

# Minced Cartilage Implantation for a Cystic Defect on the Femoral Head—Technical Note



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**Abstract:** Chondral injuries of the femoral head and their possible progression to osteoarthritis is well known. Regarding focal lesions in young patients, microfracturing or autologous chondrocyte implantation (ACI) are the most frequent used techniques to address them. Although ACI provides the better tissue quality, it is a two-step procedure and needs a lot of resources. Mincing cartilage is an old technique that has become popular again over the last few years, with good short-term results in threatening cartilage lesion in the knee. It seems intriguing to transfer this technique to the hip because you can harvest good-quality cartilage from the cam lesion, and it is a one-step procedure using autologous thrombin and fibrin. This technical note describes the repair of a parafoveal chondral defect using minced cartilage via surgical dislocation of the hip.

## Introduction

In younger patients with hip pain, chondral injuries of the femoral head are more commonly diagnosed probably as a result of improved imaging methods.<sup>1,2</sup> These defects may be caused by trauma, arthritis, dysplasia, and osteonecrosis. Femoroacetabular (FAI) impingement, particularly cam type deformities, can cause high-grade parafoveal cartilage lesions without any previous trauma.<sup>3</sup> The untreated cartilage injury may progress with further delamination to osteoarthritis.<sup>4</sup> Several treatment options for focal cartilage lesions have shown good short-term results regarding pain. Reliable long-term data, however, are scarce. Microfracturing is the most frequently used technique with improved early patient-reported outcome measures (PROMs) but those seem to decline after the first postoperative year.<sup>5–8</sup> Autologous matrix-induced chondrogenesis (AMIC) techniques have shown promising early results. A recent meta-analysis by

O'Connor et al. showed improved PROMs and decreased postoperative pain after autologous chondrocyte implantation (ACI) and AMIC.<sup>8</sup> In 201 patients, a mean improvement in the modified Harris hip score (mHSS) of  $39.9 \pm 5.9$  points after 5 years was reported by Fontana et al. using the AMIC technique.<sup>9</sup> With similar results, 32 Patients were treated with ACI, showing a significant improvement in the mHSS after 3 years.<sup>10</sup> After 5 additional years, no patients had to undergo total hip arthroplasty and no patients reported surgery-related complications.

In knee surgery, minced cartilage implantation (MCI) has recently evolved as an alternative treatment for chondral lesions.<sup>11,12</sup> This technique was first described in 1983<sup>13</sup> and became popular again, in recent years, while showing good quality of repair tissue and promising short-term clinical results.<sup>11,14</sup> Fragmentation of healthy cartilage appears to activate chondrocytes that proliferate and a de novo extracellular matrix production.<sup>12</sup> Although ACI includes two staged interventions (i.e., harvesting in a first stage followed by culturing of the cartilage with implantation of the cartilage graft in a second step), the MCI is performed as a one-stage procedure.

The aim of this technical note is to introduce MCI via an open approach (i.e., surgical hip dislocation) for chondral defects of the hip joint.

## Surgical Technique

This technique was used to treat singular chondral lesions of the femoral head in the absence of arthritic changes (Video 1). All patients complained about

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Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received April 26, 2021; accepted July 1, 2021.

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<https://doi.org/10.1016/j.eats.2021.07.011>

hip pain over several months, with no improvement due to nonoperative treatment. The indication for surgery was based on arthro-magnetic resonance imaging findings, native radiographs and the clinical examination.

Figs 1 and 2 show two examples of a typical parafoveal lesion you can see in a cam-type deformity. In both cases, you see cartilage delamination with a subchondral bone marrow edema and a subchondral cyst.

