Surgical Management of Chondral and Osteochondral Lesions

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Basic Principles

Different surgical techniques exist for the treatment of chondral and osteochondral lesions. A distinction has to be made between those techniques that debride or microfracture the subchondral bone in an attempt to stimulate a healing response, and those that transplant cartilage. Cartilage transplantation encompasses the transplantation of osteochondral grafts or a chondrocyte cell suspension. Techniques may also be thought of as palliative (e.g., chondroplasty), reparative (e.g., osteochondral grafting), or restorative (e.g., autologous chondrocyte implantation). Microfracture and abrasion will result in the formation of a fibro-cartilaginous repair tissue with biochemical and biomechanical characteristics inferior to those of articular cartilage. This fibrocartilage is characterized by an extracellular matrix which mainly consists of type I collagen rather than type II collagen, and an absence of differentiated chondrocytes. The aim of chondrocyte cell transplantation is to reproduce a hyaline-like cartilage with differentiated chondrocytes and an extracellular matrix rich in type II collagen and proteoglycans. The future of chondral restoration is likely to involve techniques using mesenchymal stem cells and gene therapy.

Diagnosis and Preoperative Planning

Multiplanar imaging is mandatory to visualize the lesion, localize it, measure its depth (grade III or IV lesion according to ICRS specification), differentiate between chondral and osteochondral lesions, and to evaluate its size. These variables will define which type of graft as well as the surgical approach is necessary. An arthroCT scan was the imaging modality of choice, but a 3 T (and now 7 T) MRI gives excellent assessment. The addition of intra-articular gadolinium (arthroMRI) may give further morphological information. These examinations not only allow evaluation of the articular lesions, but help confirm that sufficient meniscal tissue remains. Confirmation of the integrity of the ligamentous structures is essential by clinical examination and aided by MRI. Preoperative planning also includes plain radiographs. A "schuss" view allows visualization of possible kissing lesions, which will preclude cartilage restoration techniques. A long leg film evaluates the axial alignment and will indicate the necessity for associated osteotomy. For posteriorly located lesions, a lateral radiograph in knee hyper-flexion will indicate if the lesion is accessible.

Surgical Techniques and Indications

The majority of the techniques described in this chapter are performed on a regular basis in our department. Techniques such as chondrocyte transplantation are only performed in a clinical research setting.

Indications for the different techniques continue to evolve. Location, size, and depth are primary indicators. Patellar lesions respond less well to osteochondral grafting, and chondrocyte implantation methods may be more applicable. Smaller defects of the femoral condyles around 2 cm^2 may do well with osteochondral grafting. Larger lesions around 2–4 cm^2 may be best treated with chondrocyte implantation, and even larger ones by osteochondral allografts. Thus fortunately the majority of lesions, which are small, can be treated in most units around the world with simple equipment, whereas the less common larger lesions demand treatment with procedures that require more logistical support.

Other factors to be included in the algorithm for treatment include age, weight, and activity level, as well as alignment,

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state of the menisci, and stability. For the majority of patients, a technique providing durable and complete surface restoration would be ideal. This is not always feasible or appropriate however, and in higher level professional sports players, the need for rapid return to play may counterintuitively discourage the use of the ideal restorative techniques.

Perforations of the Subchondral Bone

Numerous methods exist to perforate the subchondral bone. They are probably indicated for small lesions. However, it is important to know that the success of cartilage transplantation techniques for cases where the marrow stimulation techniques that have failed may be inferior to their success in virgin cases.

- Pridie drilling: the perforations of the subchondral bone are performed using a drill. After debridement of the lesion, multiple perforations with an interval of 2–3 mm are made using a 2.0 drill. The depth of the perforations is approximately 15 mm. After the surgery, the tourniquet is deflated to verify bleeding from the perforations.
- Microfracture according to Steadman: these perforations are performed using a microfracture awl.
- Abrasions: this technique performs an abrasion of the subchondral bone using a high speed burr, or coblation with a frequency and irrigation that is adapted to cartilage.

Osteochondral Grafting and Mosaicplasty

Following the first founding symposium of the International Cartilage Repair Society in Fribourg in 1997, we started this technique, with the support of R. Jakob.

Principles

Mosaicplasty encompasses the transplantation of osteochondral plugs for the treatment of chondral and osteochondral lesions. This technique was originally described by Matsusue (1981) and was popularized by L. Hangody during the 1990s. In the English literature, Vladimir Bobic from the UK is one of the leading authors. The osteochondral autografts are harvested from the medial or lateral border of the trochlea or in the intercondylar notch. Small osteochondral grafts transplanted into the lesions and arranged in a mosaic-like fashion. Although initially described for the treatment of femoral condyle lesions, this technique has been extended to other joints. Donor areas now also include the contralateral knee and the proximal tibio-fibular joint (J. Espregueira-Mendes). Allograft is an alternative source.

