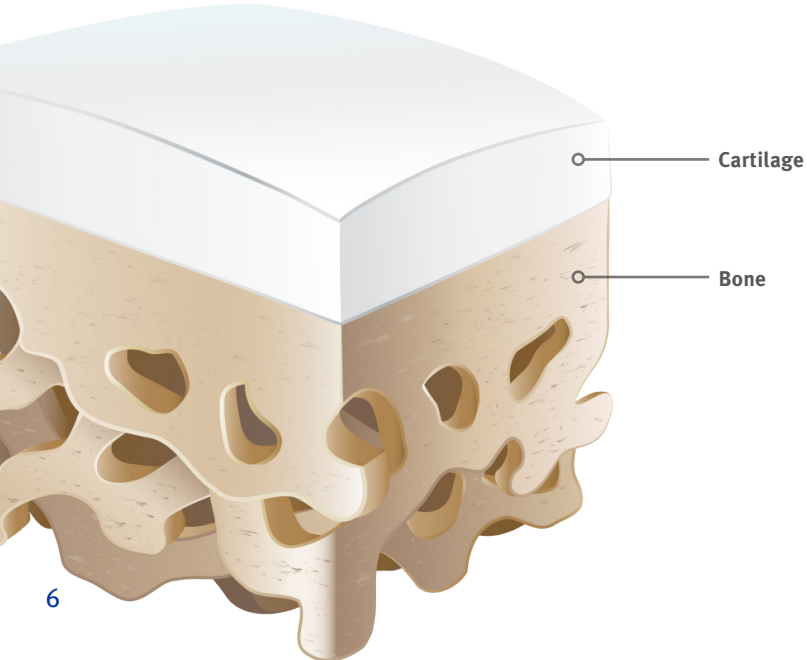
In the joints, hyaline cartilage forms a very low friction, 3–5 mm thick layer that coats the bony surfaces. This allows the bones of the joint to glide over one another during movement and, ideally, last a lifetime. It also serves as a cushion and shock absorber in the joint.

The hyaline cartilage matrix is made and maintained by a group of cells inside the matrix known as 'chondrocytes'.

The volume of cells in the cartilage is small, they make up about 1–2% of the tissue volume in adults. Cartilage contains no blood vessels, no nerves and has no lymphatic system. Nutrients have to diffuse through the matrix.

Hyaline cartilage forms a very low-friction, 3–5 mm thick layer that coats the bony surfaces of the joints.

Example of healthy hyaline cartilage



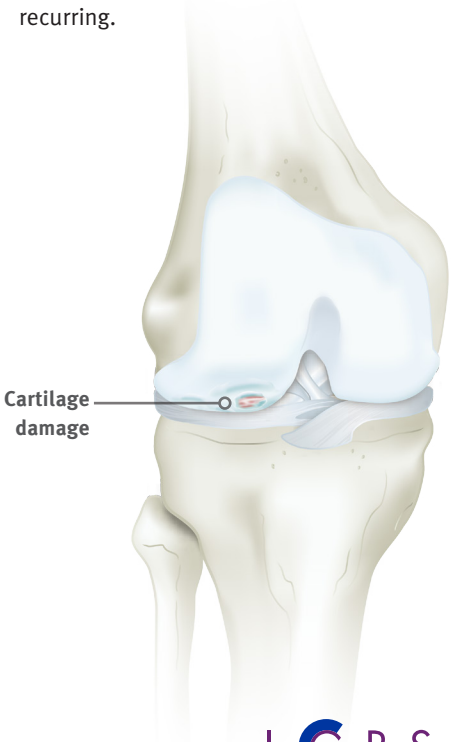
Articular Cartilage Damage

As cartilage is a highly organised structure but does not have its own blood supply, it is particularly difficult to replace once it is damaged or lost. Injury to any part of this complex system can disrupt the functional properties of cartilage.

Joint pain often arises from injury to the ligaments or, in the knee, from injury to the meniscus, which can result from injuries or tears. Cartilage injury, which can be either sudden (acute) or long-term (chronic), can also cause joint pain.

Acute cartilage injury can occur during an accident or sport, or simply result from moving in the 'wrong way'. This may have dramatic symptoms of pain.

After injury, movement can cause the cartilage to wear away. For example, the knee can mechanically 'catch' the cartilage defect, and fragments may break off into the joint fluid. This may lead to inflammation, in which the joint becomes reddened and swollen. The body's attempts to calm this reaction may in itself result in further swelling and pain.
Cartilage injury can also result from a gradual overloading due to poor positioning of the bones, resulting in continued wear, breakdown and inflammation. This is known as chronic cartilage injury. In the knee, for example, mechanical factors inside the joint may place excessive force on one surface only, which wears away the cartilage at that point. This may result from poor alignment after a ligament injury or be due to other factors. One way of looking at this is to think of a car with steering that pulls to the side, resulting in uneven wear on the tyres. Until the steering is corrected, the problem will keep recurring.



Diagnosis

The earlier the diagnosis is made, the higher the chance you can be successfully treated. The reason for this is simple - if the problem is recognised earlier in your life, the cartilage will not have had the chance to become severely damaged. The more severe the cartilage damage, the harder it is to be pain-free after surgery.

When you go to the doctor with a painful joint, one of the first things he or she will do is a clinical evaluation. He or she will push the joint in different directions, put pressure on different parts, lift it up from each side and bend and straighten it in order to locate the area that causes the pain.

If there is a suspicion that the cartilage is damaged, imaging of the joint is required.

If an X-ray is taken, it only reveals whether or not there is osteoarthritis or, after trauma, whether or not there is a fracture. Younger patients in particular can have problems in their knee that are not shown on X-ray, and magnetic resonance imaging (MRI) is therefore required.