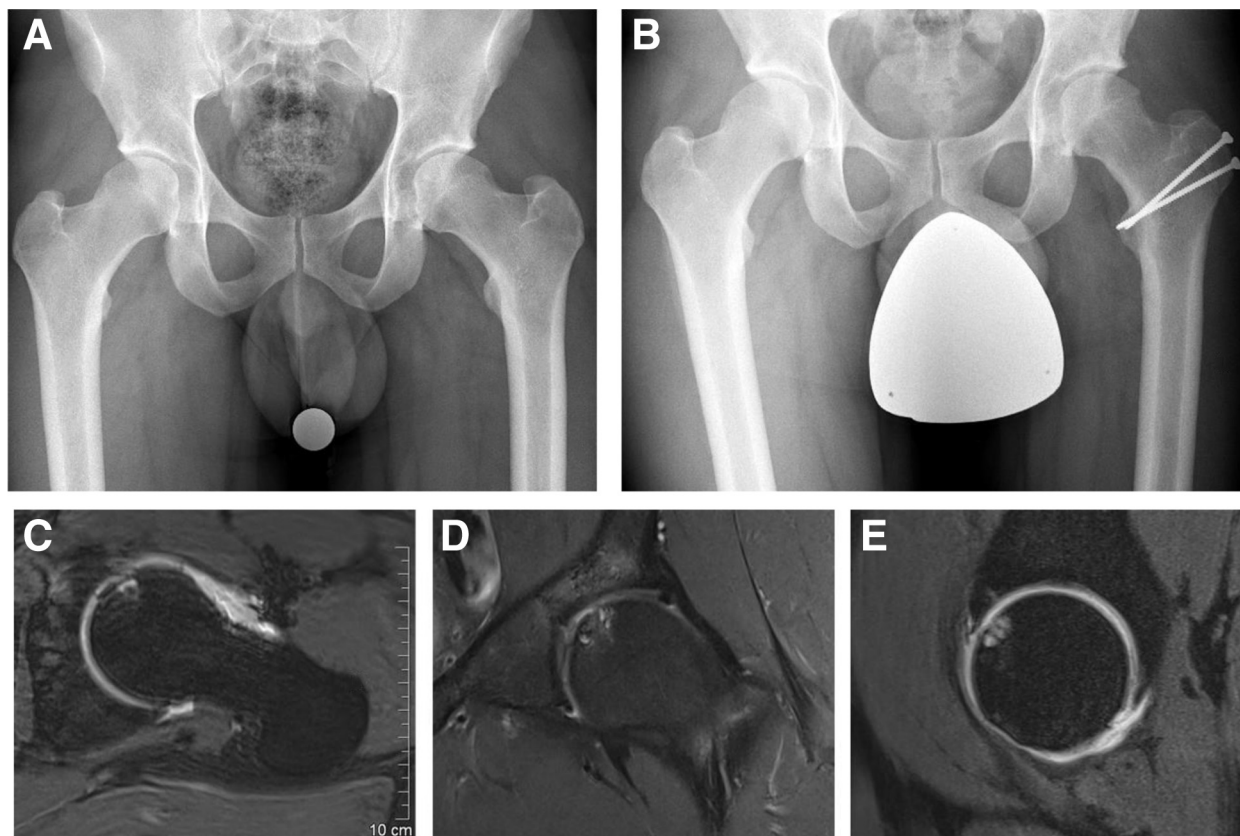
While treating the cartilage lesion using MCI, restoration of any severe subchondral bony pathology or other mechanical pathology (cam or pincer deformity, dysplasia) is mandatory during hip joint cartilage restoration surgery.

The surgery described here was realized by using the Autocart system (Arthrex, Munich, Germany). Pearls and pitfalls of the described technique are summarized in Table 1.

The patient is placed in lateral decubitus position. A standard surgical hip dislocation with trochanter osteotomy is performed, as described previously.<sup>15</sup> As it is pivotal to correct any mechanical cause for the cartilage lesion, the joint has to be thoroughly evaluated, and