Surgical Technique

The patient is placed in a supine position. A vertical lateral and a horizontal distal post are positioned and a tourniquet is used. The surgical approach depends on the location of the lesion. Most frequently, an anteromedial parapatellar arthrotomy is used. In the case of a lateral lesion, a lateral parapatellar approach is used. This approach can be associated with an osteotomy of the tibial tubercle to gain access to the posterolateral compartment. The arthrotomy, either medial or lateral, is performed in a subvastus fashion. The knee joint is systematically explored for associated lesions.

In the first step, the bottom and edges of the lesion are debrided. This step allows evaluation of the dimensions and the depth of the lesions. The number of plugs needed and their diameter can then be chosen. The osteochondral grafts should cover at least 70% of the lesion.

In the second step, the lesion area is prepared using a specific calibrated drill. The direction of the drill hole is perpendicular to the articular surface. The depth of the hole should be 15 mm in case of a chondral lesion and 25 mm with an osteochondral lesion (OCD) (Fig. 12.1).

Using a tubular harvester, the first osteochondral plug is harvested in the donor area. The primary donor area is the medial trochlea followed by the lateral trochlea or the intercondylar notch area. Again the direction of the harvester should be perpendicular to the articular surface (Fig. 12.2). The harvester is calibrated so the correct depth

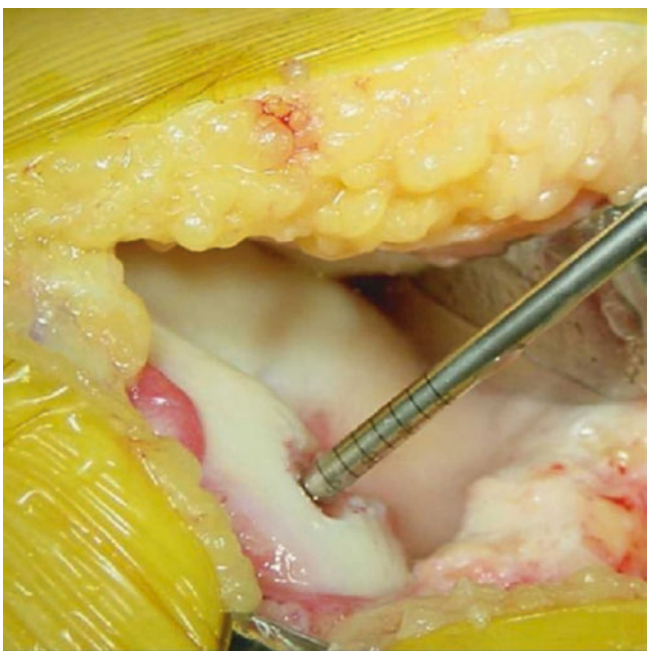

Fig. 12.1 Mosaicplasty—specific calibrated drill. The direction of the drill hole is perpendicular to the articular surface

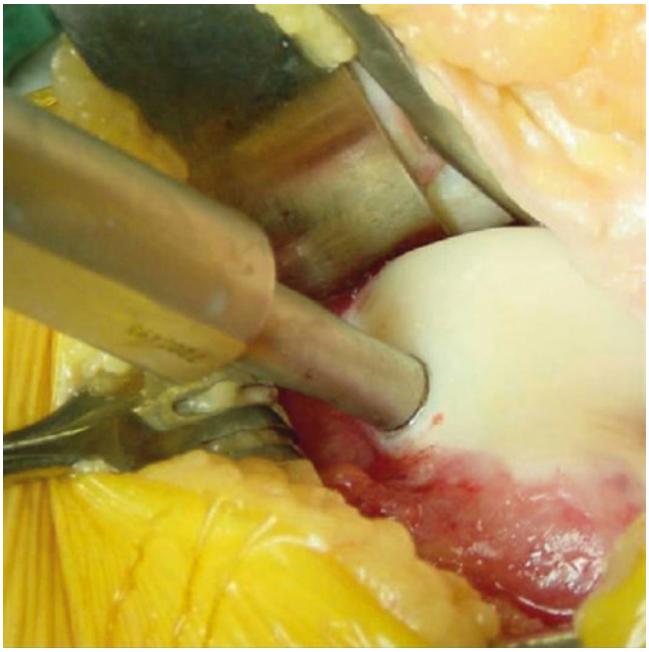

Fig. 12.2 Mosaicplasty—first osteochondral plug harvested using a tubular harvester in the donor area