MRI and arthroscopy

MRI machines use magnetic fields and radio waves to form images of a wide range of structures in the body. An MRI scan is needed to see possible cartilage problems in the joint, but a good-quality MRI scan is needed. In addition, to improve the quality of the scan, a small cage (called a joint coil) is placed around the joint. Using this together with a stronger MRI scanner ensures a high-quality and detailed image of the cartilage. In this way the different layers of the cartilage, as well as any damage, can be seen.

If you have high quality MRI scans then it will be possible to see if there are any lesions in this relatively tiny cartilage layer.

If there is a suspicion that the cartilage is damaged, imaging of the joint is required.

In addition, the person performing the MRI scan should know that you may have a cartilage problem, so that they can take a high-quality scan to visualise the cartilage. Otherwise, the images may show a problem, but it will not be possible to determine the size of the cartilage lesion, the number of lesions, and the status of the meniscus, the cruciate ligaments, and the underlying bone.

It is very important that your doctor has an idea of the condition of your bones, as you may have isolated cartilage injuries or cartilage defects, or may have bone and cartilage ('osteochondral') defects, which include the underlying bone. This is very important for choosing the right kind of therapy.

The type of therapy can also depend on other factors like the size of the cartilage defect. For very small defects, microfracture therapy can be used.

However, if there is a bigger defect, and the surrounding cartilage is not good quality, cartilage or osteochondral transplantation, may be required. A cartilage biopsy is necessary for these procedures and your doctor may ask you to sign a special consent form for this procedure. Cartilage biopsy for a second surgery cannot be performed without prior consent, as it is considered a form of therapy.

An MRI scan therefore not only allows your doctor to choose the most appropriate procedure but also indicates if a consent form for cartilage biopsy is needed. Dependent on the procedure and treatment, your post-operative care may be different.

This is why it is important to have an MRI scan before a procedure, particularly one that is cartilage-sensitive, so that the doctor can see what is happening with the cartilage, the size of the defect and the number of defects.

Cartilage Repair

Cartilage repair and regeneration is a treatment for joints that have damaged cartilage but are otherwise healthy.

The treatment is recommended for patients with cartilage damage or deterioration caused by:

- **Injury or trauma**, including sports injuries
- **Repetitive use** of the joint
- **Congenital abnormalities**, abnormalities a person is born with, that affect normal joint structure
- **Hormonal disorders** that affect bone and joint development, such as osteochondritis dissecans (OCD)

There are several types of procedures for cartilage repair and regeneration that are designed to heal the cartilage by filling the cartilage defect (like a pothole) with repair tissue.

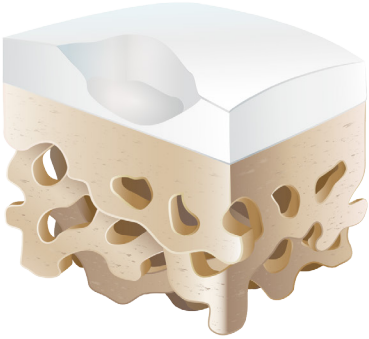
The choice of procedure depends on the size and location of the defect. Larger defects are typically treated with autologous chondrocyte transplantation or osteochondral allograft transplantation (ACI), both of which require open incisions.

Smaller defects in specific locations can be treated with marrow-stimulating techniques, autologous chondrocyte implantation (ACI), or osteochondral autograft transfer.

Cartilage has a minimal ability to repair itself and it is important to treat it as early as possible.

Cartilage damage

Normal cartilage



Cartilage defect

Cartilage defect extending down to the bone

2. Treatment Options

Treatment Options

Osteochondral/chondral repair means restoration of the cartilage (articular) surface of a joint that has been affected by an osteochondral/chondral defect.

The affected joint usually swells up following injury, and it may take weeks or even months before the swelling goes down. This swelling can recur.

Drugs such as aspirin, ibuprofen, and naproxen, known as non-steroidal anti-inflammatory drugs (NSAIDs), and other conservative treatments usually have only a limited effect on the pain, and do not treat the underlying problem.

If there is a severe fluid build-up or a loose body in the joint, removal and treatment via arthroscopy may be necessary. Arthroscopy is also useful for assessing the cartilage lesion, as knowing the extent of the affected area is crucial for deciding the best treatment.

The methods typically used for cartilage repair depend mostly on the size of the lesion. They are: microfracture, mosaicplasty, cartilage cell implantation (autologous chondrocyte implantation), large allograft implantation, or osteotomy.

The choice of treatment depends on the following factors:

- Size and location of the defect
- Whether the defect is self-contained or spread out
- Whether or not the joint has been operated on before
- Your age
- The patient's physical fitness and activity
- Whether you want to undergo surgery
- The presence of other conditions and diseases
- The presence of any associated injuries

Conservative Treatment Options

Can I be treated without surgery?

The short answer is yes - it is possible for you to be treated without surgery. However, the appropriateness of non-operative management will be based on the nature of the joint complaint. For example, if you have sustained an acute injury to your knee that has resulted in a loose piece of articular cartilage that is causing mechanical symptoms, then you may not be a candidate for non-operative management. But for the majority of cartilage and joint conditions your healthcare provider will generally first try conservative (non-operative) treatment options.

There are a variety of different non-operative interventions that can be used such as life-style modifications (weight loss and no high impact activities), physiotherapy, braces, viscosupplementation, neutraceuticals and platelet-rich plasma to name a few of the options. However, a consultation with your physician is required to identify the exact nature of your cartilage or joint problem and this will allow him/her to formulate an individualised, non-operative treatment strategy for your condition.