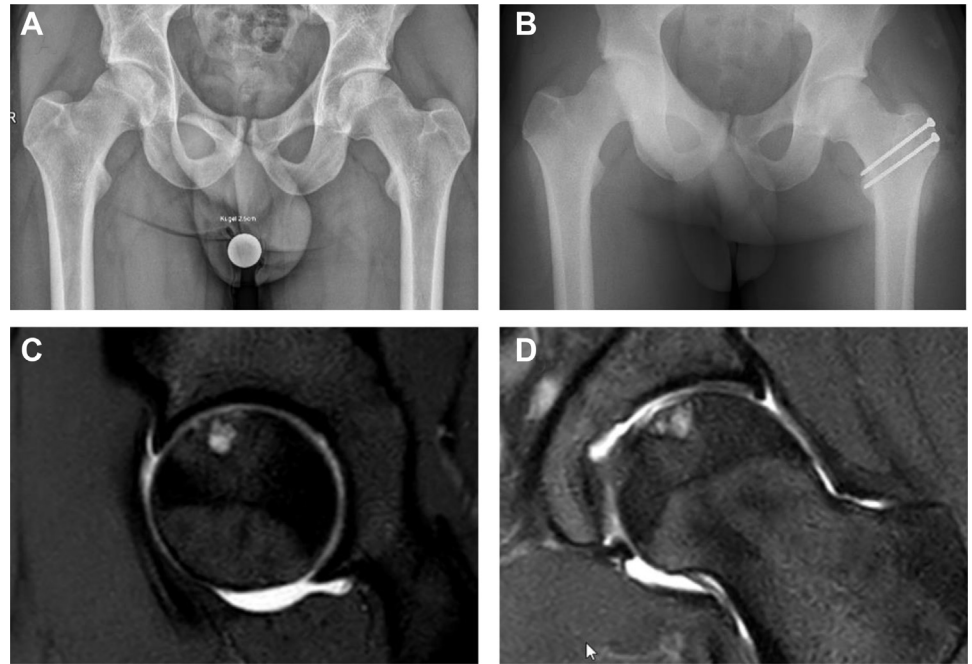
the anatomy has to be corrected (e.g., correction of femoral offset, pincer component of FAI, labral repair, and others) prior to the repair of the cartilage lesion. As soon as the chondral defect is identified, blood is drawn under sterile conditions to generate platelet-rich plasma (PRP). An amount of 10-15 mL PRP is typically required. Degenerated cartilage and chondral flaps in the defect zone are removed using a sharp spoon or a (ring) curette, thereby, creating a stable rim of vital cartilage around the lesion (Fig 3B). It is also critical to expose the entire bony surface underneath the cartilage defect. Cartilage may be harvested from the cam lesion if it appears healthy or, alternatively, close to the healthy rim of the cartilage lesion. All harvested cartilage is first manually precut with a scalpel to reduce the fragment size. The Graftnet device (Arthrex, Munich, Germany) is connected to the shaver. Then the precut pieces are finally fragmented using a 3.0 shaver device and collected within the Graftnet (Fig 3C).

Before the minced cartilage is implanted, the subchondral cyst was addressed. After debridement with a sharp spoon and removal of sclerotic bone, cancellous bone, taken from the trochanter osteotomy site, is placed into the defect.



**Fig 1.** 27-year-old male with persistent left sided hip pain over 2 years and status after hip arthroscopy. Preoperative radiograph (A) and postoperative radiograph (B) after surgical hip dislocation and minced cartilage implantation. "L" marks the left side. Preoperative magnetic resonance imaging demonstrates a parafoveal cartilage lesion with cartilage delamination and a subchondral cyst respectively subchondral edema in axial (C), coronal (D) and sagittal (E) planes.

**Fig 2.** Twenty-two-year-old soccer player with 6 months of hip pain. Preoperative radiograph (A) and postoperative radiograph (B) after surgical hip dislocation and minced cartilage implantation. Preoperative magnetic resonance imaging demonstrates a parafoveal cartilage lesion with cartilage delamination and a subchondral cyst respectively, subchondral edema in sagittal (C) and coronal (D) planes.



The cartilage chips are then mixed with 2 or 3 drops of PRP resulting in a paste-like structure. This tissue is placed into the defect (Fig 3D).

Alternatively, one can load a designated applicator device (Arthrex, Munich, Germany) with the chips-paste mixture. Such a set-up is preferable for arthroscopic approaches.

Autologous thrombin, as well as fibrin, are collected from the Thrombinator device (Arthrex, Munich, Germany). This is applied over the chips-PRP paste to initiate the coagulation process. Finally, the construct is sealed using autologous fibrin. The coagulation process usually is completed within 3-5 minutes. (Fig 3E). Video 1 summarizes all steps of the cartilage repair.

The hip is then carefully reduced avoiding any shear forces on the cartilage repair. The joint capsule is closed, and the trochanteric fragment is anatomically reduced and fixed with two 4.5-mm cortical screws.