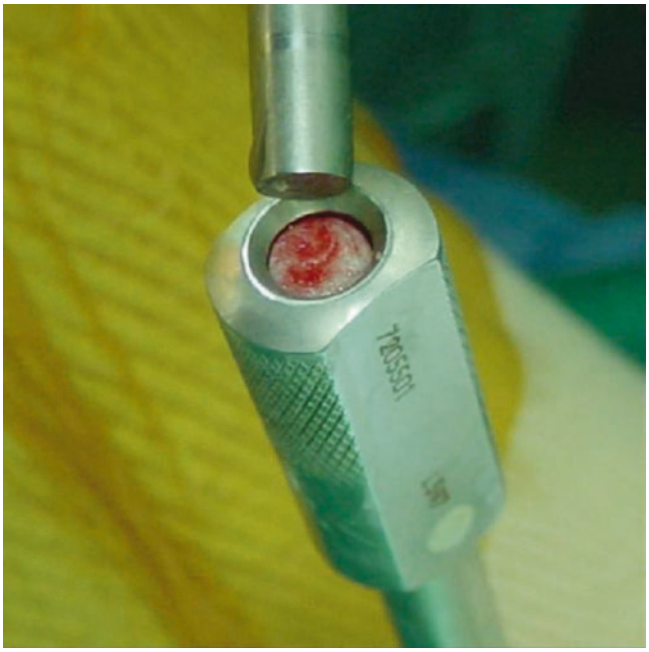

Fig. 12.4 Mosaicplasty—graded adjustable plunger

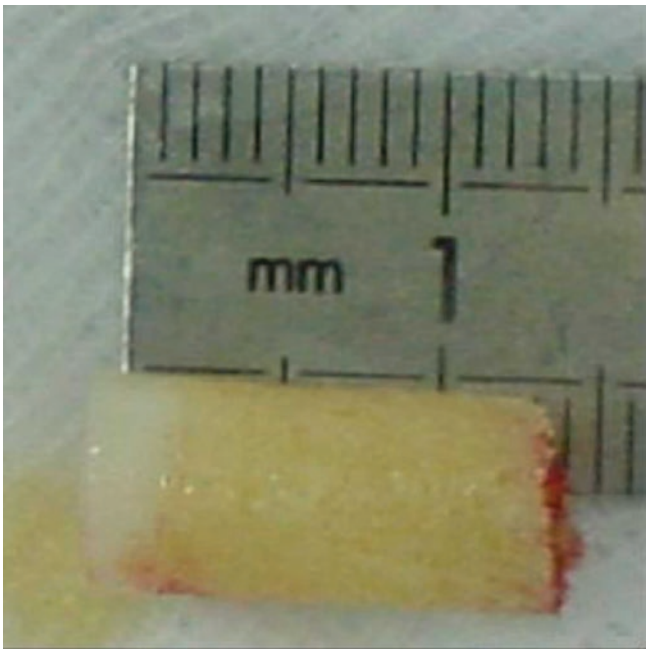

Fig. 12.3 Mosaicplasty—osteochondral plug sizing (length 15 mm, width 4.5 mm)

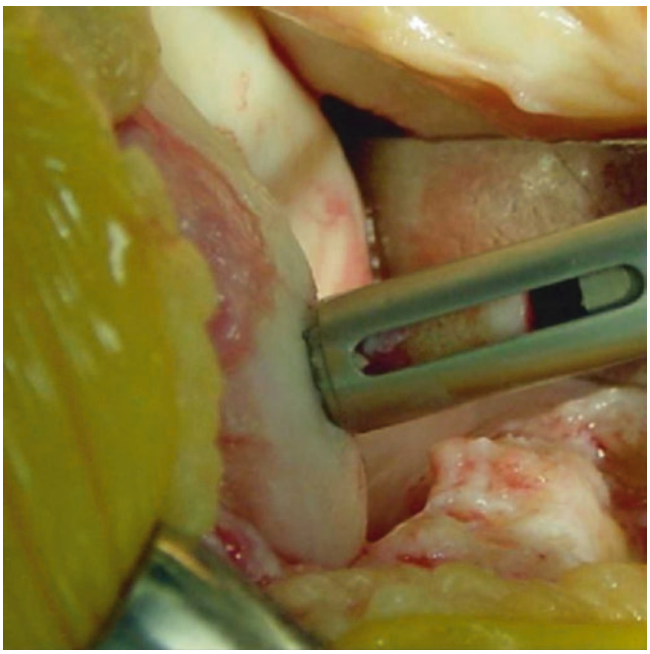

Fig. 12.5 Mosaicplasty—insertion of the osteochondral plug in the acceptor tunnel

of osteochondral plug can be acquired. The plug is measured to confirm the longitudinal dimension (Fig. 12.3).

Harvesting the osteochondral plug is done by rocking the harvester or by rotating it. This depends on the type of instrumentation. The graft is extracted from the harvester by gently taping on the osseous end of the graft or using an adapted pusher through the harvester.

Dilatation of the acceptor drill hole is done with a calibrated dilator. The insertion of the osteochondral plug in the acceptor tunnel is performed using a graded adjustable plunger (Fig. 12.4). This allows exact control of progression and final depth of the osteochondral plug in the acceptor tunnel without the application of undue force (Fig. 12.5).

