

AMIC technique for cartilage repair, a single-step surgical intervention as compared to other methods

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The past ten years have brought plenty of research and technical innovations and also preliminary clinical success in cartilage repair. The common target of all methods utilised is to produce a sufficiently stable quality of cartilage repair or regenerate. However, yet today clinical, radiological and histological results analysing the different techniques are somewhat contradictory. The different lines of clinically applied and basic research have focused on:

1. a. Spontaneous natural filling of the defect with fibrocartilage of variable solidity.
 - b. Abrasion chondroplasty, drilling or microfracturing to allow for mobilisation of progenitor cells and mesenchymal stem cells from the cancellous bone into the defect and develop to a hyaline like cartilage.
 - c. Stem cell treatment (in vivo or ex vivo theory of potential technique by which stem cells could be brought to a defect to create cartilage; so far no directly linked product available)
2. Transplantation of osteochondral auto grafts (Mosaicplasty, OATS, SDS, patellar graft) or allograft.
3. a. Autologous chondrocyte transplantation and periosteal coverage (ACT) to cover bigger surfaces.
 - b. Implantation of second and third generation ex vivo products and create less morbidity but without knowing whether the results are as long-lasting as for the originally described technique (chondrocytes cultured on membranes, MACI, in gels, implantation of a stable three-dimensional de novo cartilage disk or even engineered osteochondral grafts, AMIC: autologous membrane induced chondrogenesis).

A fair amount of today's laboratory research is focusing on the culture of the patients own chondrocytes or his own stem cells.

Clinically, some methods can be applied in all indications regardless of size, localisation, depth of the lesion up to the age of fifty years

and this is valid for lesions in the knee, the shoulder, the talus, the elbow etc. Other methods like AOCT should not be used for lesions over 2cm in diameter because of donor side morbidity. All methods claim to have *an 85% outcome success rate*. Regarding the histological content of the successful implants or the reformed cartilage, microfracturing produces a cartilage implant containing a fibrocartilage that looks similar to the hyaline like cartilage of ACI at two years. Mosaicplasty plugs provided great care is applied during insertion avoiding damage of the cylinders and cartilage death-a special instrumentation has been developed with ZIMMER, the Soft Delivery System, SDS to avoid force during impaction. They remain hyaline provided they are inserted without being prone or deep sunken and the surface convexity of the femoral condyle is restored and provided they are inserted tightly next to each other. There is agreement that this is more difficult in arthroscopic techniques. One agrees also that results are dependent on the alignment of the limb. If the compartment treated is overloaded, there is less chance for integration. Osteotomy has therefore a solid position in the armamentarium of the cartilage surgeon- up to 50% of our cases get an osteotomy as part of their treatment regardless of which technique is utilised.

As complications in *autologous osteochondral grafting we may observe* destruction of the hyaline cartilage cap, non integration and pseudarthrosis or fractures of the cylinders (of special risk are smokers), especially when grafts are not inserted tightly to each other and there is lack of stability with fluid leakage out of the cartilage caps. Rarely ossification of the cartilage is observed when a thin capped cylinder retrieved in the peripheral zone of the femoral trochlea is implanted in an area of thick cartilage as in the centre of the patella where the cartilage is 5 mm thick. Donor site pathology in mosaicplasty is an issue of concern mainly if more than six plugs are removed from the femoropatellar joint. This alone can create clinical symptoms.

Nicotine abuse, probably for all techniques decreases the rate of success of cartilage repair or regeneration and osteotomy healing.

Roughly 300 cases have been treated during the last 10 years in our institution. The results were reported in 2002 (Jakob et al).

As an *alternate single surgery technique* to microfracturing and mosaicplasty we adopted the **“Autologous membrane induced chondrogenesis” (AMIC)** technique proposed by Behrens.

Microfracture of subchondral bone results in intrinsic repair of cartilage defects. Stem or progenitor cells from bone marrow have been proposed to be involved in this regenerative process. In a study Kramer et al (2006) demonstrate for the first time that mesenchymal stem (MS) cells can be recovered from matrix material saturated with cells from bone marrow after microfracture. This introduces a new instant, single time technique for automatic MS cell isolation during arthroscopic treatment. This study demonstrates that MS cells can be attracted to a cartilage defect by guidance of a collagenous matrix after perforating subchondral bone. Protocols for application of MS cells in restoration of cartilage tissue include an initial invasive biopsy to obtain the MS cells and time-wasting in vitro proliferation and possibly differentiation of the cells before implantation. The new technique already includes attraction of MS cells to sites of cartilage defects and therefore may overcome the necessity of in vitro proliferation and differentiation of MS cells prior to transplantation.

Furthermore Breinan et al (2000) have shown that the fibrocartilaginous filling of a microfracture treated defect is superior when covered with a collagen membrane than when left uncovered.

We find this technique especially useful in OCD. In this relatively young technique we curette the defect and apply microfractures to the basis of the osseous defect. Then we gain cancellous bone from the tibial plateau and mix it with fibrin glue, of which 50% of the thrombin portion is replaced by the serum of the patient as a source of growth factor. This paste of bone and enriched fibrin glue is filled in the defect which is then covered by the porcine Chondrogide membrane (Geistlich) that is glued on and which we can well suture to the defect. The AMIC technique in combination with microfractures can be utilised

for the coverage of pure cartilage defects alone, where the membrane is glued alone or fixed on the defect in combination with 5-0 resorbable sutures. In the first two weeks following surgery, aftertreatment is very defensive to avoid loss of the membrane. After two months of crutch walking with 15 kg of weight we observe a nice osseous integration of the graft and a covering layer that looks promising. After 4-6 months activity can be increased depending on the size of the defect. This is a young technique that we adopted in mid 2003 with 40 cases treated so far. Femoropatellar joint with OA due to chronic subluxation, 21 cases; femoralcondylar pure cartilage lesions, 6 cases; OCD lesions, 7 cases; talar lesions, 6 cases; total 40 cases.

Strict observation is required over the upcoming years regarding clinical results and durability and also the composition of this neocartilage, mainly also to see whether it is superior to Microfracturing alone.

So far it seems to be an interesting alternative to Mosaicplasty or Microfracturing alone since it combines principles of cell therapy with an artificial and instant biological containment that acts against the loss of cells thus acting as a internal bioreactor with the patients own growth factor support.

Literature

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