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Evaluation of the Mini-open Treatment for CAM-type Femoroacetabular Impingement

Evaluación de tratamiento con mini-open para pinzamiento femoroacetabular tipo CAM

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Abstract

Objective To describe and evaluate the results of the treatment of femoroacetabular impingement (FAI) with the unassisted mini-open approach in a defined population.

Materials and Methods We performed a prospective clinical and functional assessment of fifty young patients with CAM-type FAI, with very low sports demand, treated by the unassisted mini-open approach. We included patients older than 18 years of age, with a diagnosis of symptomatic FAI, complete radiologic study, and positive lidocaine test. We excluded patients with previous hip pathology. We compared the pre- and postoperative modified Harris Hip Score (MHHS) (through the Wilcoxon test) and the pre- and postoperative scores on the Visual Analogue Scale (VAS) (through the Friedman analysis of variance [ANOVA] test). significance was established as $p < 0.05$. In total, 50 patients met the described inclusion criteria: 33 male and 17 female subjects.

Results The average age was of 36.8 ± 6.5 years. The average alfa angle was of $62.6^{\circ} \pm 5.6^{\circ}$. All patients had grade-1 Tonnis index osteoarthritis. In total, 39 patients had level 3 of activity (according to the Tegner scale). The mean follow-up was of 27.3 ± 6.2 (minimum of 12) months. The score on the MHHS improved from a preoperative median of 60.5 (range: 30.8–84.7) points to a postoperative median of 96.8 (range: 91.3–100) points ($p < 0.001$). All patients presented a significant decrease in pain, with a median VAS score of 0 at 1 year of follow-up.

Conclusions This technique presents good clinical and functional outcomes in patients with low sports demand. There is a lack of studies showing the advantages and limitations of the mini-open approach concerning the resection of larger bumps or in other locations. Level of Evidence: 4.

Keywords

- femoracetabular impingement/ surgery
- femoracetabular impingement/ complications
- treatment outcome
- humans
- minimally-invasive surgical procedures
- postoperative complications

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Resumen

Objetivo Describir y evaluar los resultados del tratamiento del pinzamiento femoroacetabular (PFA) con *mini-open* no asistido en una población definida.

Materiales y Métodos Se realiza una descripción prospectiva de cincuenta pacientes jóvenes con diagnóstico de PFA tipo CAM, con baja demanda deportiva, tratados con *mini-open* no asistido. Se incluyeron pacientes mayores de 18 años con PFA sintomático, con estudio radiológico completo y con test de lidocaína positivo. Se excluyeron pacientes con patología previa o subyacente de cadera comprometida. Se comparó la Escala de Cadera Harris modificada (Modified Harris Hip Score, MHHS, en inglés) en los periodos pre y posoperatorio (por el test de Wilcoxon) y los puntajes pre y posoperatorio en la escala visual análoga (EVA) (por el test análisis de la varianza [*analysis of variance*, ANOVA, en inglés] de Friedman). Se consideró significativo un valor de $p < 0{,}05$. En total, 50 pacientes cumplían los criterios de inclusión: 33 hombres y 17 mujeres.

Resultados La edad promedio fue de $36{,}8 \pm 6{,}5$ años. El ángulo alfa promedio fue de $62{,}6^\circ \pm 5{,}6^\circ$. Todos presentaron artrosis de grado 1 de Tonnis. Un total de 39 pacientes tenían nivel de actividad 3 (en la escala de Tegner). El seguimiento promedio fue de $27{,}3 \pm 6{,}2$ (mínimo de 12) meses. El MHHS mejoró desde una mediana preoperatoria de 60,5 (rango: 30,8–84,7) puntos a una mediana posoperatoria de 96,8 (rango: 91,3–100) puntos ($p < 0{,}001$). Todos los pacientes presentaron disminución significativa del dolor, con mediana de 0 en la EVA al año de seguimiento.