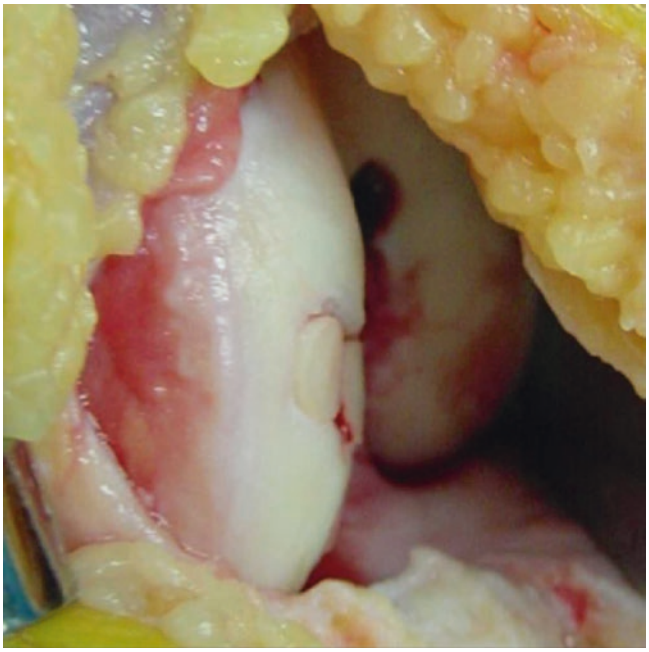

Fig. 12.6 Mosaicplasty—final aspect. The levels of the osteochondral plugs are in line with the adjacent cartilage. Note the trochlear donor site

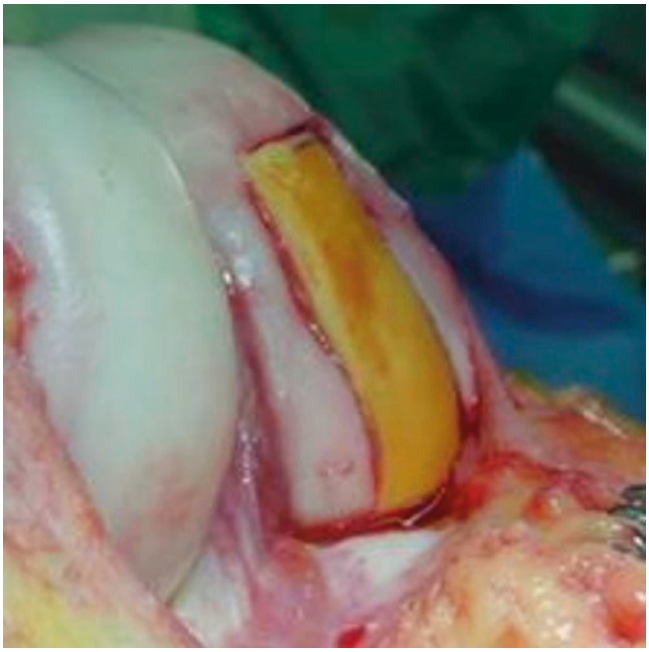

Fig. 12.7 Osteochondral allograft. Note the perfect match (appropriate size and curvature)

The level of the osteochondral plug should be in line with the adjacent cartilage. Too prominent a graft or too deep a graft should be avoided (Fig. 12.6). The commercial kits available today make the technique more systematic.

Postoperative Guidelines

The patient should wear a brace. Weight bearing is prohibited for 45 days and thromboprophylaxis is considered for this period. Continuous passive motion is allowed on the first postoperative day. The patella should be mobilized. Open and close kinetic chain exercises are prescribed. Return to sports is allowed after 6 months.

Osteochondral Allograft

When addressing very large lesions (over 6 cm^2), harvesting sufficient autologous cartilage for a classic mosaicplasty is impossible. Specific large diameter instruments are available in order to use the same technique with allograft material, but results are questionable. For very large lesions, a monoblock allograft with custom dimensions is optimal. In these cases, the donor condyle should be of the same size and curvature as the native condyle to obtain a perfect match (Fig. 12.7).

Autologous Chondrocyte Transplantation

The evaluation and preparation of lesions and the surgical approach has been described previously. Autologous chondrocytes transplantation can address lesions up to 5 mm in thickness.

Chondrocytes Cultures

Autologous chondrocytes are proliferated in vitro. First, a cartilage biopsy of approximately 200 mg is harvested arthroscopically from the medial trochlea or the intercondylar notch. The cells are isolated by enzymatic digestion of the matrix and are subsequently cultured as a monolayer in order to obtain the desired cell quantity (approximately 10 million cells).

Implantation

Technique According to Brittberg and Peterson (ACI: Autologous Chondrocyte Implantation)

The cells are transplanted as a cell suspension. To contain the cells within the defect, a periosteal or collagen membrane is needed to cover the defect. This membrane is sutured to the defect edges as has been described by Brittberg (Fig. 12.8).