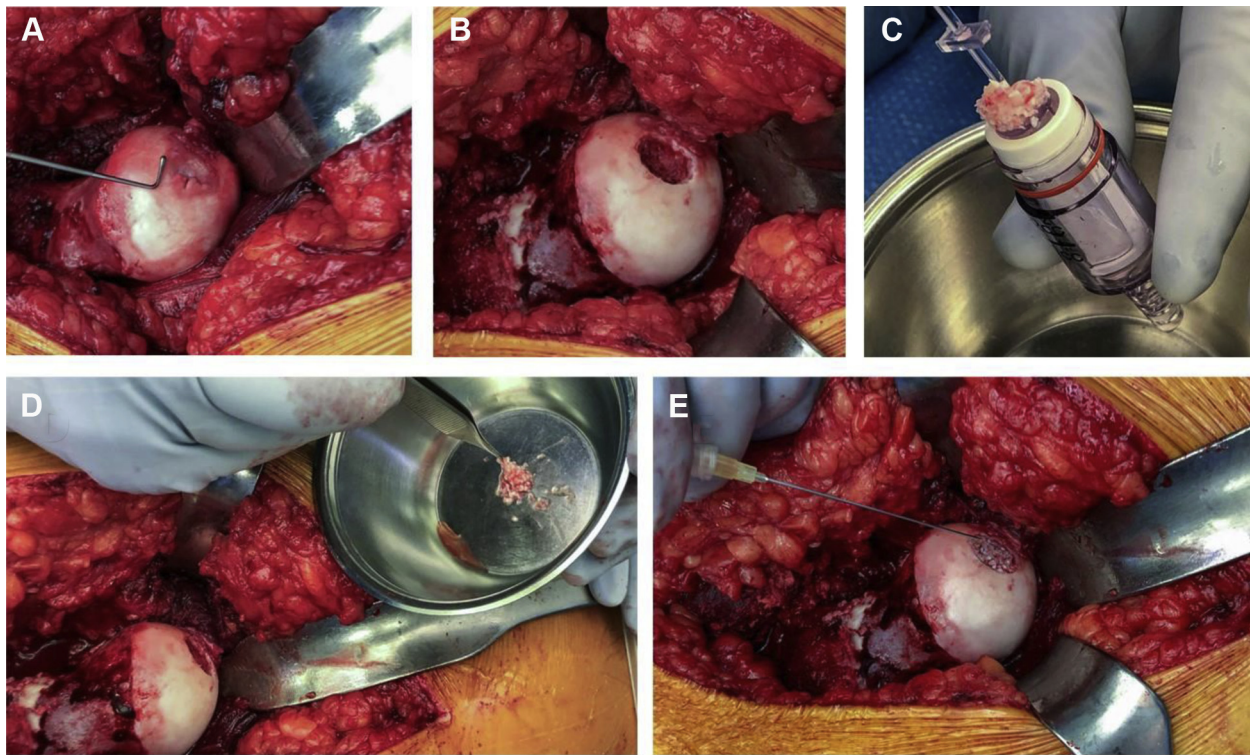
Postoperatively, patients are mobilized with partial weight-bearing of 15 kg, and hip flexion was limited to 90° for 6 weeks.

## Discussion

The technique of mincing cartilage dates back to the early 1980s. Recently, Salzman et al. published an overview of how chondral and osteochondral lesions in the knee joint can be treated by autologous minced cartilage implantation.<sup>12</sup> The basic principle is the activation of the chondrocytes through fragmentation of cartilage tissue, leading to migration and development of extracellular matrix. The result is a hyaline-like chondral repair. Lind and Christensen showed that there is no disadvantage regarding repair capacity in comparison to ACI,<sup>16</sup> and the repair tissue is superior compared to classic bone marrow activation like microfracturing.<sup>16,17</sup> The degree of fragmentation directly affects proliferation, and the differentiation capacity as Bonasia et al. showed in an experimental in vitro trial. They reported increased fragmentation increases extracellular matrix production.<sup>18</sup> Levinson et al. compared mincing with a device, like a shaver, versus scalpel mincing. There were no disadvantages regarding the mincing device, cutting the cartilage into smaller pieces, more quickly. In our technique, we used a 3.0 shaver and filtered the chondral pieces with the GraftNet device (Arthrex, Munich, Germany). In our technique, the cartilage fragments are stabilized by combining PRP and thrombin, resulting in natural fibrin. No expensive synthetic matrix is needed. Fixation is as good as with fibrin glue with the additional