Conclusión Esta técnica presenta buenos resultados clínicos y funcionales en pacientes de baja demanda deportiva. Faltan estudios que demuestren sus ventajas respecto de la resección de *bump* de mayor tamaño o en otras localizaciones.
Nivel de Evidencia: 4.

Palabras clave

- pinzamiento femoroacetabular/cirugía
- pinzamiento femoroacetabular/complicaciones
- resultado de tratamiento
- humanos
- procedimientos quirúrgicos mínimamente invasivos
- complicaciones posoperatorias

Introduction

Since its first description, and especially during the last decades, femoroacetabular impingement (FAI) has become increasingly relevant in the traumatology literature. Femoroacetabular impingement is a dynamic conflict causing a direct change in the spatial relationship or clearance between the femoral head and neck union and the acetabular chondrolabral union.[1,2] This conflict can generate progressive damage, which begins with labral rupture, and acetabular chondral damage to different degrees, up to microfractures resulting from repeated stress.[3,4] Because of the above mechanism, FAI has been proposed as a cause of coxarthrosis.[5,6]

There are three techniques for the surgical treatment of FAI: controlled dislocation, hip arthroscopy[7,8] (undoubtedly the most popular now), and the mini-open procedure (the least widespread).[9,10] The mini-open technique may have arthroscopic assistance or not,[11] and it can be performed under a direct anterior approach or through the Hueter interval. The latter has the advantage of a shorter learning curve (even more evident in professionals with no previous arthroscopic training), a lower operational cost, and the need for less surgical time to achieve the same goals. In addition, it shares with arthroscopy a lower rate of complications (which are of low complexity) compared with controlled dislocation.

The orthopedic literature contains few reports on the unassisted mini-open surgical treatment of FAI. Despite its good outcomes, there is wide variability in surgical techniques and evaluation scores, and the treated population is often young and involved in sports activities. Our series describe young patients with low sports demand, at an age of maximum work performance, presenting discomfort altering their daily life routines and work-limiting pain.

The present study consists of a prospective clinical and functional evaluation of young patients with FAI and low sports demand treated with the mini-open technique through the modified Hueter approach and describes their outcomes.

Materials and Methods

The institutional ethics committee approved the present study. We collected and recorded clinical, imaging, evolution, and follow-up data of patients undergoing surgical treatment for CAM-type FAI using an open mini-open technique from November 2010 to December 2012. The main author of the present study performed all surgeries.

The inclusion criteria were the following: adult patients with a diagnosis of FAI at radiograph (pelvic anteroposterior [AP]-Lowenstein/hip AP, cross table, and false lateral views) and magnetic resonance imaging (MRI), plus a positive

lidocaine test. The patients were symptomatic at the time of surgery and had partial or no response to medical treatment for >1 month (including oral analgesia and physical therapy). All patients could choose between the arthroscopic or open treatment using a mini-open technique and the modified Heuter approach. The exclusion criteria were the following: patients with previous surgical interventions on the same hip, a history of hip dysplasia in childhood, subjects with concomitant neurological disorders, and those with moderate or severe hip osteoarthritis defined by a Tonnis score ≥ 2. In addition, we excluded from the analysis patients who opted for arthroscopic treatment.

Surgical procedure

We performed a longitudinal approach of approximately 5 cm to 6 cm in the Hueter interval with blunt dissection using Hohmann MIS retractors but no tendon disinsertion. Then a capsulotomy in T or H was performed, and we explored the labral instability or rupture with an arthroscopic palpator. We proceeded to femoroplasty with curved chisels and regularization with a 5.5 mm Abrader (Smith and Nephew, London, United Kingdom). Curettage and labral reinsertion or stabilization with 2.3 mm polyether ether ketone (PEEK) Osteoraptor anchors (Smith and Nephew) were performed as required.

After regularization according to the preoperative planning, we did intraoperative impingement tests to compare and confirm the free flexion-rotational incursion. We considered an internal rotation from 25 to 30 degrees acceptable with no evidence of bone conflict. We did not use bone wax for the osteotomy and left no drains as in other studies. We did not employ intraoperative fluoroscopy.