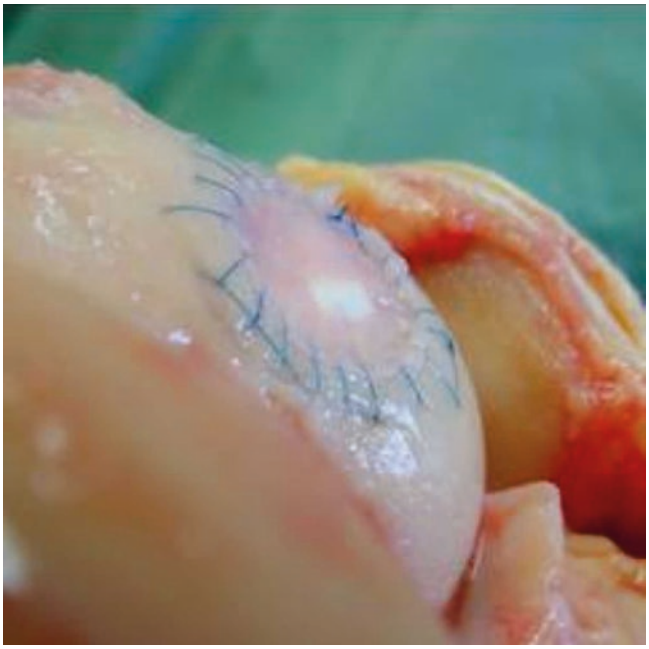

Fig. 12.8 Autologous chondrocyte implantation (ACI, Brittberg, and Peterson)

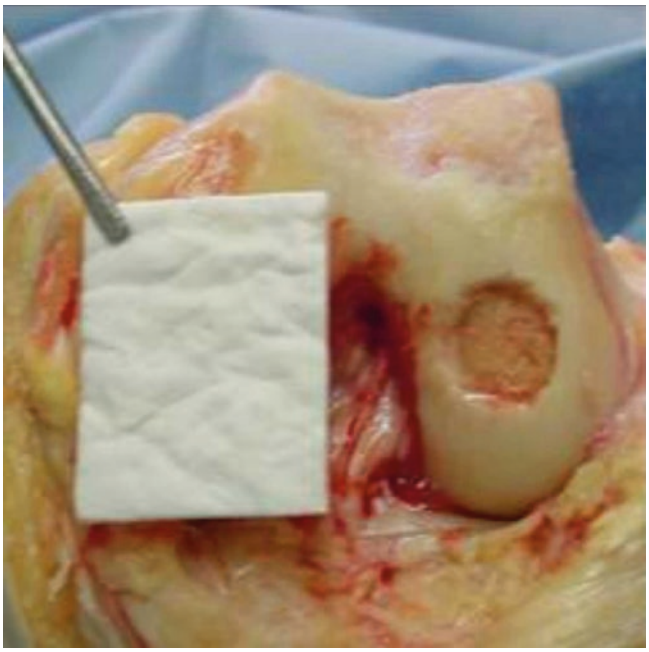

Fig. 12.9 Three-dimensional collagen matrix (Geistlich)

Cell transplantation with the use of a three-dimensional matrix improves chondrocytes re-differentiation and thus ensures the correct production of different extracellular matrix proteins. Different types of matrices are available on the market: such as a sponge-type matrix (Fig. 12.9) or gel (alginate and agarose gel such as Cartipatch) (Fig. 12.10). The following is the description of the Cartipatch technique. Although in our department we now use a different matrix, the technique is very similar.

