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Articular Cartilage Injuries in the Knee: FAQs

What is articular cartilage?

Articular cartilage is the white shiny covering over the ends of the bones in a joint (Fig. 1) – it is the substance which makes a joint a joint, rather than two pieces of bone rubbing together. Articular cartilage has unique mechanical properties, being very low friction, highly shock absorbing, and anaesthetic (it has no nerves). There is no colloquial term for articular cartilage in English, but it is known as 'soft bone' in Chinese. The colloquial term 'cartilage' when used in reference to knees or knee injuries, usually refers to the menisci (or meniscal cartilages) which are a pair of crescent moon-shaped 'spacers' made of fibrocartilage, and which help to spread the load across the joint, and therefore protect the articular cartilage. For more information on meniscal cartilage, please see **'Meniscal Tears FAQs'** at **www.asiamedicalspecialists.hk.**

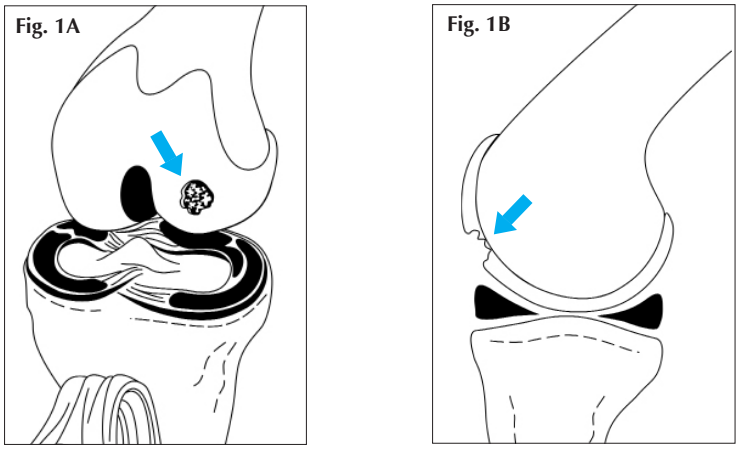

Fig. 1A Knee with area of cartilage damage on the thigh bone (arrow).
Fig. 1B Cross section through the injury shows the layer of articular cartilage on the thigh bone, with an area of injury (arrow). The black triangles are the meniscal cartilages.

How is articular cartilage injured?

Articular cartilage injuries in the knee usually come from a twist or a fall. They may be associated with other injuries, for example meniscal or ligament injuries, such as an ACL tear.

These injuries are more common in children than adults, probably because children have relatively thick cartilage and weak bone.

How are articular cartilage injuries diagnosed?

Articular cartilage defects can often be difficult to diagnose. Most commonly they cause vague pain. Other symptoms include swelling, and mechanical symptoms, such as popping, catching, giving way and even locking.

On examination, typically there is not much to find unless there are other injuries or a fresh are of damage is within reach of the examiner's touch.

X-rays

Generally, X-rays are not very sensitive for picking up articular cartilage injuries, as X-rays do not show cartilage. The cartilage 'appears' on the X-ray as the space between the bones, which will be reduced if there is severe cartilage loss, as in osteoarthritis. Sometimes a chunk of cartilage and bone are chipped off together, (Fig. 2) and this may be seen on an X-ray. These pieces are known as 'osteochondral' fragments from the Latin & Greek terms for bone (osteo) and cartilage (chondral).

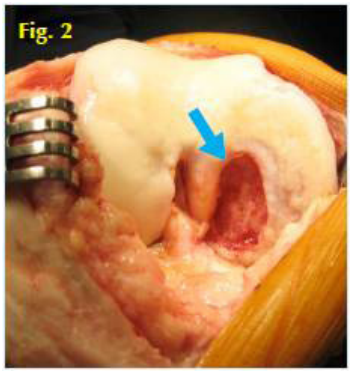

Fig. 2 Knee joint surgically opened reveals a large area of bare bone (arrow) where a chunk of cartilage and bone has been knocked off in an injury.

MRI

Magnetic Resonance Imaging (MRI) is the most sensitive non-invasive investigation for diagnosing articular cartilage injuries, however there is still a significant false negative rate, as a small cartilage injury does not involve much tissue, so is hard for the MRI to pick up.

What is the 'natural history' of an articular cartilage injury?

Once it is damaged, articular cartilage is unusual in that it does … nothing! The cartilage does not try to repair itself. (If articular cartilage did self-repair, arthritis would be a much smaller problem than it is.) The natural history of untreated articular cartilage injuries:

- sharp edges to round off (Fig. 3);
- loose fragments of cartilage floating around in the joint to either be resorbed or to grow larger as they are nourished by the synovial lubricant fluid;
- exposed bone 'heals' by forming scar tissue (composed of fibrocartilage, which, while better than nothing, does not have the same mechanical properties of articular cartilage).