We collected demographic data, comorbidities, and physical activity according to the Tegner scale (ranging from 0 to 10, according to increasing activity).[12] In addition, we determined the following preoperative imaging parameters: osteoarthritis index (Tonnis), acetabular retroversion, presence of labral rupture or disinsertion, and alpha angle of the head-neck union. We recorded pre- and postoperative (3 months) values obtained on the Modified Harris Hip Score (MHHS).[13] Pain assessment according to the visual analog scale (VAS) occurred preoperatively and postoperatively (days 1, 30, and 90). In addition, we recorded the results from the Short Form-8 (SF-8) questionnaire after 1 year.

Statistical methods

Sample size calculation assumed the change of MHHS before and after surgery as the primary outcome. As a reference, we used variations of 14 points in the MHHS reported in the literature, with a standard deviation (SD) of 15 points.[14,15] The confidence level and power were defined as 95% and 90%, respectively. With these data, we obtained a minimum sample size of 25 patients (calculation made in www.openepi.com)

The numerical variables were recorded as mean $\pm$ SD values or medians with their respective ranges according to their symmetry and distribution. The categorical variables were recorded as their absolute values and percentages. A Wilcoxon test analyzed pre- and postoperative MHHS median values; a comparison of VAS values used the Friedman analysis of variance (ANOVA) test for dependent variables after data distribution analysis. A p-value < 0.05 was considered significant. IBM SPSS Statistics for Windows version 20.0 (IBM Corp., Armonk, NY, United States) performed the calculations.

Results

A total of 50 hips from 50 patients meeting the inclusion criteria underwent surgical treatment during the study. Sixty-six percent of the operated patients were male (33), with an average age of 36.8 ± 6.5 years. The right hip was operated on in 54% of the patients (27 hips). The average alpha angle was $62.6\,^{\circ} \pm 5.6^{\circ}$. All hips presented Tonnis grade 1 osteoarthritis. Only four had acetabular retroversion on radiographs, but not consistent with MRI or intraoperative findings.

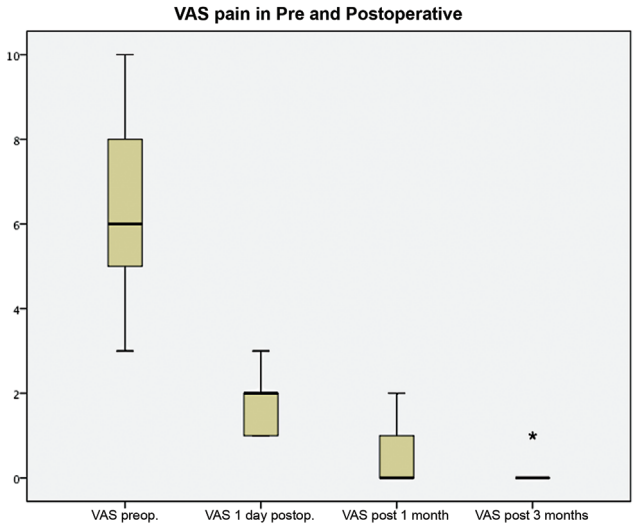
Overall, 20% of the patients performed some physical activity but irregularly, and 39 (74%) patients had an activity level of 3 according to the Tegner scale, corresponding to light work. The remaining 11 patients had a lower level of activity. For all study subjects, the minimum follow-up period was 12 months, with an average of 27.3 ± 6.2 months.

The intervention consisted of femoral neck osteoplasty in all patients with no acetabular osteoplasty. The average duration of the surgery was 61.2 ± 10.2 minutes. In total, 48 (96%) hips presented damage or detachment of the acetabular labrum during the intervention, requiring repair with 2.3-mm PEEK anchors (Smith and Nephew). In total, 16 hips received a single anchor, and 32 received 2 anchors.