The decision to proceed with surgery is multifactorial and some of the key issues to be considered are the character (size, location and chronicity) of the defect, prior interventions, the presence of any other concomitant injuries and your overall health.

After careful consultation with your surgeon about the nature of your articular cartilage injury, and if appropriate for your injury, a trial of non-operative, then the decision to proceed with surgery is generally made. The nature of the surgical procedure will be tailored to your injury and may consist of an arthroscopic surgery, an open procedure, or a combination of the two different procedures.

Your doctor is required to identify the exact nature of your cartilage or joint problem. A non-operative treatment strategy may be possible.

Physiotherapy

Depending on the amount of damage to your cartilage, conservative management such as physiotherapy or braces may be an option.

As it is non-invasive, it may be suitable for people who are perhaps not ready to have a more invasive procedure, such as surgery, or perhaps may be too young to consider a total or partial joint replacement.

Even if you will end up having a more invasive procedure, it is good to consider conservative management options before a surgical intervention, so that you are familiar and compliant with the exercises. If you have any questions about the intervention or what to expect after surgery in terms of the rehabilitation process, the physiotherapist can serve as a wonderful resource and educator.

More specifically, physiotherapists can identify if there are any pre-existing weaknesses, known as 'biomechanical deficiency', before an operation and determine if the patient can be successfully treated in a conservative way. For a patient in their 50s, 60s or 70s with pain in one part of their knee (uni-compartmental knee pain), physiotherapists can look for muscle imbalances, overall weakness, altered loading patterns and deficits in flexibility. Physiotherapists can explain these concepts, and can formulate a home exercise programme that is safe for their current state, so they do not damage the remaining articular cartilage surfaces. They can also be offered treatments that they can use at home if they have edema (swelling) or any kind of swelling after a long walk or increased activity.

This educational process can have an empowering effect on patients, because it provides them with some autonomy, and the ability to be proactive and involved in their care.

The main goals of the physiotherapist are:

- To be educators.
- To salvage and preserve the articular cartilage patients still have.
- Identify the true source ('aetiology') of the degeneration and intervene appropriately.

For example, at times the physiotherapist will identify profound lateral hip and gluteal muscle weaknesses, and those are very easy things to build into a thorough home exercise or clinical-based programme. Significant results can be achieved just by increasing strength in weaker muscle groups

PRP

Blood is a mixture of red blood cells, white blood cells, platelets and a solution of proteins called 'plasma'. PRP, or 'platelet-rich plasma', is a concentrated solution of platelets taken from 'autologous' blood (from your own blood) which can then be injected to treat cartilage defects, as well as ligament problems and osteoarthritis.

To prepare PRP you need to have blood taken, around 10-60 ml. The blood is then used to prepare PRP either in a laboratory or using a commercial device. The blood is separated into the different components using a centrifuge; this separates out the red blood cells, white blood cells and platelets into a number of different layers. One layer is rich in red blood cells, another layer (the buffy coat) may be rich in platelets and white cells, and another layer will contain platelet-poor plasma. The basic concept behind PRP centers around isolating the layer of platelet-rich plasma, while trying to leave as many of the red and white blood cells behind as possible. However, depending on the preparation method, some products will create a platelet-rich plasma that either contains lots of white blood cells, known as 'white blood cell enriched', or one that is 'white blood cell depleted'.
The issue here is that a white blood cell enriched solution will contain proteins, known as pro-inflammatory cytokines that can potentially trigger an inflammatory reaction. In other words, it may contain factors that can create inflammation in tissues, be it in the joint or in the soft tissues where the PRP is injected. Depending upon the indication for the PRP, this may or may not be helpful. Recent research would suggest that white blood cell enriched PRP might be detrimental to tissue healing.

PRP has been around for many years, but it gained significant popularity in 2006, when it was used to treat the American football player, Hines Ward, who had sustained an injury to his medial collateral ligament. The use of PRP has grown significantly since then. A number of PRP studies were also published around that time, and interest in research into PRP rose exponentially. Although PRP has been investigated extensively in the basic science laboratory, and numerous clinical studies have been published, the evidence justifying its clinical use is not very strong. However, because it is relatively harmless and patients appear to like the idea of being injected with a solution derived from their own blood, its use has taken off.

If you look at the basic science studies, PRP supports the growth of articular cartilage cells (chondrocytes) in the laboratory by nourishing chondrocytes and growing extracellular matrix. In other words, it grows the constituents of cartilage around it, within a culture medium.

However, data on clinical use of PRP are limited. Despite this, it many surgeons are using PRP to augment cartilage repair and there are clinical studies ongoing to analyse the outcomes of this promising treatment modality.

Although PRP is derived from the patient, there are still risks involved with its use. There is evidence to suggest that injections of PRP into ligaments, particularly into the patella tendon for patella tendonitis, cause an inflammatory reaction. These effects have largely been seen with PRPs that are white cell enriched, but more studies are needed to determine if the use of 'white blood cell depleted' PRP would help prevent this reaction.

The use of PRP is however extremely costly, and is typically not covered by your insurance company. Therefore, it is important to discuss the use, risks and benefits of PRP with your healthcare provider prior to making a significant financial investment.

Surgical Treatment Options

Debridement and microfracture

Debridement - which can be simply thought of as 'shaving away damaged tissue' has been an established technique for removing loose cartilage defects for a number of decades. Loose pieces of cartilage or large meniscal tears can cause a lot of pain, and this basic technique can therefore offer a short-term option to alleviate pain and treat mechanical symptoms, such as locking or catching of the knee. **Lavage** is a procedure during which intra-articular fluid is aspirated and the joint is 'washed out'.

However, debridement and/or lavage as sole treatment are rarely used nowadays since studies have shown that this approach does not have long lasting success.

