

# Capsular management in the arthroscopic treatment of the femoro-acetabular impingement in athletes: our experience

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**Summary.** *Background and aim of the work:* In the last decade, thanks to the improvement of the surgical techniques, arthroscopic treatment of hip diseases has significantly spread and evolved and currently it represents the gold standard for the treatment of femoral-acetabular impingement. In the recent years, the function of the joint capsule (and therefore the results of an arthroscopic capsulotomy) has been better understood, opening a heated debate. The Literature is still torn about a proper capsular management and the need for a capsular suture, but latest studies are more oriented to its execution at the end of the surgical procedure. According to these recent studies, the joint capsule performs an essential function on primary stability, so a conservative capsulotomy and its final closure are therefore recommended to restore the native anatomy and physiology. Although capsular management remains a controversial topic, in recent years we have developed a new conservative capsulotomy technique associated with a final capsular suture. The aim of the present retrospective study is to assess the influence of different capsulotomy techniques and a possible capsular suture role on the patient's functional outcome in a cohort of patients with femoral-acetabular impingement arthroscopically treated. *Hypothesis:* Our hypothesis is that a conservative "longitudinal" capsulotomy with a proper capsular suture positively influences the patient's functional outcome in athletes. *Methods:* 36 patients (competitive athletes) treated with hip arthroscopy for femoral-acetabular impingement have been retrospectively enrolled at the Orthopaedic Clinic of Academic Hospital of Udine during a period of two years (2016-2018); collected data have been analyzed and compared with a retrospective model. Patients have been divided into three equivalent groups, 12 without a suitable capsular management (T-Capsulotomy technique), 12 performing a Longitudinal Capsulotomy but without a final suture and 12 treated with a conservative Longitudinal Capsulotomy and a capsular suture. Patient's post-operative functional outcome has been analysed using the modified Harris Hip Score (mHHS), the Hip Outcome Score-Activity of Daily Living (HOS-ADL) and the Hip Outcome Score-Sport Scale (HOS-SS). Return to sport. *Results:* In our series there was no statistically significant difference in functional scores, however longitudinal capsulotomy seems to be associated with a higher percentage of return to sports activity (91,6% vs 75%). *Conclusions:* The new longitudinal shape capsulotomy technique and a capsular suture with a single side-to-side stitch at the end of the procedure in athletes can positively influence the patient's functional outcome. (www.actabiomedica.it)

**Key words.** Hip arthroscopy, capsular suture, capsulotomy, femoral-acetabular impingement, athletes

## Introduction

Hip related pathology in elite athletes represent not only a source of pain in the athletes but above all time lost to play (1). One of the hip pathology sports related is the femoroacetabular impingement (FAI). (2-7) In recent decades, hip arthroscopy has considerably grown as a treatment of diseases affecting the coxo-femoral joint and its surrounding structures. This increase is likely related to the improvement of surgical techniques, the raised surgeons' interests about this approach and, finally, the evolution of the diagnostic techniques and dedicated tools. Currently, hip arthroscopy represents the gold standard for the treatment of femoral-acetabular impingement (FAI) (1).

Hip arthroscopy for the treatment of FAI requires some precautions: firstly, mini-accesses for specific portals (the most used are the Antero-Lateral and the Mid-Lateral); secondly, a minimally invasive management of extra-articular tissues to be less demolitive as possible, but also to obtain an adequate view of the joint capsule. Moreover, the best possible capsulotomy must be performed to obtain a good manoeuvrability of the instruments, a better exposition of the intra-articular structures (including the acetabular labrum) and an acceptable workspace for the treatment of impingement, avoiding a major demolition of the capsule, which can lead to micro-instability and complications.

Currently the most used surgical techniques are the Periportal/Interportal capsulotomy technique and the "from outside to inside" T-capsulotomy; if the first technique spares the joint capsule but does not allow a good level of vision and manoeuvrability, the second one is highly destructive to the capsule.

Recently we have developed a surgical technique which could be the right compromise between the two previously described techniques; we call it "Longitudinal Conservative Capsulotomy".

Our surgical approach is performed in the supine position on the traction bed under general anesthesia. The affected limb is immobilized in the special boot with an internal rotation of about 20 degrees, while the pelvis is supported by a padded pillow, in order to protect the genitals and pudendal nerve at the time of traction. After the preparation of the sterile field, the landmarks for arthroscopic accesses are marked with

a dermatographic pen: the profile of the Greater Trochanter and the Anterior Superior Iliac Spine (ASIS) are highlighted.