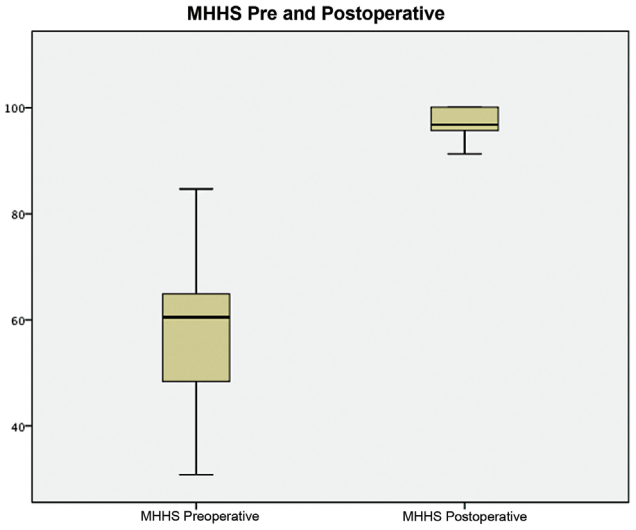
Clinical evaluation

The MHHS improved from a preoperative median of 60.5 (range: 30.8–84.7) points to a postoperative median of 96.8 (range: 91.3–100) points ($p < 0.001$) (►**Graph 2**).

According to the VAS, all patients presented a significant decrease in pain, with a preoperative median of 6 (range: 3–10) points, of 2 (range: 1–3) points on the first postoperative day, of 0 (range: 0–2) points at 1 month, and of 0 (range: 0–1)



Graph 1 Pre- and postoperative VAS scores (boxplot).



Graph 2 Pre- and postoperative scores on the MHHS (boxplot).

points at 3 months (►**Graph 1**). At the annual follow-up, using the SF-8 questionnaire, the median physical component score was 57 (range: 51–59) points, and the median mental component score was 57 (range: 49–59) points.

The patients remained hospitalized for an average period of 1.7 ± 0.54 days. Two patients presented postoperative neuropraxia at the lateral femoral cutaneous nerve, with resolution in one subject in one month and in the other in three months. One patient developed self-limited psoas tendinopathy teo months later. Another patient had a heterotopic ossification of the hip six months later (grade 1 per the Brooker classification) but with no major symptoms.

Discussion

Our results show a simple procedure with an apparent fast learning curve, good clinical outcomes, and a low complication rate in patients with low sports demand. These results are consistent with those of other series. As far as we know, this is one of the few unassisted mini-open series performed using the Hueter approach, which can solve most FAI-related conditions. It is easy to convert it into an assisted mini-open procedure, use traction, and work intra-articularly to solve specific central compartment issues, such as fibrin patches for cartilage delamination adherence, or perform microfractures.

The literature recognizes the importance of FAI and the direct relationship between anatomical alteration and the eventual development of osteoarthritis. It also describes the relative effectiveness of several techniques or procedures that attempt to solve these conditions, either openly or arthroscopically. However, few comparative studies reliably favor one or the other.

Although the ideal objective for any technique is to prevent or stop chondrolabral damage and subsequently delay osteoarthritis onset, the short-term goals are to relieve pain, improve joint range, and return to previous daily activities, including sports. These goals are achieved by reinserting or fixing the labrum in its position and normalizing the femoral head sphericity at its union with the femoral neck.

The controlled dislocation described by Ganz became the gold standard to achieve these goals and resulted in good clinical and functional outcomes. Despite its demands, this technique is reproducible but not exempt from complications, including neurological lesions, avascular necrosis, heterotopic ossification, osteotomy nonunion, osteosynthesis material failure, and slower recovery and return to daily life and sports activities. In addition, there are other considerations, such as those shown by a retrospective study by Boone et al.,[16] from the Hospital for Special Surgery (HSS). These authors caution against controlled dislocation in patients over 40 years old due to a low symptom resolution rate (only 50%) and a considerable conversion rate to a total hip replacement within 2 years (27%).