The ultimate goal when removing damaged cartilage is to replace it with new, functioning cartilage. To achieve this, **microfracture** has emerged as an effective tool to kick-start the body into restoring a cartilage like material naturally in the damaged area.

Following a debridement to remove the old and damaged cartilage, an orthopaedic surgeon makes several small holes in the bone to a depth of around 2–4 mm. This causes blood and bone marrow to seep out of the holes and create a fibrin cloth on the damaged area. This clot contains cartilage-building stem cells and other biological factors that make new cartilage. The new tissue that is formed after microfracture is called fibrocartilage. It might take up to a year before the fibrocartilage formation is completed.

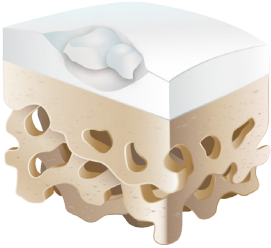
Following surgery

It is of paramount importance that patients undergoing microfracture surgery follow a regime of physiotherapy. Rehabilitation programme should be designed to stimulate the bone marrow cells clotting in the holes to develop into cartilage cells.

For the first few weeks after surgery, it is likely you will be using a continuously passive motion (CPM) machine, which will move, or 'articulate', the joint to reduce inflammation and pain, and help promote healing and repair of the new tissue.

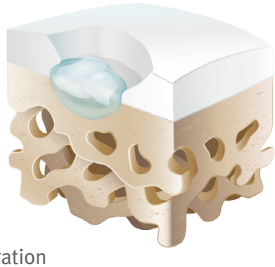
Weight bearing on the affected joint should be minimised for about 8 weeks following surgery, to ensure that proper function is restored.

Debridement and microfracture

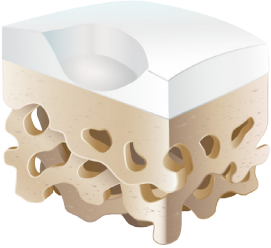


Defect with loose cartilage

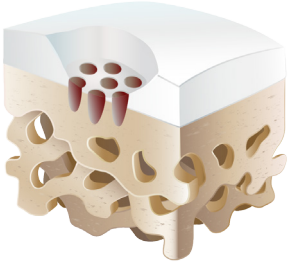
Lavage



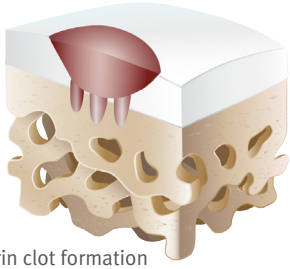
Aspiration



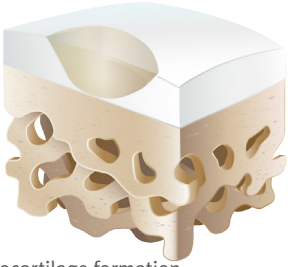
Defect without damaged tissue



Microfracture



Fibrin clot formation
(Not blood clot formation)



Fibrocartilage formation

Mosaicplasty

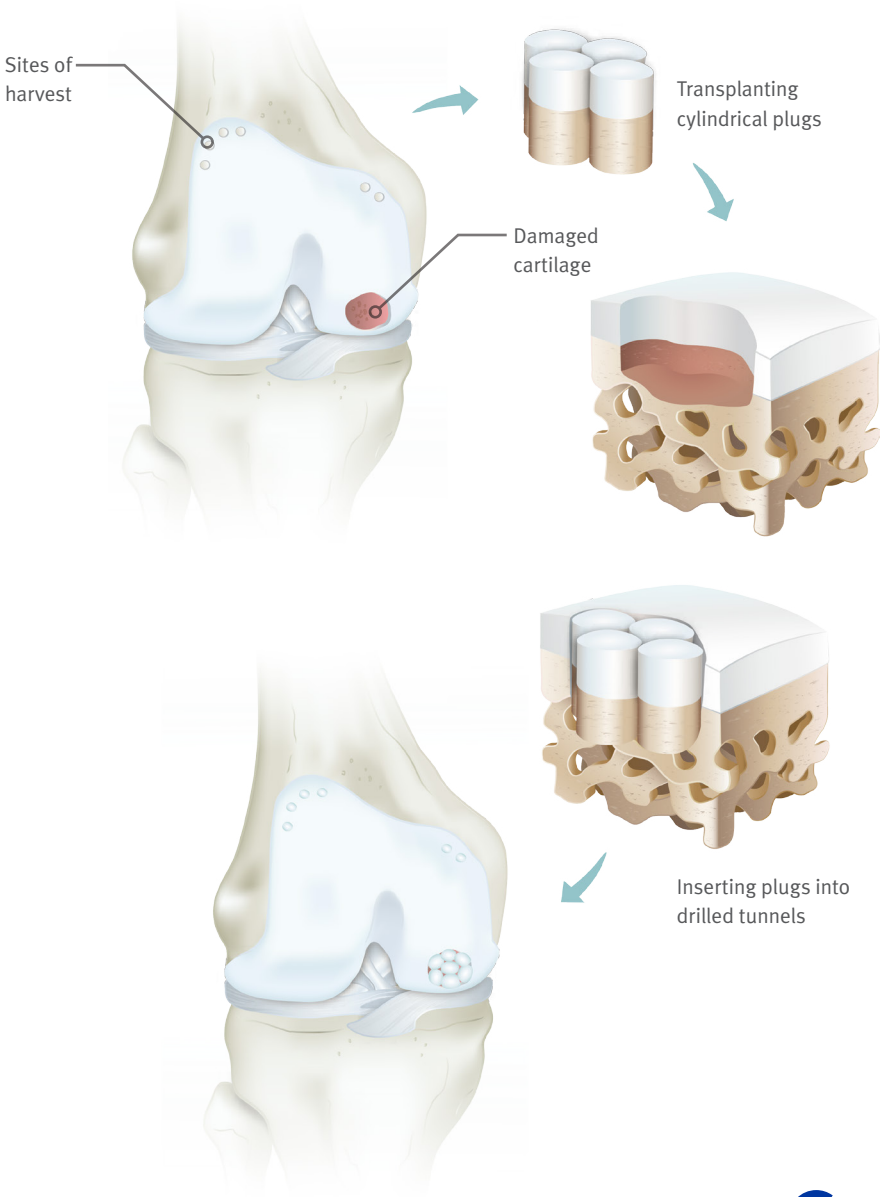
Untreated joint (articular) cartilage defects can eventually lead to degeneration of the joint and disability, in terms of joint function. Several cartilage repair techniques exist for the treatment of cartilage defects. **Mosaicplasty** is a technique in which cartilage ('chondral') lesions and bone and cartilage ('osteochondral') lesions are repaired by harvesting and transplanting cylindrical plugs of bone and cartilage from healthy tissue. In the knee, these plugs are taken from less weight-bearing areas, termed 'donor sites', and inserted into drilled tunnels in the defective section of the cartilage.