Using these two landmarks, it is possible to define our two standard accesses, the AnteroLateral and Mid-AnteroLateral portal (Fig.1).

The Anterolateral portal is located about 1 centimeter proximal and medial to the anteromedial angle of the profile of the greater trochanter. For a precise identification of the Mid-AnteroLateral access, it is necessary to trace a line from the ASIS towards the lateral profile of the patella; the correct incision point is about 7 centimeters distal and 2 centimeters lateral from the ASIS.

In our opinion this maneuvers simplify the complicated portal identification process.

The Antero-lateral portal is used to insert the arthroscope. Afterward, it can be triangulated with the radiofrequency instrument by entering through the Mid-AnteroLateral portal. The triangulation of the instruments takes place in the extracapsular territory, through the removal of the excess subfascial tissue and the recognition of the joint capsule.

It is important to highlight that our procedure does not require fluoroscopy at any stage; instead of the "intracapsular" technique with Periportal Capsulotomy, which always requires a preventive study of accesses under fluoroscopy.

According to this classical technique, the surgeon is forced to put the leg under traction to directly reach



**Figure 1.** Our surgery field; it should be noted how the landmarks are drawn (ASIS, greater trochanter and hypothetical position of the femoral head); from these you get the two AnteroLateral and Mid-AnteroLateral accesses (marked with a cross).

the central compartment (from the Anterolateral access and through the small capsular portal) using a 70 degrees optics. Our extracapsular technique, on the other hand, by freeing up space for both vision and movement already in the extracapsular area, certainly is more comfortable and manageable for most. At this point it is possible to perform the capsulotomy (Fig. 2); our technique involves a partial and optimized capsulotomy; the incision takes place in the midcervical area with a medial-proximal direction, following the profile of the neck and the femoral head, up to the acetabular labrum. The incision can be extended if necessary, both in the proximal and distal direction, also converting it into a T-shape. This new technique represents an adequate compromise between an acceptable freedom of vision and movement and a conservative capsulotomy.

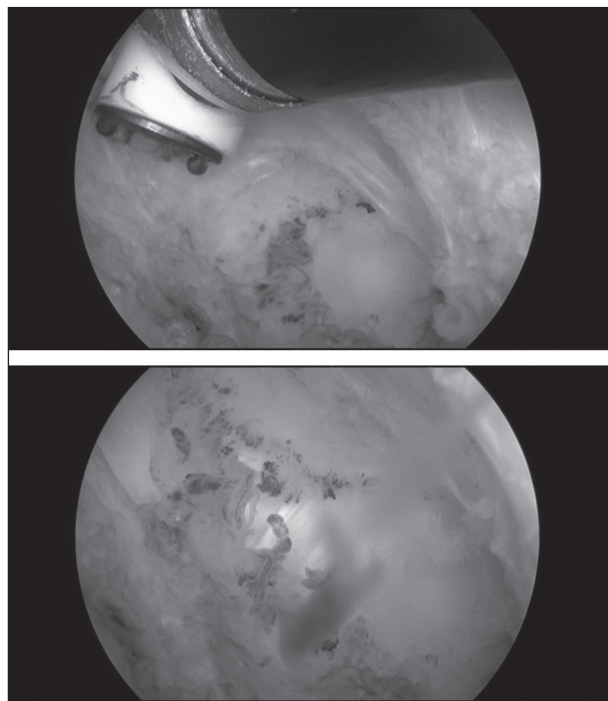
The acetabular labrum is easily visible and most therapeutic approaches (repair, profiling, suturing, removal, etc.) could be performed. PINCER lesions are also clearly visible and treated from medial to lateral. At this point the lower limbs are put under traction and the entire intra-articular compartment is observable and treatable with a 70° scope. Using a radiofrequency

instrument, it is possible to evaluate any cartilage lesions, the presence of intra-articular mobile body, the pulvinar fat, the quadrilateral lamina and the femoral head ligament. At the end of this procedures it is possible to release the traction. This allows to limit the traction time to a maximum of ten minutes, thus reducing the risk for possible iatrogenic damages. Finally, the femoral neck and the presence of CAM lesions, easily recognizable both in the anterior and lateral area, can be evaluated. By gradually flexing the hip, it is possible to perform osteochondroplasty, observing the extent and depth of the surgical act. The procedure ends with a final diagnostic arthroscopic appraisal, evaluating the residual impingement at all degrees of flexion and rotation. The last surgical act is the capsular suture; unnecessary moment in the Periportal and Interportal approaches, when the T-Capsulotomy is performed, at least two stitches are required to obtain an acceptable suture. With our conservative capsulotomy is sufficient only one side-to-side point in the center of the cut.

