Evaluation of the Results of Mosaicplasty in the Treatment of Articular Knee Ulcers

Systematic Review / Meta-Analysis for Partial Fulfillment of Master Degree in Orthopedic Surgery

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List of Abbreviations

Abb.	Full term
ACI	Autologous chondrocyte implantation
ACL	Anterior cruciate ligament
AP	Antero-posterior
BMI	Body mass index
CL	Confidence limits
CT-OAM	CT osteo-absorpiometric
ECM	Extracellular matrix
FATSAT	Fat saturation
FUP	Follow up
HSS	Hospital for Special Surgery scoring system
I^2	I-square index
ICRS	International cartilage research society
IKDC	International Knee Documentation Committee
JOA	Japanese orthopedic association
K-L	Kellgren– Lawrence grades
KOOS	Knee Osteoarthritis and Outcome Survey
MFx	Microfracture
MRI	Magnetic resonance imaging
MSC	Meniscus
OA	Osteoarthritis
OAT	Osteo-articular transfer
OCD	Osteochondritis dissecans
OKS	Oxford knee score
PGs	Proteoglycans
Q	Cochran chi square
REM	Random-effects method

List of Abbreviations Cont...

Abb.	Full term
RHSSK	Revised Hospital for Special Surgery Knee Score
SD	Standard of deviation
SE	Standard error
SPIR	Single photon inversion recovery
STIR	Short tau inversion recovery
VAS	Visual analogue scale
WOMAC	Western Ontario and McMaster's

INTRODUCTION

The layer of cartilage covering the knee joint surfaces helps protect the joint and reduce friction during movement. Cartilage injuries of the knee in adults can result from trauma, such as during sport, or from a cartilage disease (osteochondritis dissicans). If left untreated, cartilage injuries do not mend by themselves and can lead to significant destruction of the joint (osteoarthritis). (1)

It is important and necessary to thoroughly document and grade chondral lesions when treating patients with articular cartilage defects. In 1961, Outerbridge (2) described the simplest scale by directly observing damaged patellae during arthrotomy. The Outerbridge grading system is widely accepted, although it has size, depth and lesion locale descriptive limitations. Many other classification systems have been established to indicate the severity and type of articular cartilage damage. The international cartilage research society (ICRS) grading system observes the importance of subchondral osseous involvement and is used to describe the defect (area, depth, location).(3)

A number of treatment options are available for cartilage injuries but are often aimed at treating symptoms such as pain rather than providing a cure. Non-surgical methods, such as physical therapy, may relieve symptoms but cannot heal cartilage injuries. Microfracture, drilling, mosaicplasty, and allograft transplantation are surgical treatments that attempt to preserve the joint.[1]

Current cartilage repair algorithms [4,5,6,7] aim for the optimal treatment to reduce symptoms and restore function. These algorithms stress the importance of lesion-specific factors such as size and intra-articular location (patellofemoral or tibiofemoral). Patient knee demand level, as well as other knee-specific comorbidities (meniscal deficiency, mechanical malalignment, ligamentous laxity) also affect treatment choice. Patient-specific factors such as age and physical activity level are also common considerations.[7,8,9,10,11] Several factors have been found to affect cartilage defect treatment outcomes, yet have not been included in most existing algorithms. For instance, the intra-articular location of the lesion, specifically the medial femoral condyle, has been shown to predict better outcomes of autologous chondrocyte implantation (ACI) and microfracture (MFx) than lateral defects.[12] Higher patient body mass index (BMI) has also been associated with worse outcomes of MFx.[13] Further, female sex has been linked to greater cartilage loss and defect progression.[14]

The treatment of full-thickness cartilage defects of the articular surfaces of weight-bearing joints is a frequent problem in orthopaedic practice. Previous experimental and clinical experience with autogenous osteochondral grafting has demonstrated that the transplanted hyaline cartilage has had a good rate of survival. [15,16,17,18]

The use of small-sized multiple cylindrical grafts would permit more tissue to be transplanted while preserving the integrity of the donor site and that the implantation of grafts in a mosaic-like fashion would allow progressive contouring of the new surface. [19, 20]

Aim of the Work

The aim of this review is to give surgeons a smart idea and some logic expectations about mosaicplasty in the treatment of articular knee ulcers while making their own decision in treatment.