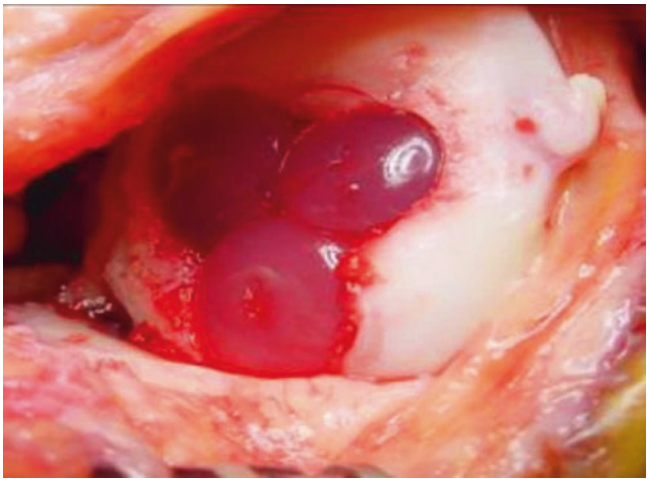

Fig. 12.10 Cartipatch®—14 mm diameter grafts

Cartipatch Technique

The Cartipatch technique is very similar to the mosaic plasty. Preoperative planning and preparation however is mandatory. A biopsy harvest arthroscopy should be performed as well as preoperative imaging to evaluate the lesion. According to the size of the lesions, a number of Cartipatch grafts can be prepared. The Cartipatch graft is available in three different diameters: 10, 14, and 18 mm. For lesions close to the intercondylar notch, primary stability of the Cartipatch graft is obtained as long as the graft is contained along at least two thirds of its circumference. Specific instrumentations including calibrated drill bits are available to prepare the recipient area (Fig. 12.11). Trial components allow evaluation of the position and the height of the defect with respect to the normal cartilage (Fig. 12.12). The graft is subsequently introduced into the prepared defect using a needle (Fig. 12.13). The needle will guide the positioning, evacuate the air, and temporarily fix the graft in the defect in case of multiple grafts (Fig. 12.14). At the end of the intervention, the tourniquet is deflated to observe possible expulsion of the graft. The knee is then cycled to test primary stability of the grafts within the defect. The knee is immobilized for 48 h, thromboprophylaxis is prescribed, and weight bearing is not allowed for 45 days. Continuous passive motion of the knee between 0 and 90° is prescribed for 1 month. Sports are allowed after 1 year.

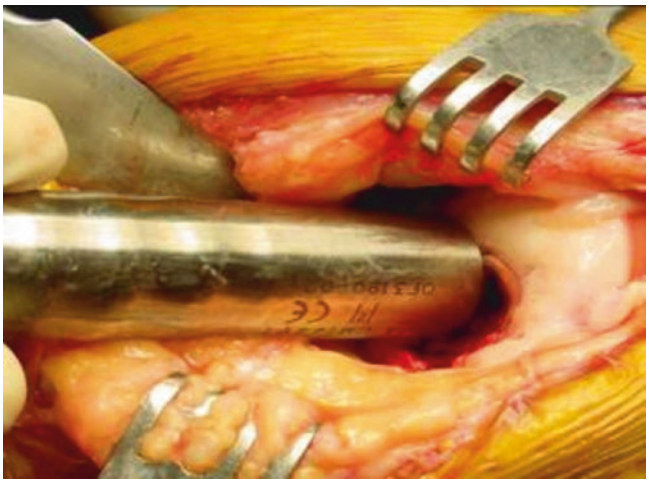

Fig. 12.11 Cartipatch®—calibrated drill bit

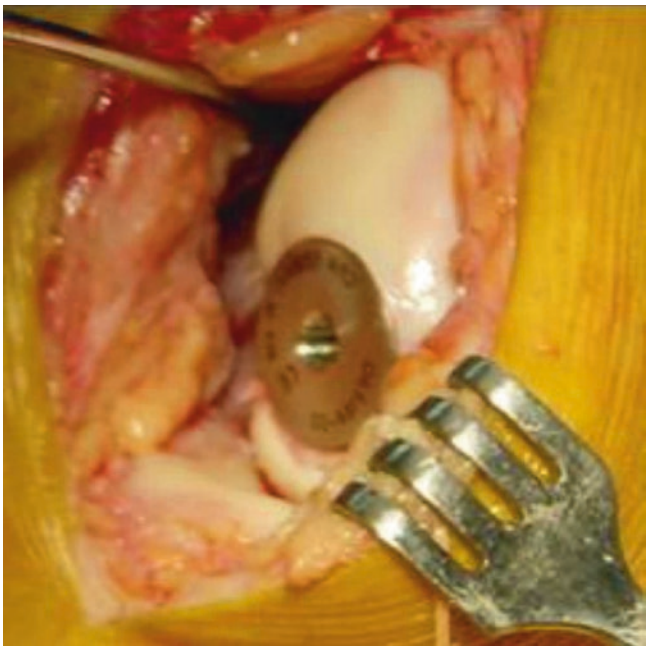

Fig. 12.12 Cartipatch®—trial component

Associated Procedures

Specific associated conditions can negatively affect the outcome of a cartilage lesion. Therefore, these conditions have to be corrected previously or concomitantly. These associated lesions include ligamentous laxity (e.g., anterior cruciate ligament rupture) and meniscus lesions. Malalignment of the lower limb exceeding 5° can be addressed by an osteotomy and should be discussed within the context of the chondral lesions or other associated lesions. Meniscal allograft transplantation can be discussed if the patient is deficient in this regard.