## Materials and methods

In the present retrospective study 36 patients treated with hip arthroscopy in the period between February 2016 and October 2018 were enrolled. All the operations were performed by the same expert surgeon. Inclusion criteria were: competitive sports participation, clinically confirmed FAI diagnosis with dedicated radiographs and MRI study, age between 17 and 35 years, pre-operative pain for at least 6 months not regressed with physical, physiotherapeutic and analgesic therapies. Exclusion criteria included: evidence of hip dysplasia, coxa profunda or coxa protrusa, signs of advanced osteoarthritic status, outcomes of traumatic events such as fractures, previous local surgery, severe acetabular deformity, concomitant presence of other joint and extrarticular pathologies, any intra-operative complications, arthroscopic surgery on the contralateral limb within the year.

Patients have been divided into three groups according to the capsulotomy performed: 12 with a T-Capsulotomy but without a suitable capsular management, 12 with a Longitudinal Capsulotomy but without a final suture and 12 treated with a conserva-



**Figure 2.** Our execution of the longitudinal partial and conservative capsulotomy

tive Longitudinal Capsulotomy and a capsular suture (Fig. 3). Each group of 12 patients consisted of 6 men and 6 women. All patients underwent usual follow up at 2 weeks from the index procedure, at 45 days, at 3 months, at 6 months and at 1 year. Data have been collected 2 years after the surgery through a face-to-face interview filling in the modified Harris Hip Score (mHHS), Hip Outcome Score- Activity of Daily Living Scale (HOS-ADL) and Hip Outcome Score-Sport Scale (HOS-SS).

The statistical analysis was done using GraphPad Prism 8.0. To compare the obtained values a Kruskal Wallis test o Anova test was used according to distribution of values. A p-value < 0.05 was considered statistically significant for all differences.

## Results

The enrolled patients were young (average age 25.5 years ), with a very active lifestyle. For each group, all of the participants carried out competitive sports (volleyball, basketball, rugby, soccer). At the end of the post-operative rehabilitation period, most patients were able to resume competitive physical activities (9 patients of Group 1, 11 of Group 2 and 11 of Group 3). Although this is not an empirical statistic, has to be noted how our surgical practice has generally reached the set target, guaranteeing patients a resumption of sports activity.

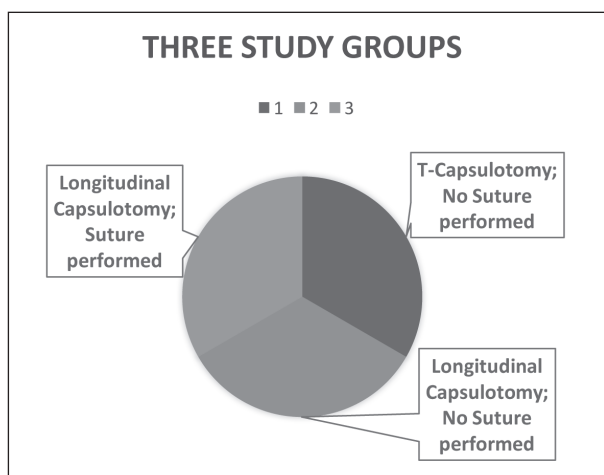


Figure 3. Patient's distribution

Table 1. Score results

	mHHS	HOS-ADL	HOS-SS
<b>GROUP 1</b>			
<i>Pre-op</i>	64,1±10,1	63,1±7,7	61,5±7,4
<i>Post-op</i>	84,75±6,9	85,3±6,2	84,4±5,9
<b>D</b>	<b>20,65</b>	<b>22,2</b>	<b>22,8</b>
<b>GROUP 2</b>			
<i>Pre-op</i>	67,1±10,4	62,6±9,1	60,2±13,4
<i>Post-op</i>	86,4±7,9	86±9,8	85,3±7,1
<b>D</b>	<b>19,3</b>	<b>23,4</b>	<b>24,8</b>
<b>GROUP 3</b>			
<i>Pre-op</i>	65,5±8,9	59,1±7,4	58,3±7,4
<i>Post-op</i>	87,7±7,4	89,3±4,1	86±6,1
<b>D</b>	<b>22,25</b>	<b>30,1</b>	<b>27,7</b>

Table 2. return to sport at the same level

Group	Return to sport	%
1 T-shape capsulotomy	9/12	75
2 longitudinal capsulotomy	11/12	91,6
3 short longitudinal and capsular closure	11/12	91,6