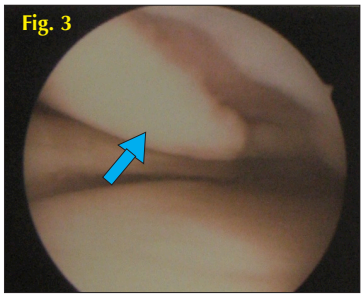

Fig. 3 Arthroscopic view inside the knee showing a loose flap of white cartilage (arrow) detached from the underlying pink bone. Note that the edges have 'rounded off' but no other healing has occurred.

Treatment

Non-operative treatment is recommended for very small injuries and very severe injuries: the small asymptomatic injury and very extensive injuries that are outside the capabilities of current cartilage restoration techniques. Very severe injuries that do not recover become 'arthritis' and treatment is described in the **'Knee Osteoarthritis FAQs'** at www.asiamedicalspecialists.hk .

Non-operative treatment includes physical therapy to optimise muscle strengthen and balance, soft soled shoes to absorb impact, avodiing impact, taking glucosamine, and 'viscosupplementation' – the injection of lubricants into the joint as explained in the **'Knee Osteoarthritis FAQs'**.

Operative treatment is for those who have a small injury that has not got better with non-operative treatment, or who have a loose piece of cartilage on their MRI. The goals of treatment are to stabilise loose articular cartilage, decrease pain and improve function.

There are several options:

1. Repairing the loose pieces of cartilage or cartilage and bone
2. Removing loose fragments or free-floating 'loose bodies'
3. 'Microfracture'
4. 'Osteochondral grafting'
5. 'Autologous chondrocyte implantation'
6. Salvage type surgery, such as osteotomy or joint replacement

Repair

If the injury is recent, it may be possible to fix a loose fragment of cartilage or cartilage and bone (ie an 'osteochondral' fragment). Either can be replaced in its correct position with glue or a mechanical device such as a screw or dart. It is more difficult to get cartilage to heal, because, as previously mentioned, it does not respond to injury by trying to heal. It is easier to fix and osteochondral injury, because bone heals very well. Depending on the exact problem, the procedure may be performed arthroscopically (ie by 'keyhole surgery') or may require a surgical incision.

Removing loose fragments or free-floating 'loose bodies'

Removing loose fragments of cartilage so the edges of any crater are clean (Fig. 4), and removing 'loose bodies', which are floating around in the joint, may significantly improve pain and mechanical symptoms, even though the 'clean' crater will not 'heal'. This procedure can usually be performed arthroscopically.

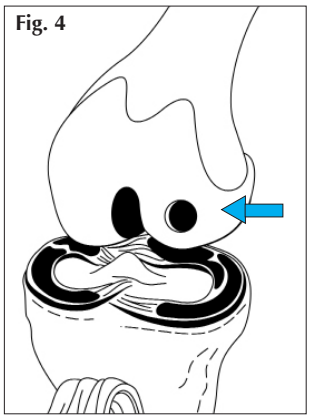

Fig. 4 The rough edges and base of the 'crater' have been cleaned up.

Fig. 5A Microfracture seen at arthroscopy – there are small holes in the pink bone, some of which are bleeding.

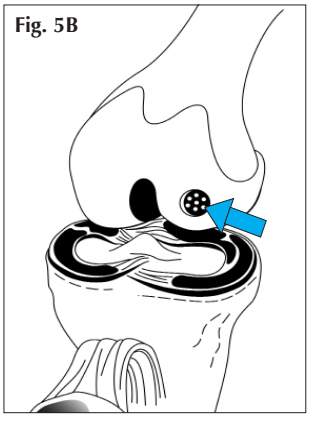

Fig. 5B Diagrammatically, the holes are placed in the base of the 'crater'.

Microfracture

'Microfracture' is the technique of making little holes in the bone in the base of a cartilage crater to cause bleeding. The bleeding encourages 'healing' by the formation of scar fibrocartilage, which can be thought of as scar tissue (Fig. 5). The surgery is short, minimal invasive and with a quick recovery. It is the most frequently used cartilage procedure [1] and seem to result in significant functional improvement [2,3], however there are very few controlled trial, ie comparing microfracture to other forms of treatment.

Osteochondral grafts

The original technique was to take a cylindrical 'plug' of bone and cartilage from a less important part of the knee and tamp it into a same sized hole made in the injured area (Fig. 6) like placing tiles in a mosaic, hence the alternative name 'mosaicplasty'. Because bone heals well, this is a successful procedure, but the drawback is that the cartilage in less important areas of the knee is thinner than in the weight-bearing areas (which are usually the ones which cause symptoms when injured, and thus need this kind of advanced treatment).

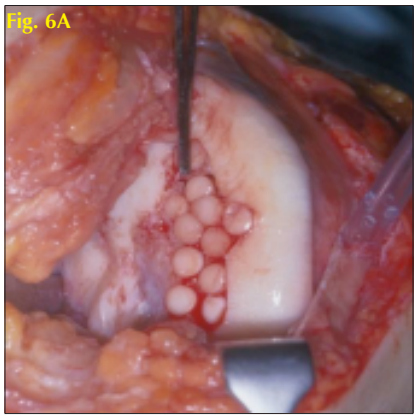

Fig. 6A Intraoperative view of osteochondral grafts placed in the knee.