The transplanted hyaline cartilage is capable of surviving and produces a more durable surface, than if the defective cartilage had been left to heal on its own. The donor site heals on its own. The tunnels become filled with cancellous bone and the surface is covered with fibrocartilage built by marrow-derived cells.

Mosaicplasty is indicated for small areas of defective cartilage, as it depends primarily on the size of the donor area and other factors. Furthermore, the procedure should only take place in patients under 50 years of age, due to the decreased ability to repair tissue.

Mosaicplasty is not recommended if osteoarthritis or rheumatoid arthritis is present, or for lesions caused by infection or tumours. This is because the survival of the transplanted hyaline cartilage in the recipient site is affected by these conditions.

Mosaicplasty



Autologous chondrocyte implantation

Damage to joint (articular) cartilage (known as chondral lesions), or damage to both the cartilage and the underlying bone (known as osteochondral lesions), does not repair itself spontaneously and results in joint pain and poor function.

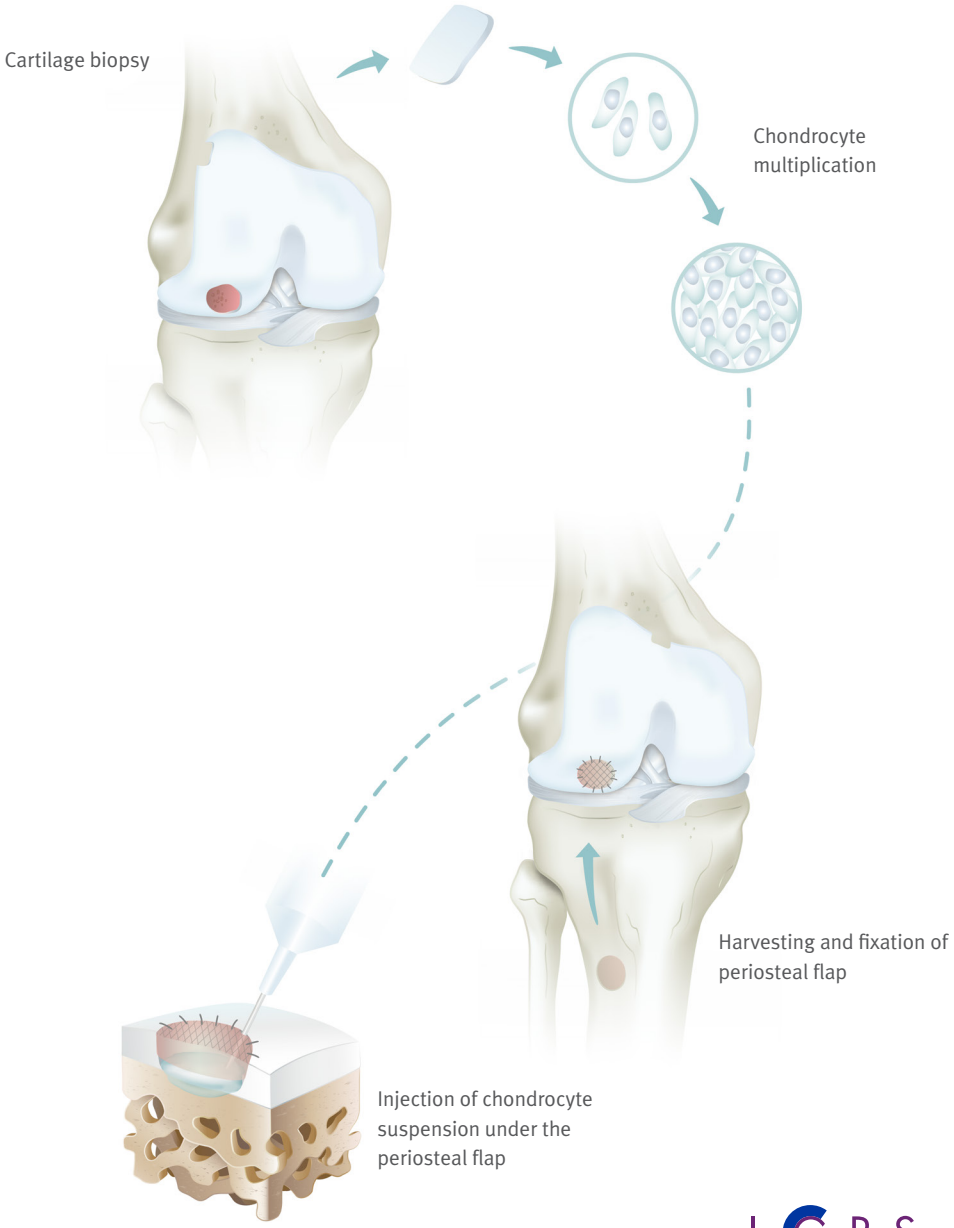
If left untreated, such damage, which is common after trauma, can lead to osteoarthritis. The knee is the most commonly affected joint. Patients aged over 60 years with osteoarthritis are more likely to have a total knee replacement. However, younger patients face a problem, as metallic resurfacing has a limited lifespan and in young patients invasive revision surgery is often needed.