The results of our pre and post-operative evaluations are described in the tables and graphs above; In each study group and for each functional score, the variation in values was increasing between pre and post-operative; this means that the surgery has brought some form of benefit to the patients, even allowing the resumption of sports activity. The central element of the results is the variability between pre-operative and post-operative scores; these data indeed suggest which is the surgical technique that guarantees the most favorable outcome for the patient. About the modified-Harris Hip Scale (Fig. 4), the difference in the result between the three Groups was not statistically significant (p 0,617). Our hypothesis is that these results simply confirm the aspecificity of the mHHS; it is important to remember that this functional scale was not developed either for the femoral-acetabular impingement or to evaluate the arthroscopic technique, but to generally estimate arthritic and non-arthritic coxo-femoral joint pathologies.

With regard to the HOS-ADL (Fig. 5), the results follow an expected linearity: the evolution of our technique corresponds to a significant improvement of

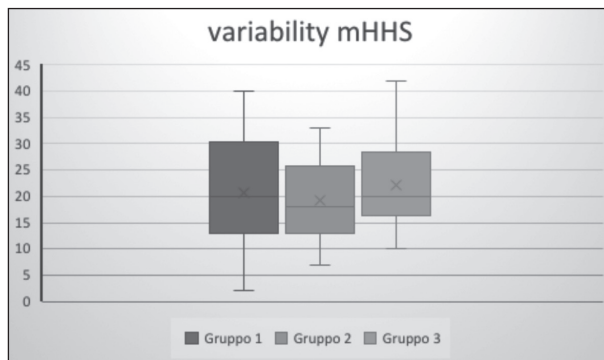


Figure 4. mHHS variability

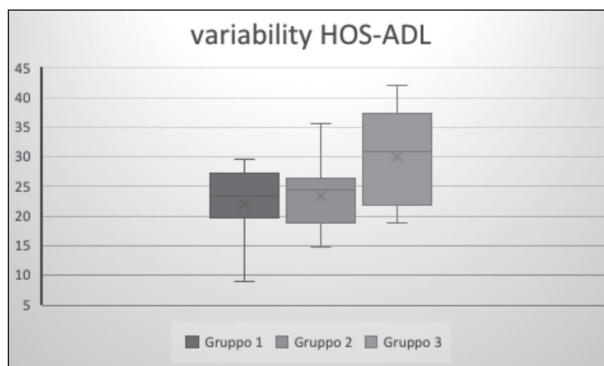


Figure 5. HOS-ADL variability

the data (but not statistically significant,  $p$  value 0,21). This functional scale is probably the one that gives us the most interesting data; the HOS-ADL measures the return to an acceptable quality of life and includes low intensity physical activity; it is the best scale to describe the post-operative outcome of hip arthroscopy for femoro-acetabular impingement.

Finally, about the HOS-SS data (Fig. 6), it is interesting to note how conservative capsulotomy

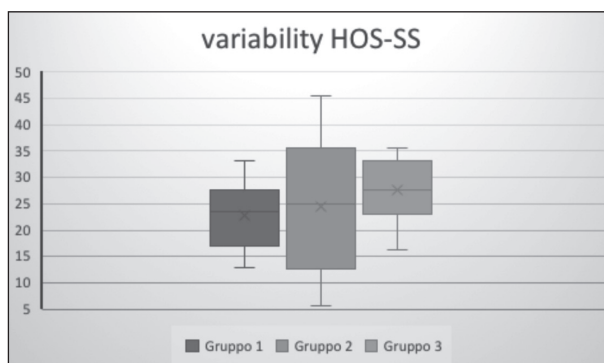


Figure 6. HOS-SS variability

promises better results and the final capsular suture guarantees a better outcome for athletes, but again in our series there is not statistically significant results ( $p$  value 0,81).

However, one indication is clear and significant: the values of Group 3 are always higher than Group 1; this suggests that the choice of performing a conservative capsulotomy and completing the surgery procedure with a final capsular suture is a winning strategy. Finally, this data indicates that the management of the joint capsule influences the patient's functional outcome and therefore the final result of the surgery.

## Discussion and conclusions

Over the last decade, the use of hip arthroscopy has increased exponentially; the procedure is now the standard technique for the treatment of non-arthritic intra and extra-articular pathologies of the hip. In conjunction with the spread of the surgical technique, an intense debate has arisen regarding the management of the joint capsule: What is the true biomechanical role of the capsule? How much an incorrect intraoperative capsular management influence the outcome of the surgery? Which is the surgical technique that allows for its adequate conservation and therefore a better outcome for the patient? Literature is not yet in agreement on the answers to be given to these questions.

