New Evidence Supporting Joint Preservation Procedures of the Hip

A confocal microscopy study of the femoral head

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Surgical indication of joint preserving alternative procedures, remain extremely rare worldwide in comparison to total hip arthroplasty. The aim of our study was to map the femoral head in regard to quality of the articular surface using confocal microscopy, and to bring more arguments that would encourage orthopedic surgeons to take into consideration procedures that preserve the femoral head and joint in young patients, as opposed to direct total arthroplasty of the hip. Furthermore we believe that new procedures could be described in order to reach these two main goals: sparing the femoral head and, of course, better function of the hip. Our results show that while the superior pole of the femoral head presents completely deteriorated cartilage and contact surface, other areas of the femoral head present relatively good quality cartilage, whereas the inferior pole of the femoral head which is non-weightbearing has unaltered surface anatomy. In conclusion, we do encourage for further research in the direction of femoral head sparing procedures of the hip, in order to improve function and delay total hip arthroplasty in carefully selected patients.

Keywords: confocal microscopy, femoral head, orthopedic surgeons, arthroplasty

Joint preserving procedures of the hip joint in young patients with avascular necrosis of the femoral head is a captivating subject and rarely discussed in daily practice. Since the well known publication of Sugioka Y. et al. [1] reporting 90% percent success rate of trans-trochanteric rotational osteotomy of the femoral head, some publications reported controversial results. However, joint preserving procedures should undergo further research with possible new techniques, in order to address young patients with aseptic necrosis of the femoral head [1, 2].

The aim of our study was to offer arguments for extensive research in the domain of joint preserving procedures, by mapping the quality of the cartilage and joint surface of the femoral head in a 60 year old pacient suffering from grade II aseptic necrosis of the femoral head, which underwent total hip arthroplasty. Pain was the main complaint in this case, as radiological images did not show extensive degenerative changes in the hip joint.

Femoral head resurfacing is also considered a bone stock preserving surgical procedure, but relatively short survival rate, and need for complete arthroplasty lead to a dramatic decrease in indication. Ramos et al. published results suggesting that offset of the implant contributes to short survival rate and showed that negative offset (valgus position) and the natural position are the best equilibrated for better long-term results. Even if longer lifespan will be achieved, preserving the biological joint would still be preferable until the moment when age is compatible with total hip arthroplasty.

Biological regenerative therapies also offer exciting perspectives for the future but in patients with a collapsed region of the femoral head in the weight bearing area it has yet not proven the ability to cure or manage joint degeneration [3]. Further research is on the way and data is promising.

It is essential to demonstrate that in carefully selected cases the femoral head has regions with perfectly healthy cartilage in non-weight bearing areas or partial weight bearing areas, thus making the decision of total hip arthroplasty seem somewhat aggressive. With further interest and research in the domain of joint preserving procedures, such patients could benefit and still preserve the advantages of their own biological hip joint for a limited amount of time that could make a significant difference for the patient [4-6].

Confocal microscopy can be extremely helpful to understand surface defects and it has been used for diverse purposes. He Y. et al. has used it to better understand temporo-mandibular joint pathology using animal model [7], while Chiang et al. used it to validate ultrasound characterization of osteoarthritic joint features as early as 1997 [8].

Experimental part

Material and methods

Osteochondral fragments were harvested from the femoral head of a patient with primary coxarthrosis that underwent total hip arthroplasty in our clinic, from three specific areas of the femoral head: full weight bearing superior region, partially weight bearing posterior region and full non-weight bearing inferior region of the femoral head. We used a regular orthopedic oscillating saw and great care was taken not to affect in any way the articular surface in order to avoid false imaging results. The osteochondral fragment were kept in saline and processed the same day at the confocal microscope so that structure and morphology are not influenced.

Freshly resected osteochondral fragments were immediately scanned on an Olympus Fluoview FV1000 confocal laser scanning microscope, with a UPLSAPO 10x objective (NA = 0.40), using 405nm laser excitation and

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detection of the emitted light at 461nm. Z-stacks of 1024x1024 pixels images were taken at 1.5µm intervals. The resulting datasets were 3D reconstructed on a Bitplane Imaris v7.4 platform. [9]

Results and discussions

The 3D reconstruction images obtained using specific software are extremely suggestive of the fact that major cartilage damage only occurs in the weight bearing region of the femoral head.

The images below (Fig. 1) show complete degeneration of surface cartilage, with subchondral bone already exposed explaining clinical aspect as well, as this patient addressed our clinic due to chronic pain, with poor response to anti-inflammatory medication.

The images from Figure 2 are obtained from the osteochondral piece harvested from the posterior surface of the femoral head, considered partially weight bearing. Cartilage surface quality is significantly better than in the full weight bearing region.