Techniques that promote regeneration of the native hyaline cartilage are therefore extremely attractive, as they offer the possibility of both repairing the tissue and allowing younger patients to return to their previous activities. One such technique is autologous chondrocyte implantation (ACI).

ACI is a technique for regenerating hyaline cartilage in a diseased or damaged area of a joint through the implantation of cartilage cells harvested from your own cartilage. The cartilage cells are extracted and multiplied in a laboratory and then inserted into the damaged area. The technique has been used extensively since it was introduced in the 1980s. It has achieved excellent long term results, both in terms of cartilage repair and helping patients returning to previous activity levels.

ACI is recommended for younger patients who have symptoms of joint pain and swelling, related to a chondral articular lesion.

Autologous chondrocyte implantation



New Scaffolds and Cells

Another method to help restore the damaged tissue as closely as possible to the original cartilage is the use of scaffold together with cartilage cells. This is similar to autologous chondrocyte implantation (ACI) and is known as matrix-assisted autologous chondrocyte transplantation (MACT) or matrix-assisted autologous chondrocyte implantation (MACI).

Scaffolds are temporary 3D biodegradable structures that are placed inside cartilage defects. The scaffolds typically fall into four main types:

- protein-based scaffolds,
- carbohydrate-based scaffolds,
- synthetic or artificial polymer-based scaffolds, and
- a combination of any of these types.

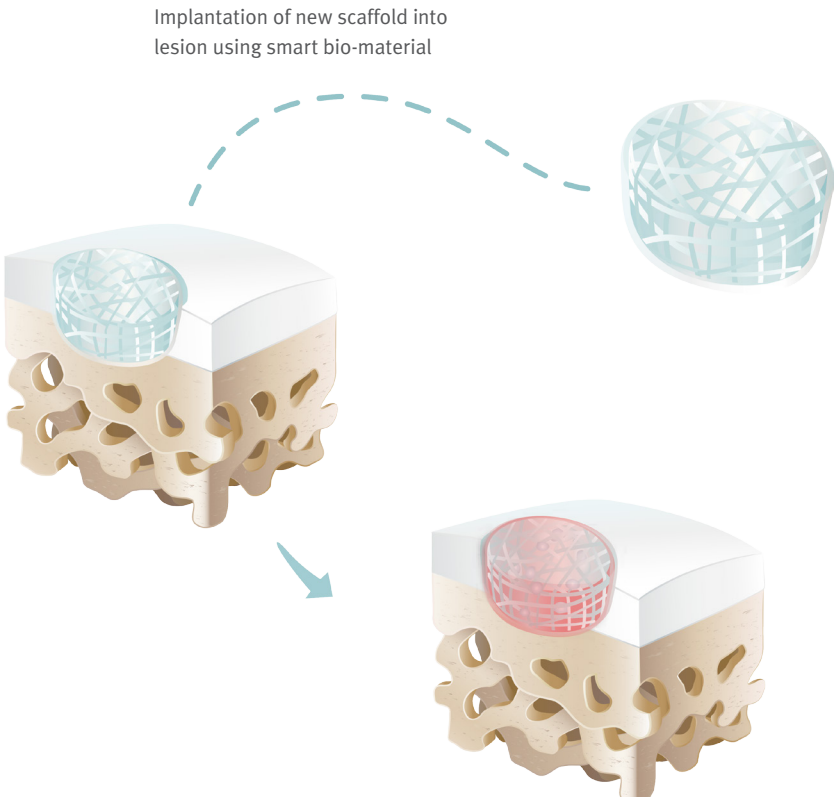
Scaffolds can also be in several forms: membranes, meshes or hydrogels.

Scaffolds should be:

- Biocompatible, and cause little or no inflammatory response in the body
- Harmless when broken down by the body
- Porous enough to allow new cartilage growth and the eventual breakdown of the scaffold, while forming a 'net' to maintain the most suitable environment for cartilage repair
- Easy to produce and versatile, depending on the size and shape required, and
- Able to withstand the stresses and forces within the joint (e.g. the knee)

Scaffolds can be implanted as part of a two-step procedure, in which the scaffolds are combined with cartilage cells (chondrocytes) multiplied previously in the laboratory, as in ACI. This procedure has been shown to produce good long-term results. Alternatively, the scaffolds are implanted in a one-step procedure, in which the scaffold is placed in the defective cartilage either after marrow stimulation (drilling or microfracture) or as a plug that encourages new cartilage growth (known as 'smart' scaffolds). However, this procedure is relatively new and there is little data showing long-term results of this procedure. While there is long-term follow-up showing that the previously used scaffolds plus chondrocytes produce good results, longer-term data for the newer 'smart' scaffolds are awaited.

One step technique for scaffold cartilage repair



Two step technique for scaffold cartilage repair

Allograft

Allografting or, to give its full name, 'fresh osteochondral allograft transplantation (OCA)' is an operation in which a damaged or diseased area of a joint is reconstructed using a bone and cartilage transplant from a recently deceased donor. The cartilage cells can survive the transplantation only if the tissue is 'fresh', which means it has not been exposed to radiation or prolonged freezing.