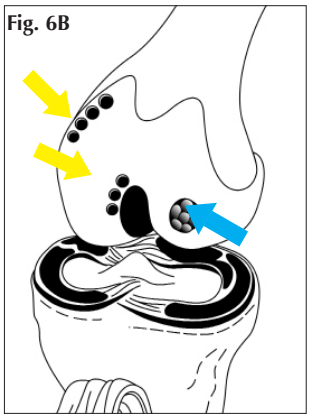

Fig. 6B Diagrammatically: The grafts are taken from less important areas (yellow arrow) and placed in the damaged area (blue arrow).

The donor site fills up with fibrocartilage, and the chondrocyte and osteocytes in the graft survive [4].

Indications include primary treatment of small to medium sized injuries in relatively high-demand patients. It is advantageous by virtue of using the patient's own tissue and eliminating immunological concerns. It is limited by the size of the graft. The major risk is plug failure and donor site problems. Post-operative rehabilitation includes early range of motion and non-weight bearing for 2 weeks, with an increase to full-weight bearing from 2-6 weeks. The results have been favourable with intermediate-term follow-up [5,6]. Studies in athletes under the age of 40 has shown significant superiority over microfracture, with a higher chance of return to sports at the pre-injury level [7].

With the success of this technique surgeons have also performed 'allografts' where tissue is taken from a donor, and synthetic grafts, where a synthetic material acts as a 'scaffold' for the patients own cells to grow on. These procedures have the advantages of no donor site problems, but the disadvantage that they do not bring in living articular cartilage cells.

Autologous Chondrocyte Implantation

Autologous chondrocyte implantation (ACI) is a very appealing treatment because it brings new cartilage cells to help heal the injury, but it involves two operations, and it is quite expensive. It is a two-stage procedure beginning with biopsy of normal cartilage from the non-weight bearing area (Fig. 7). The cartilage cells are then cultured in a special laboratory, where they multiply until there are enough to repair the damage. At a second procedure they are implanted into the defect. The result is 'articular-like' cartilage which is biomechanically superior to fibrocartilage.

ACI is often used as a secondary procedure (because of the inconvenience and cost) for the treatment of medium to large cartilage injuries in young patients with high physical demands. Results in appropriate cases are >85% good and excellent. Micheli et al [8] reported superior results with ACI when the procedure is performed early after the onset of cartilage pathology and poor results with delayed treatment. It suggests that the remaining articular cartilage is damaged by abnormal loading over time [9,10,11].

The latest 'third generation' technique is called 'matrix-induced autologous chondrocyte implantation' (MACI) (Fig. 8). The cartilage cells grow on a protein sheet, which can be rolled up and delivered into the joint arthroscopically, allowing the technique to be used in areas of the joint which are not accessible by other means.

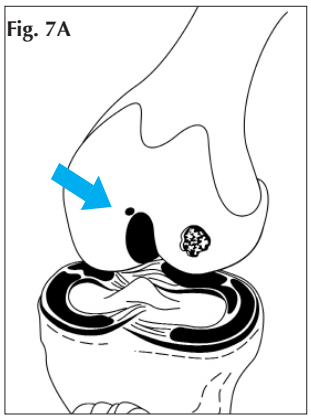

Fig. 7A Stage 1: A small 'biopsy' is taken from a less important area and sent to the laboratory.

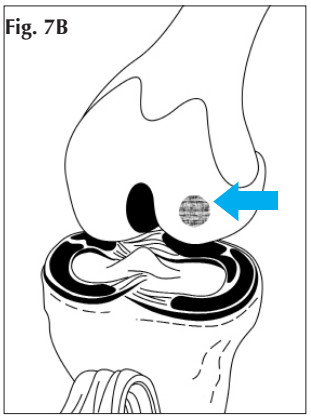

Fig. 7B Stage 2: The cartilage cells grown in the laboratory are fixed into the damaged area.

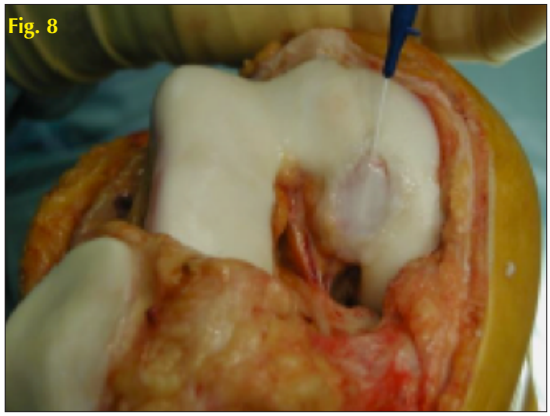

Fig. 8 Matrix-induced Autologous Chondrocyte Implantation (MACI). The pale pink membrane is being glued into place in the knee.

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