In the last two images we can observe perfectly smooth articular surface with healthy cartilage and good quality contact surface (fig. 3). These images were obtained from the osteo-chondral fragment collected from the inferior non-weight bearing region of the femoral head.

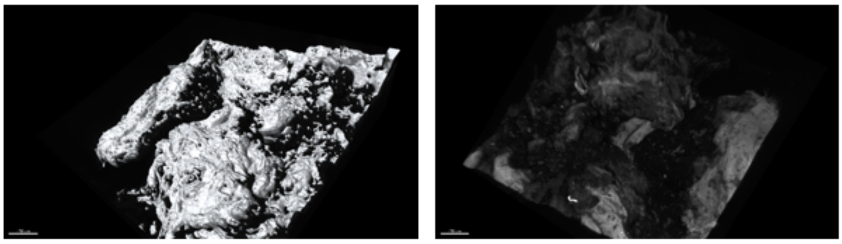
Further confocal microscopy studies must be carried out on a large group of patients to gain statistical relevance and further analyses the pattern of femoral head surface degeneration in younger patients but establishing the technique and protocol is in our opinion one step forward towards our goal.

Karim et al. [10] demonstrated recently using confocal microscopy and fluorescently labelled human chondrocytes that abnormal morphology and clustering of cells seem to be the first signs of cartilage degeneration. Surface anatomy alteration as shown in the images we obtained happens significantly later in the joint degeneration process, but might be better linked to pacient symptomatology as it affects global joint biomechanics.

Bone preserving surgical techniques in the management of secondary coxarthrosis and even some cases of primary coxarthrosis should be taken into consideration, and have become relatively outdated due to the progress of hip arthroplasty all around the world.

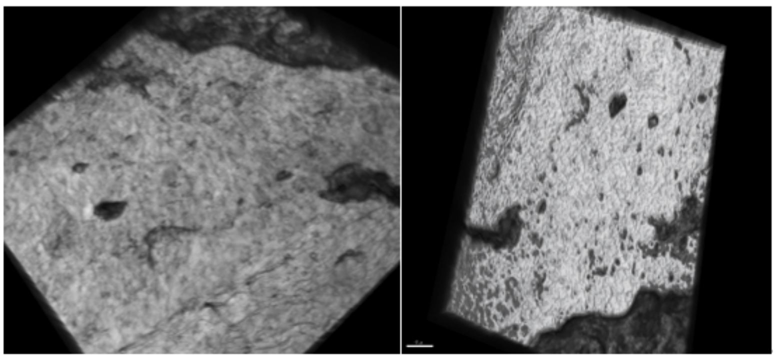
Trochanteric rotational osteotomy described by Sugioka is one option but we do feel that the research in this direction is incomplete and we believe that other techniques can be imagined in order to take advantage of the healthy articular surface found on the inferior half of the femoral head. Viamont-Guerra et al. [11] reports promising results in this direction using mosaic plasty with osteochondral autografts from the ipsilateral femoral head with significant improvement of function and pain [12]. However mosaic plasty can be taken into consideration in chondral lesions less than 16 mm in diameter [11].

We encourage further research in the direction of joint preserving procedures for the hip in carefully selected patients, as confocal microscopy proves healthy contact surface on more than half of the femoral head [13-15].



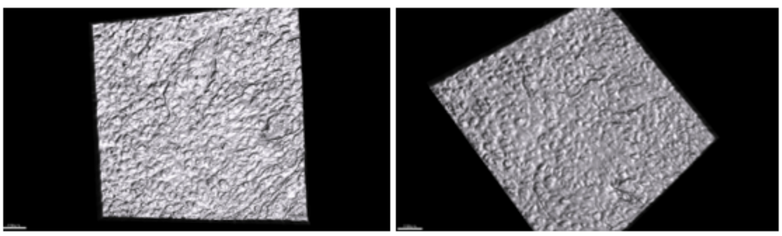
a. b.

Fig.1. Images focused on full weight bearing area of the femoral head



a. b.

Fig.2. Images focused on partial weight bearing area of the femoral head showing partial surface anatomy degeneration



a. b.

Fig. 3. Image focused on non weight bearing area of the femoral head showing normal surface anatomy and smooth cartilage surface

Conclusions

Confocal microscopy offers a good evaluation of articular surface in human osteochondral analysis and can be applied in various studies to evaluate different therapeutic interventions in the treatment of cartilage pathology.

More than 50% of the contact surface of the femoral head in this particular case is covered in relatively healthy cartilage, thus rendering total hip arthroplasty rather aggressive. Shifting the weight-bearing areas could offer benefits and delay joint replacement taking into consideration the age of the pacient.

Data evidence can be applied in many other cases and such confocal imaging studies could reveal even more significant results when analyzing osteochondral fragments collected from even younger patients with diverse pathology like aseptic necrosis or traumatic osteochondritis that undergo total hip replacement because of a lack of therapeutic options.

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