OCA was pioneered at the beginning of the 20th century, and has had a long and successful history. It is becoming increasingly popular as a treatment for large traumatic injuries, osteochondritis dissecans, and bone death (osteonecrosis) resulting from lack of blood flow to the bone supporting the joint cartilage.

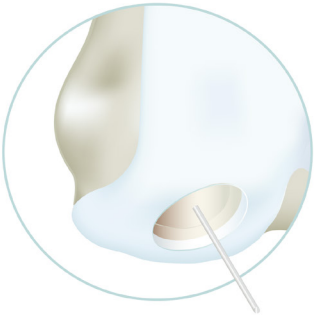
The most common reasons for performing OCA are:

- A focal cartilage lesion greater than 2 cm^2
- Re-treatment (revision or salvage) of previous cartilage surgery, such as microfracture, autologous osteochondral transfer (OAT) or autologous chondrocyte transplantation (ACI)
- Severe (type III or IV) osteochondritis dissecans
- Osteonecrosis (bone death)
- Joint reconstruction after a fracture, known as post-traumatic reconstruction

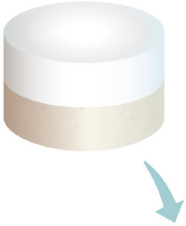
The surgery itself is fairly straightforward but the patient should understand that they will receive living human tissue that has been donated. Fortunately, patients do not need to take anti-rejection drugs after surgery, as the immune response from these grafts is, in the majority of cases, mild or non-existent.

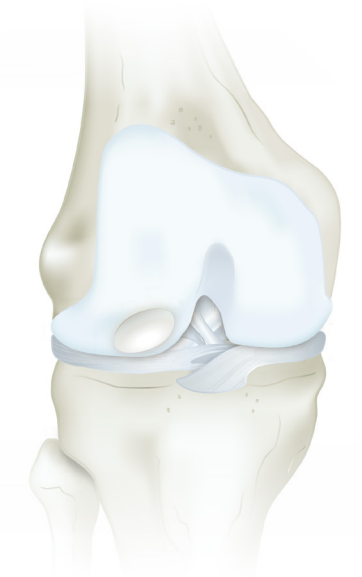
However, because the tissue comes from a donor it is often difficult to predict availability and patients must therefore be prepared for surgery with a few days' notice.

Allograft

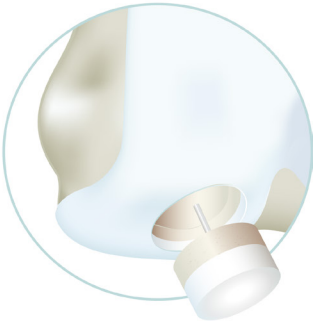


Placement of a guide pin in the lesion perpendicular to the joint surface

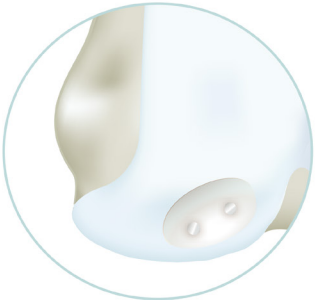




Insertion of the graft plug matching the size and depth of the widened lesion



Insertion of screws to secure the plug into place



Osteotomy

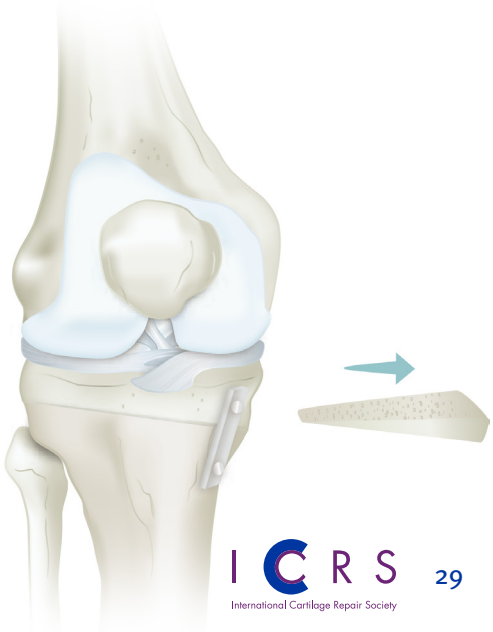
Osteotomy (literally 'bone cutting') is an operation in which a bone is cut to allow the bone to be repositioned; for example, to shorten, lengthen or realign. It may also be used to correct bones that have not healed properly following fractures or injuries. In the case of cartilage damage (whether recent or long-standing, such as in arthritis), it is also used to relieve pain and improve the environment for cartilage restoration in cases where poor alignment ('malalignment') is causing overload. This is analogous to a car that is out of alignment and has caused excessive tyre wear on one side.

The primary aim of osteotomy is to correct poor bone alignment and thus relieve pain, through the transfer of weight bearing from damaged to healthier areas of the joint, such as in the knee. This hopefully increases the time to when a replacement joint is needed.
Due to the nature of the procedure, the operation is performed under general, spinal, epidural or regional anaesthetic.

This procedure is indicated for patients with malalignment, commonly called being bowlegged or having knock-knees, or having a malaligned knee cap. Your doctor will take detailed –rays and possibly a CT or MRI scan to assess the level of malalignment.

Osteotomy is beneficial for younger patients who have active lifestyles, as it may delay the need for joint replacement. It is, however, not suitable for patients with:

- Poor cartilage on the opposite side of the poorly aligned bone
- Inflammatory arthritis
- Severely limited motion
- Obesity
- Joint dislocation
- Osteoporosis
- Nicotine use



3. Postoperative Care

Rehabilitation

Rehabilitation is the post-surgical programme of re-establishing joint motion, muscle strength around the joint and finally joint function. It is very important to understand that rehabilitation is a long process. While the surgery is performed within hours, the rehabilitation needs many months, potentially up to a year. The difference between the length of the surgery and the time needed for rehabilitation is huge, and patients should have that clearly in mind.