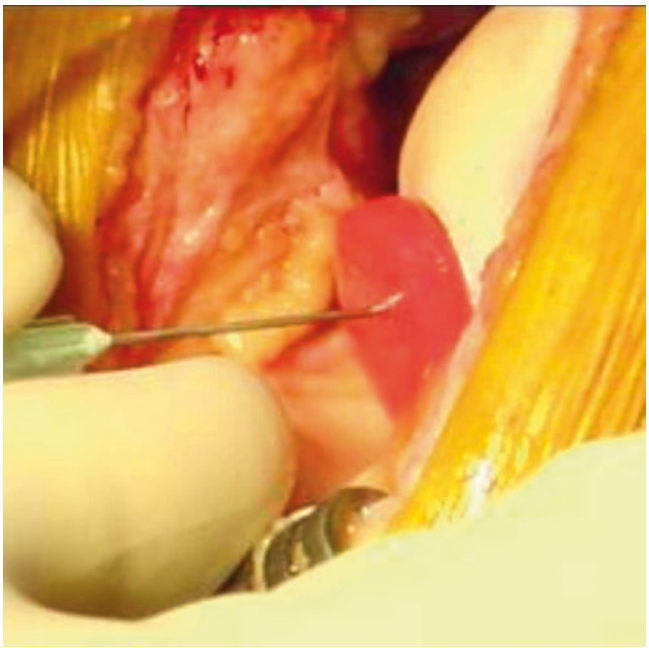

Fig. 12.13 Cartipatch®—insertion of the graft using an IM needle

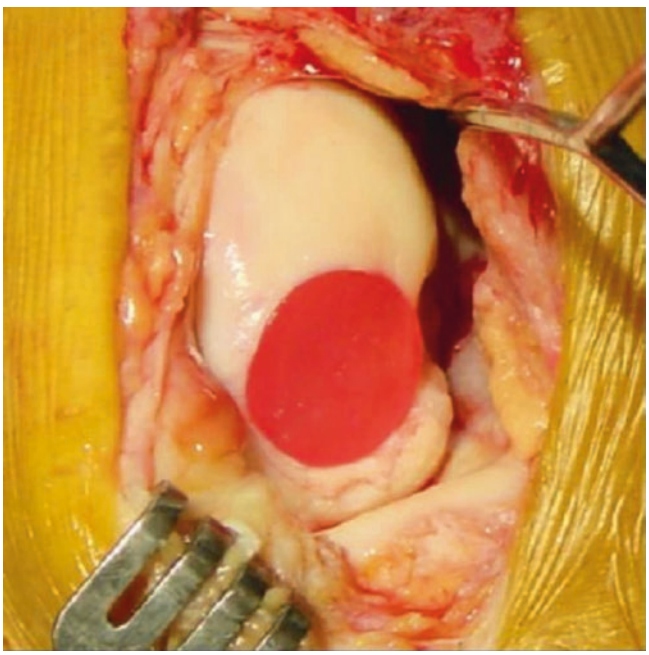

Fig. 12.14 Cartipatch®—single 18 mm diameter graft

Conservative Surgical Techniques

Fixation

A traumatic osteochondral lesion or osteochondritis dissecans (OCD) lesion can be treated with fixation to preserve the patient's original cartilage. Several types of fixation