In the first instance, it is important to define the role and function of the joint capsule; recent studies on the cadaver have allowed us to understand the actual role of the capsule in joint stability; in fact, it plays a primary role of stabilization in translation and rotation movements (in particular at extreme degrees). Myers et al explored the role of the iliofemoral ligament, recognizing its fundamental function in limiting excessive anterior translation (8).

Once this concept has been clarified, the need for a surgical restoration of the anatomy and capsular physiology as similar to the native one is easy to understand. To achieve this result, it is necessary to limit the insult of the surgical act to the stabilizing elements, without compromising, however, the need for adequate manoeuvring space to perform the surgical act. Historical joint approaches such as the Peripor-

tal or Interportal are respectful of the peri-articular soft tissues like capsule, but they do not guarantee adequate visibility and ability to maneuver for the operator, restricting the effectiveness of the surgical act. The evolution of the surgical technique has led to the spread of the T-Capsulotomy; more operators prefer a "from outside to inside" approach, which guarantees all the necessary visibility and maneuverability. However, this technique tears a large part of the iliofemoral ligament, causing an important insult to the peri-articular and capsular tissues. As a result, the debate about the final capsular repair at the end of the surgical act has opened.

In recent years our surgical team has studied the strengths and weaknesses of the various surgical techniques, trying to obtain an effective compromise; we have recently developed a partial form of capsulotomy, which provides a longitudinal access that follows the profile of the femoral neck up to the acetabular labrum. This technique determines an acceptable insult of the soft tissues and guarantees visibility and maneuverability in the intra-articular spaces. In the last period, the final suture of the joint capsule was added to the surgical act.

The purpose of the study is to ascertain to what extent the different capsular management methods (capsulotomy and capsular suture) affect the patient's post-operative outcome. +

As mentioned, a full agreement has not yet been reached; some studies suggest that the management of the joint capsule does not positively affect the final result of the arthroscopic surgery (9).

Ekhtiari et al specifies that there is still no evidence of how much the capsular suture acts in the long term on joint stability (10). Very interesting is the review performed by Westermann et al on some studies related to our topic: he concludes that the literature with high scientific evidence (Level 2 and 3) supports the capsular suture only in the case of an arthroscopic revision; he also does not suggest the need for a specific capsulotomy technique, since they do not positively influence the patient's outcome, in particular that of sport activities (11).

However, two recent studies have found that adequate capsular management plays a protective role by limiting the need for a subsequent revision surgery

(12,13). Other studies also show how the capsular suture promote an early return to sport, also limiting the development of heterotopic ossifications (14,15).

The most recent literature is therefore increasingly oriented towards arguing that adequate capsular management with final suture favours the patient's outcome, including joint function, quality of life and post-operative satisfaction (16-18).

Abrams et al, studying the effects of capsulotomy on joint excursion, recognized that the preservation and repair of the capsule helps restore a physiological range of motion (19).

Khair et al agrees with this thesis: with cadaver analysis, he concludes that joint stability is strongly conditioned by the size of the capsulotomy (20). Baha et al promotes the capsular suture as a necessary action to restore the native function of the operated hip (21). Furthermore, Philippon et al, with a 5-year follow-up, analyzes the post-operative outcome with three functional scales (mHHS, HOS-ADL, HOS-SS), recognizing a greater increase in patients with capsular sutures; he also found twice the number of patients who underwent a prosthetic conversion in the analysis group without capsular suture (22).

Finally, Waterman et al studied the intra-articular volume difference between an intact capsule and a T capsulotomy on cadaver, finding that inadequate management clearly alters the joint volume, favouring instability and laxity (23).

## Conclusions

In summary, therefore, although the literature is not yet uniform in its conclusions, the management of the joint capsule is a moment to be absolutely taken into consideration in the arthroscopic surgical approach. Excessive resection or limited capsular management can lead to micro and macro instability of the joint, so the final capsular suture can positively influence the success of the operation. Our surgical team has embraced this concept: our surgical technique has evolved to favour the health of the joint capsule as best as possible, while ensuring high post-operative results. The results of our study, despite the various limitations and non-statistically significant values, seem to con-

firm this need. The data obtained have been shown to be in line with the most recent studies reported in the literature; however, the sample we examined is rather small. It would therefore be interesting to involve more patients, reassess them at different times and for a longer time in the post-operative period, to obtain a longer and more homogeneous follow-up, which can more precisely define the effectiveness of the treatment.

**Conflict of Interest:** Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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