**Table 1.** Pearls and Pitfalls of MCI of the Femoral Head

Pearls	Pitfalls
Quick procedure	Consider PRP contraindications
Only autologous tissue	Timing and quality of the PRP, thrombin and fibrin preparation
Spontaneous application possible	Degenerative changes like early onset arthritis need to be considered
Potential to perform the application via an arthroscopic approach	Necessity of repairing subchondral defects
Possibility to harvest cartilage from a cam deformity	



**Fig 3.** The patient is in lateral decubitus position. Surgical hip dislocation was performed, and a good exposition of the femoral head is established. (A) Parafoveal chondral lesion of the femoral head (arrow). After inspection of the whole joint indication for the repair and resection of a cam deformity was given. (B) Debridement of the defect to create a stable cartilage rim (arrow), filling of a subchondral cyst (\*), and trimming of the cam defect. (C) Harvested and minced cartilage collected in the tissue collector, which was adapted to an 3.0 shaver. We took the cartilage from the area surrounding the defect, while creating a stable cartilage rim in the same step. (D) After adding platelet-rich plasma to the minced cartilage it gets a paste like structure (arrow) and can be placed in the defect. The defect should be covered up to 80% to 90%. (E) With dripping autologous thrombin (with the cannula) over the cartilage, you start coagulation and fixation of the minced pieces. Finally, a layer of autologous fibrin seals the repair. The joint is then carefully reduced avoiding shear stress on the repair. Postoperatively, we allow for partial weight bearing and a hip flexion limited to 90° for 6 weeks.

effect that a positive milieu for cartilage homeostasis could be created by PRP.<sup>19</sup>

In hip surgery, microfracturing is still the easiest and most popular option, but several studies indicate a decline of PROMs within the first postoperative year.<sup>8</sup> Magnetic resonance imaging has sensitivity (25% to 90%) and specificity (50% to 90%), which makes the preoperative detection of a chondral lesion and the

planning of a repair sometimes difficult.<sup>20,21</sup> Therefore, one of the biggest disadvantages of ACI is the need for two surgeries, which makes unplanned chondral repairs difficult. Finally, there are limitations regarding the use of ex vivo cultured autologous chondrocytes in some health care systems.

Here, we describe a technique, which does not depend on extensive laboratory techniques. Harvesting cartilage from the defect zone and from a possible cam deformity allows for unplanned chondral repair, if necessary. Wilken et al. found an adequate quality with sufficient chondrogenic potential and histology of cells taken from the cam region during ostoplasty.<sup>22</sup> The baseline viability of the collected cartilage in a small sample size was proven to be >50%.<sup>23</sup>

Recently, Craig et al. published a technical note presenting a single-stage arthroscopic cartilage repair for the hip.<sup>24</sup> The arthroscopic approach is intriguing for the patients, as the procedure is obviously less invasive and has a shorter hospital stay and smaller scars. The AutoCart technique has been used in the

**Table 2.** Advantages and Disadvantages of MCI of the Femoral Head

Advantages	Disadvantages
One-step procedure	Eventually limited by defect size
Transplantation of chondrocytes and extracellular matrix	Invasive open approach
Economically attractive	No long-term follow-up
Quick procedure and easy to learn	
No additional donor site morbidity to harvest the cartilage	

knee,<sup>12</sup> and ankle arthroscopy.<sup>25</sup> While a surgical hip dislocation is more invasive compared to the arthroscopic technique, exposure of the a given cartilage lesion is easier, and cartilage repair may, therefore, be simpler, as in the presented case with a parafoveal defect.

In summary, MCI has a number of advantages compared to other techniques of chondrocyte transplantation (Table 2); it is an economic and rapid one-stage procedure with transplantation of chondrocytes and extracellular matrix. Donor site morbidity is barely relevant, as cartilage may be harvested from the cam region. If performed through a surgical hip dislocation, mechanical causes for the cartilage lesions may be treated during the same procedure (e.g., pincer or cam deformities, labral tears). Preclinical data show a strong biologic potential of fragmented chondrocytes. However, we are not aware of studies comparing minced cartilage repair techniques with other techniques of chondrocyte transplantation. Finally, long-term clinical and radiological data are missing to date.

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