Chapter 1

HISTOLOGY

1- Histology of articular cartilage:

Articular cartilage forms a layer that varies in thickness between 1 and 7 mm which covers tightly the underlying bony surface. This layer mostly intensifies or alter the superficial geometry of the bone. The thinnest portion is usually in center of concave surface and vice versa on convex side. The general characteristics of a healthy young articular cartilage change by ageing. It passes from a smooth compressible white shinny cartilage to a brittle darker less cellular and conspicuously less functional cartilage. (21)

The articular cartilage remains adherent to the subchondral bony surface throughout life and varies in chemistry and constitution from one site to another in the same joint and to higher extent from one joint to another.(22) Studies also showed that the 2 to 3 mm in average layer of cartilage that covers most of our joints can withstand a compressive power of 150 and 600 pounds per inch square for an average of 2 million times a year due to its well-designed architectural collagenous deposition. (23)

In a shell nut, this cartilage is composed of chondrocytes (the main cellular portion) and extracellular matrix (ECM). 60 to 85 % of the ECM is water and dissolved electrolytes. The backbone on which the ECM is built is formed of collagen fibers (10 to 30%), proteoglycans (3 to 10%), non-collagenous proteins and glycoproteins. [24]

Arising from mesenchymal cells, the chondrocytes have a crucial role in the formation and maintenance of the ECM. [25] These cells form about 1% of the whole cartilage volume leaving the rest 99% for ECM complex. [26] Chondrocytes are present into cavities called lacunae. Their presence could be isolated on in aggregations. In both conditions, no direct contact between cells is present. Only cilia are propagating into the adjacent ECM. [26]

Water distribution is variable due to difference in aggregation of macromolecules and to higher extent proteoglycans.[27,28] Also, it has been proven that an unstopping movement of entry and exit of water is present at the articular cartilage in response to compression and lubrication needs.[29]

Up to seven types of collagen has been identified in the articular cartilage which includes the following: type II, III, IV, IX, XI, XII and XIV. [30] 90 to 95% of the whole content of collagen is of type II. In conjunction with type IX and XI, type II collagen fibrils form a mesh which acts as a backbone for the ECM. [31] The resting types of collagen are present in small amounts and of a lesser importance. [32,33,34]

Proteoglycans, due to being highly negatively charged, play an important role in determining the watery content of cartilage. [35] 50 to 85 % of the whole PGs content is formed of versican and aggrecan. These PGs form the base on which unbranched glycosaminoglycans including chondroitin sulfate and keratin sulfate get attached. [36,37] Zonal and genetic differences leads to alteration of the arrangement these PGs. [38]

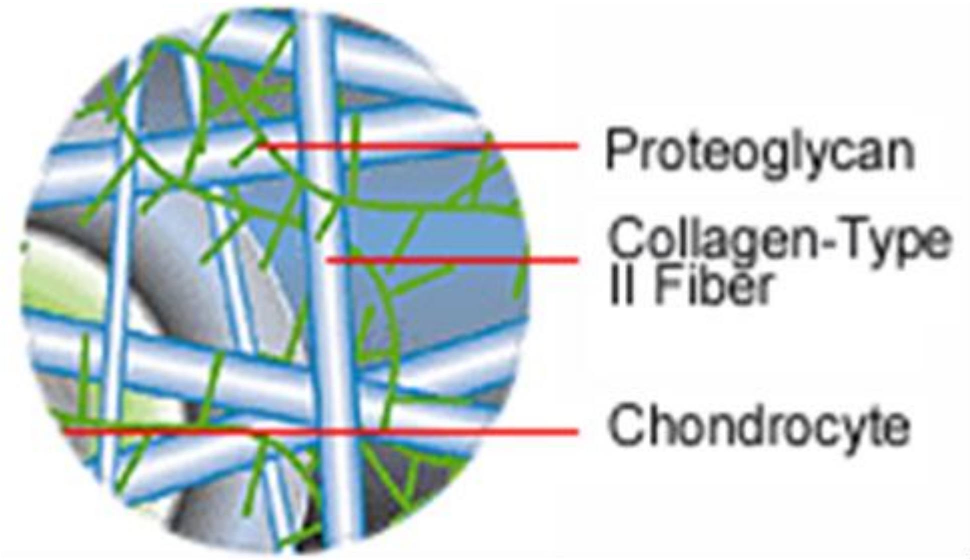

Figure (1): The arrangement of articular cartilage fibrils. [39]

The articular cartilage is also divided according to depth into zones: -zone 1 superficial or tangential layer –zone 2 intermediate or transitional layer –zone 3 deep layer also called radiate layer –zone 4 calcified layer. Each zone has its characteristic cell volume and shape, watery content and collagenous deposition.[22] On the other hand, cartilage could be divided according to distance from chondrocytes into regions: