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Microfracture for cartilage defects in today's Orthopaedics: Pearls and Pitfalls

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Experience

Microfracture for cartilage defects in today's Orthopaedics: Pearls and Pitfalls

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Abstract

Microfracture technique has vacillating clinical outcomes, limited demographic applicability, high failure rate, and variable patient satisfaction. Although it does not deserve to be a gold standard technique, there has not been a technique that could overcome all possible disadvantages associated with the technique and at the same time give a favourable result/be suitable for widespread use/not have its own disadvantages. Microfracture, integrated with biomaterial/stem cell transfer has shown promise over the past decade but studies evaluating the long-term efficacy of the tests and standardization are lacking. Besides, cost and operative difficulties limit widespread use. Twenty-five years into the field, microfracture still stands as the first-line choice for most surgeons across the world for a satisfactory articular cartilage repair.

Key words: Articular cartilage, biomaterial, gold standard, microfracture, stem cell

Introduction

Articular cartilage plays a crucial role in weight-bearing, shock absorption, and the limitation of friction at the joint surface. It is frequently damaged in the setting of trauma, degenerative disease, and repetitive wear and tear. Cartilage being an avascular structure, constantly subjected to mechanical stress and having poor pluripotent cell depot at the surface, defects here rarely heal and over time, end up heralding degenerative joint process, leading to debilitating joint pain, and functional impairment. Surgical intervention in the form of palliative procedures (such as debridement and lavage), reparative techniques (like Pridie drilling, microfracture), restorative techniques (mosaicplasty, osteochondral allografts/autografts), and regenerative techniques (like autologous chondrocyte implantation, stem cell-based therapy) thus become necessary.

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It could well be said that cartilage resurfacing techniques did not have a path-breaking revolution since the first use of the microfracture technique by Steadman *et.al.*, in 1994.[1] Numerous improvisations and innovations have come through but the technique, despite its shortcomings, has stood the test of time and is still considered the gold standard in this field.

Microfracture technique

Currently, the microfracture technique is considered the first-line modality in treating small-sized cartilage defects. It is a bone marrow stimulation technique that involves the creation of small holes in the subchondral bone, which is later filled up by blood clots, giving the defects the access for recruitment of progenitor cells from the bone marrow, promoting healing. Utilizing the body's own healing abilities to bring about a technically simple, low-cost repair with minimal surgical site damage is the hallmark of this technique.[2]

Although considered a first-line treatment modality, the technique has a 50% failure rate, largely attributed to insufficient tissue volume filling up the defect.[3, 4] Fibrous tissue invasion from the stem cell niche, is responsible for failure to reproduce

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the native tissue function because fibrous cartilage is biochemically inferior to the articular cartilage (fibrocartilage has more type I collagen and less/abnormal proteoglycan versus articular cartilage which has predominantly type II collagen and hydrophilic proteoglycans, which make it tough and resilient).[5] It is also biomechanically inferior (denser and less stiff).[6] Ingrowth of osteogenic tissue to the area of the lesion has been reported in 20-50% of cases.[3, 7] Studies have also reported that the long-term efficacy of the technique is debatable, since irrespective of the size of the lesion, cartilage degeneration was seen five years after the treatment.[8] The success of the treatment is found to be dependent on several parameters including size of the lesion, age and built of the patient, location of the lesion, and duration of symptoms, positive results largely not favouring the demography of interest (low success rate in age > 40 years and obese individuals; lesions > 2cm2, lesions in weight-bearing areas and chronic symptoms).[3, 9, 10] Clinical efficacy has been found to be variable, with some patients reporting little improvement in pain, and some not being able to return to sports activities.[10-12] Moreover, trials have also been shown that post-treatment, a long rehabilitation program (involving a continuous passive motion for up to eight weeks and prolonged toe-touch weight-bearing) is a must for success, mandating strict patient compliance.[10] The technique is contraindicated in partial-thickness defects and in those with associated subchondral bony defect, global degenerative osteoarthrosis with capsular contraction, synovitis, flexion contracture, scarred anterior interval, and systemic immune-mediated disease.[13, 14]

Alternative techniques

Over the years, there have been many advances in the treatment of cartilage defects; while overcoming the drawbacks of microfracture technique has been their highlight, other adverse effects attributable to the treatment have caused them to take a setback. 'Like for like replacement procedures' such as autologous osteochondral transplantation (AOT), which involve transferring osteochondral plugs from non-weight bearing areas of the joint to fill the damaged area, have been shown to have better clinical success.[15] But early transplant failure, donor site morbidity, cartilage and bone collapse, difficulty matching defect size have been the drawbacks.[16] Cell-based techniques like autologous chondrocyte implantation (ACI), yielding high-quality hyaline-like regenerative tissue have shown excellent long-term clinical results, but with a risk of chondrocyte dedifferentiation.[17,18] Besides, the need for a second surgery, long recovery time, high cost, and technical difficulties associated with the cellular transfer are probably why the technique, though with superior outcomes, has not been used widely.[19] Of late, mesenchymal stem cells (MSC) have been used for cartilage repair but failed seeding, hypertrophic cartilage phenotype, risk of tumorigenesis, and lack of standardized bioprocessing are its disadvantages.[20, 21]

The microfracture technique has been augmented for better functional outcomes (Microfracture plus techniques). Promising results have been reported with the use of scaffolding matrix and acellular polymer-based implants for efficient chondrocyte restoration like collagen membrane, fibrin glue, hyaluronic acid, and polyethylene glycol, with or without adhesives like hyaluronic acid for better tissue integration.[3] While the technique displayed faster defect closure, reduced variability in clinical outcome, reduced fibrous and osseous ingrowths and possibly extended demographic target, variable tissue integration and lack of reliable clinical data on long term clinical efficacy, cost analysis, and technical difficulties are drawbacks.[3] MSC transfer has also been combined with microfracture for better results.[20, 21] Bioactive agents like growth factors (TGF-Beta superfamily) and cytokines/platelet-rich plasma have also been employed but a short preservation period and high cost have limited widespread clinical use.[22]

Conclusion

Thus, a technique like a microfracture, having vacillating clinical outcomes, limited demographic applicability, high failure rate, and variable patient satisfaction, does not deserve to be a gold standard technique.

Till today, there is no solution that can overcome all possible disadvantages associated with these

techniques, at the same time give a favourable result or be suitable for widespread use or not have its own disadvantages.

Microfracture, integrated with biomaterial/stem cell transfer has shown promise over the past decade but studies evaluating the long-term efficacy of the tests and standardization are lacking. Besides, cost and operative difficulties limit widespread use.

In our opinion, the king might not be deserving enough to wear the crown, but the princes have failed to show capability enough to dethrone him!

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