Because of the reasons described above, the controlled dislocation technique is currently being replaced by hip arthroscopy, achieving good outcomes with a lower rate of complications.[17]

Zingg et al.[18] prospectively compared the clinical and radiological outcomes from controlled hip dislocation and hip arthroscopy. From 200 selected patients, 38 agreed to participate in the study, and only 28 accepted randomizations. Their clinical outcomes were similar to those described in other publications, with hospital discharge, time off work, and short-term functional scores favoring arthroscopy. Regarding the morphological measurement of the femoroplasty, patients undergoing arthroscopy presented a relative overcorrection. The high number of patients who did not opt for a "major" procedure, such as controlled dislocation, and preferred treatment outside the study was striking.

We believe the mini-open technique is a real alternative with good outcomes and low complications, comparable to hip arthroscopy. Unfortunately, there are few scientific papers about this technique and no comparative studies. Current evidence shows short- and medium-term outcomes consistent with hip arthroscopy. To date, there is only one systematic review, by Gupta et al.,[19] which concludes that the mini-open technique shares low complication and conversion rates with total hip replacement; moreover, it is a less complex procedure compared with arthroscopy, ideal for the transition from open to arthroscopic surgery.

The first report and description of this technique were carried out by Clohisy and McClure in 2005.[20] These authors, along with Laude et al.[11] and Hartmann and Günther,[21] first described arthroscopy through traditional portals, initially at the central compartment. Next, they performed the mini-open technique to solve problems of the peripheral compartment using the Hueter approach. Their surgical time was longer and there were traction-related injuries, such as perineal hypoesthesia despite using a protection roll during the procedure. This is how the assisted mini-open techniques have been done by specialists trained only in open reconstructive surgery. They use it to solve the impingement

without an arthroscope or to carry out the transition and learning curve of the technically demanding hip arthroscopy.

Ribas et al.[22] published a study in which 117 hips were divided into three groups according to the Tonnis classification and were submitted to an assisted mini-open procedure. They reported significant improvement in the functional scores Merle d'Aubigné-Postel, Dexeus Combined Score (DCS), and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) within the first year, with good to excellent outcomes in 93.4% of the Tonnis 1 group and 91.3% of the Tonnis 2 group. They[22] did not observe avascular necrosis, heterotopic fracture, or ossification. Eighteen percent of the subjects presented paresthesia in the lateral femoral cutaneous nerve (LFCN) territory and 27% had a hypertrophic scar. Tonnis 3 patients showed no significant change or improvement in functional scores. In contrast, eight patients from this group received a coated prosthesis because of persistent discomfort.

Parvizi et al.[23] presents a series of 293 hips operated using the mini-open technique through a direct anterior approach (instead of Hueter), with good postoperative outcomes at functional scores such as MHHS, WOMAC, and Super Simple Hip (SUSHI). The 2.3-year follow-up showed 11 patients receiving a total hip prosthesis, one subtrochanteric fracture requiring osteosynthesis, one patient with a neuroma submitted to resection, one patient with refractory trochanteric bursitis that underwent surgery, and one case of labral rerupture that underwent arthroscopy.

Conclusion

This technique is relatively simple and within the reach of a joint reconstructive surgeon with no arthroscopic training or little experience. In addition, it has low costs compared with arthroscopy, with good functional outcomes in the short and medium term. This technique represents a real alternative for patients with no access to arthroscopy or surgeons with no experience, with results comparable to hip arthroscopy. Further studies are still required to demonstrate its advantages over the resection of larger bumps or in other locations and to observe the long-term evolution of these patients and their final conversion rate to a total hip prosthesis.

Limitations

The main limitation of the present study is the lack of a control group for comparison. In addition, the functional evaluation consisted of a limited number of tools, leaving aside other scores widely described in the literature. It is important to emphasize that this occurred in an attempt to improve patient adherence to postoperative evaluation. Moreover, there is still no consensus on which score provides a more reliable assessment for this type of patient.

Conflict of Interests
The authors have no conflict of interests to declare.

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