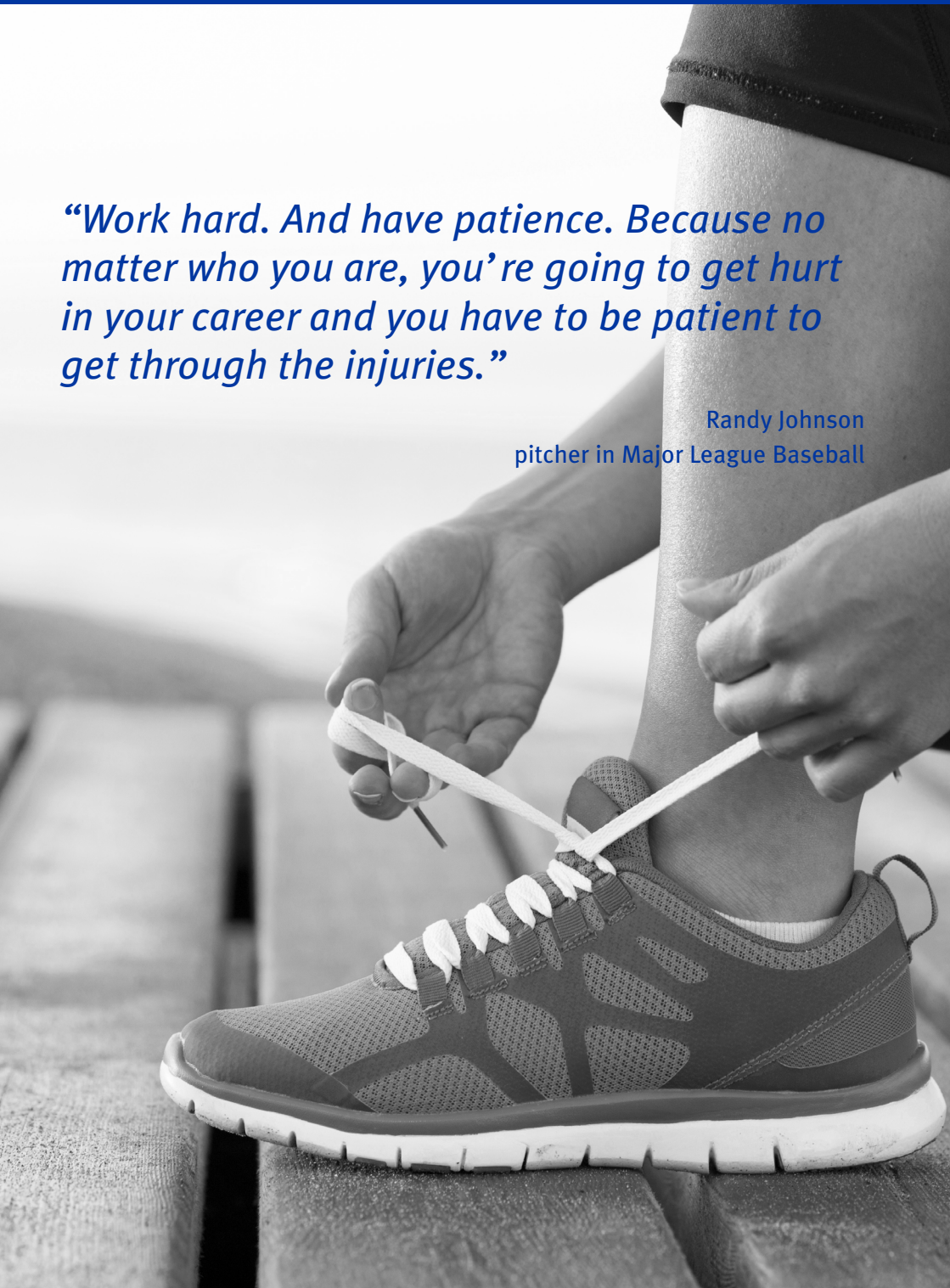
When the patient undergoes cartilage surgery of the knee, ankle or shoulder, for example, by whatever method, they should be aware that they need a long recovery period.

It is therefore very important that the patient is committed to the whole process. However, it should also be borne in mind the timeframe of one year for recovery is an example of the amount of time required compared to the hours of the surgery. The actual timeframe required depends on a large number of factors.

The second important point is that rehabilitation is a progressive activity. In this context, 'progression' means safely increasing workloads and stimuli on the repaired joint during the recovery process.

The third point is that the tissues need to be stimulated, as they cannot recover by themselves. It is important to properly stimulate the limb and joint after the cartilage surgery. This is, biologically, a very complex process, because we need to let the tissue mature. The process could be likened to baking bread. You have to wait for the dough to rise before you can put it in the oven. It is the same with the cartilage – you must wait for some time to help the biological process, and that process needs stimulation. The right stimulation is protected range of motion and exercise.

Consequently, the core of rehabilitation is doing the right exercises at the right time, with the right balance between not enough and too much exercise. So, neither complete rest nor sporting activities is advisable in this phase of rehabilitation. Something in the middle is required. That balance changes during the weeks and months after surgery. What this means in practice is that the intensity of the stimulation increases progressively.



“Work hard. And have patience. Because no matter who you are, you’re going to get hurt in your career and you have to be patient to get through the injuries.”

Randy Johnson
pitcher in Major League Baseball

Colophon
'What is cartilage?' is a publication by International Cartilage Repair Society (ICRS).

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