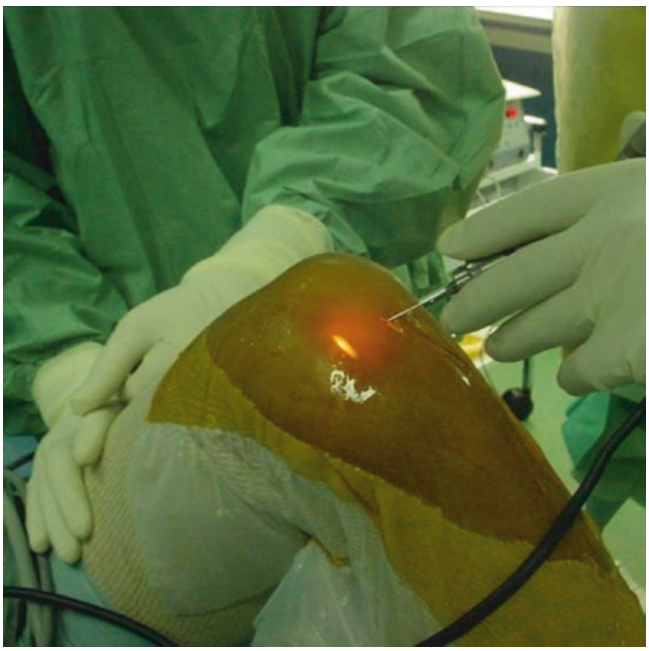

Fig. 12.15 Fixation—trans-tendinous portal, according to Gillquist

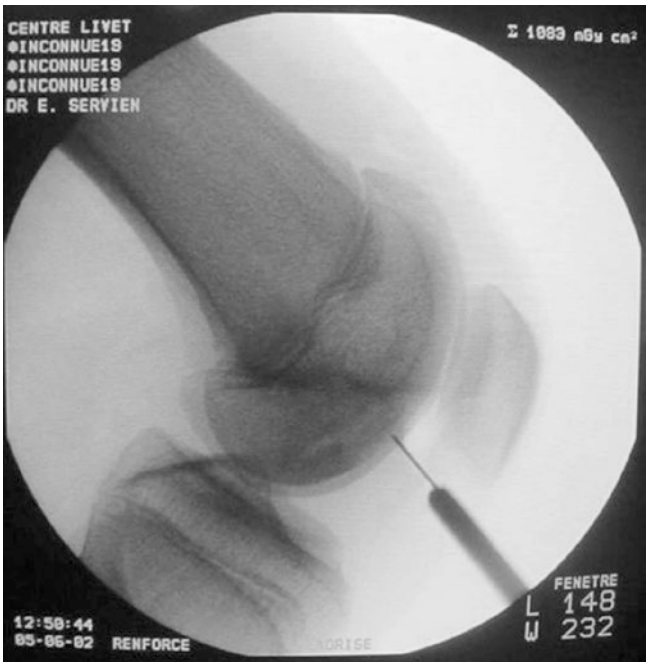

Fig. 12.16 Fixation—fluoroscopic control of the location and direction of the screw

device are available including sutures, pins, and screws (absorbable or not). The common characteristic is that these devices can be inserted completely and that they do not harm the opposing cartilage. Herbert, or other types of headless screws, are very useful for this. This technique can be performed as open surgery or under arthroscopic control. During the arthroscopy, a needle inserted perpendicular to the defect surface will illustrate the trajectory and will indicate the correct position of the portal. Very frequently, a trans-tendinous portal (according to Gillquist) is used (Fig. 12.15). Image intensified control can help to obtain the perfect direction and placement of the screw (Fig. 12.16).

OCD lesions in a young child have a good chance of healing spontaneously as long as the cartilage is intact. If the articular cartilage is breached or the fragment has become unstable, the bony lesion has to be debrided in order to stimulate bony healing. Sometimes, it will be necessary to use autologous bone graft to fill the underlying bony defect. Since the bony defect and bone fragment may not be the same size, care must be taken to avoid articular incongruity (Fig. 12.17).

Drilling

In a number of conditions, more specifically in the osteochondritis dissecans in the child with no breach of the articular cartilage, the bony lesions can be perforated arthroscopically from within the knee joint with a 2 mm drill, or alternatively in a retrograde fashion extra-articularly.

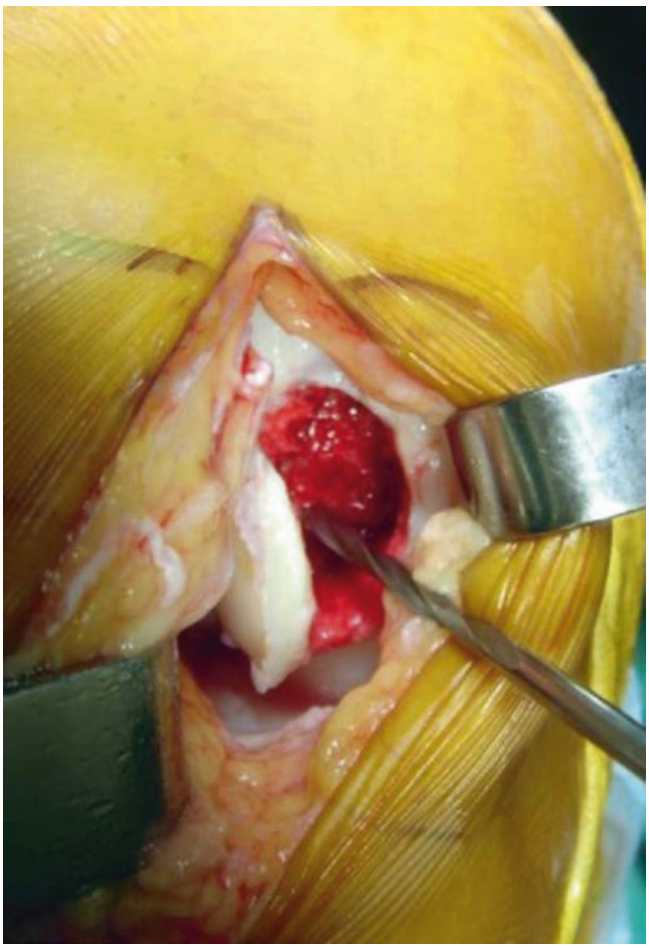

Fig. 12.17 Fixation—debridement and autologous bone graft are sometimes necessary to fill the underlying bony defect

In the case of an unstable lesion, additional fixation can be provided by a mosaic plug or screws.

Postoperative Guidelines

Weight bearing is not allowed for 45 days. Rehabilitation starts on day 1.

Pearls

Kissing lesions are a contraindication for cartilage transplantation (best identified on the Schuss view).

Conservative treatment is the treatment of choice for OCD lesions in the young child.

If an osteotomy is considered for pain, the therapeutic value of cartilage surgery should be questioned.