

Arthroscopic Treatment and Injection of Plasma Rich in Growth Factors in the Treatment Femoroacetabular Impingement of the Hip: Results with Two Years of Follow-up

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ABSTRACT

Femoroacetabular impingement has been described as a cause of injury to the acetabular labrum and degeneration of the hip joint. Surgical treatment is based in correction of the femoral neck deformity as well as the prominence of the anterior acetabular rim by open and arthroscopic techniques. A prospective study performed between April 2011 and April 2012 with 44 consecutive patients with osteoarthritic changes of the hip (Tönnis grade 1 and 2) and symptomatic femoroacetabular impingement underwent arthroscopic debridement of the acetabular rims and femoral neck. During the same period of time, 28 patients consecutively underwent hip arthroscopy without degenerative changes. All patients had injection

of plasma rich in growth factors into the affected hip joint. We evaluated the results at two years after surgery using general and specific validated instruments. Eight patients (7 Tennis 2 and 1 Tennis 1) underwent a second surgery for total hip replacement within the 2-year minimum follow-up. 36 (81.8%) of the 44 patients showed statistically significant improvement in pain, stiffness and functional capacity in evaluation by HOS, WOMAC, mHHS and VAS. This study showed good results in patients after arthroscopic debridement of the acetabular rim and femoral neck for femoroacetabular impingement and injection of plasma rich in osteoarthritic hips. This surgery in properly selected patients can improve patients' pain, stiffness and functional capacity for at least two years after surgery. It is unclear whether the surgery alone or the addition of plasma rich in growth factors was responsible for the results. Level of evidence. Level IV of evidence, therapeutic case series.

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Key words: Hip arthroscopy; PRP; Platelet-rich plasma; Osteoarthritis; Tennis; Degenerative change

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INTRODUCTION

Femoroacetabular impingement of the hip has been described as a cause of degeneration of the acetabular labrum and the femoroacetabular joint^[1-5]. Several validated instruments can be used to measure pain and alteration of functional capacity in activities of daily living and in sports^[6], such as SF-36, WOMAC or the more hip-

related questionnaires Hip Outcome Score of modified Harries Hip Score.

The repeated compression of an abnormal femoral neck (cam type impingement) against a prominent acetabular rim (pincer type impingement) that can occur in maximal flexion and internal rotation of the hip can produce pain and progressive degenerative changes. Beck *et al* reported that both the cam and pincer mechanisms are underlying factors in most patients who have femoroacetabular impingement^[1,2].

In 2001, Ganz *et al* described an open surgical technique designed to correct abnormal cervicocephalic relationship in the hip. This procedure required dislocation of the hip although no incidence of postoperative osteonecrosis was reported, which is a known sequela of traumatic hip dislocations^[7]. Arthroscopic surgical treatment has also been reported to be effective in restoring the femoroacetabular relationship and in reducing pain^[7-13]. However, 20 to 40% of patients who had arthroscopic treatment for this condition subsequently had total hip arthroplasty performed within two years^[3,14,15].

The use of plasma rich in growth factors (PRGF) is reported as a good treatment to improve pain, stiffness and functional capacity in articular surfaces, as well as improving cartilage healing^[16,17]. A recent randomized controlled trial showed that PRGF is safe and significantly superior to hyaluronic acid in patients with symptomatic knee osteoarthritis^[18]. The preparation of PRGF was according to the previously described by Anitua *et al*^[19].

The osteoarthritic hips present a lack in their treatment between the physiotherapy and the arthroplasty where hip arthroscopy could play a role in the improvement of these patients.

The purpose of this study is to evaluate the results of arthroscopic debridement and injection of plasma rich in growth factors into osteoarthritic hips.

MATERIALS AND METHODS

A prospective study was carried out between April 2011 and April 2012 with 44 patients with osteoarthritic changes of the hip (Tennis grades 1 and 2)^[20] and symptomatic femoroacetabular impingement underwent arthroscopic debridement of the acetabular rims and femoral neck. All patients had injection of plasma rich in growth factors (PRGF) into the affected hip joint. All patients had restriction of activities of daily living and sports and were initially managed conservatively with a physical therapy program for at least six weeks, and when these conservative treatments had failed, surgery was the proposed plan. 21 of these patients were classified before surgery as Tönnis grade 1 and 23 patients as Tönnis grade 2, using X-ray. The arthroscopic surgery involved wide capsulotomy and extensive capsule excision, removal of loose bodies and debris, impingement correction, with resection of femoral head and acetabular osteophytes, excise ossified labrum and intra-articular injection of nine cc of PRGF. Microfractures were performed in Outerbridge grade IV^[21] lesions (3 patients). Labrum management was the most conservative when possible, suturing those that were possible and performing excision of the remaining cases.

All patients followed a rehabilitation programme that included two weeks of partial weight bearing with deambulation with crutches, progressive total range of movement of the hip, static cycling and swimming in the second week after surgery.

All patients were evaluated pre and postoperatively, at three, six and 12 months and two years with the following validated outcome instruments: visual analogical score (VAS), hip outcome score (HOS)^[22,23], Short Form-36 (SF-36)^[24], modified Harris Hip Score

(mHHS)^[25] and WOMAC^[26]. For the present paper we evaluated the preoperative results and two years follow-up. In the same period 28 patients were operated on but without degenerative changes for FAI and although the same protocol was followed they weren't included in the present study. We included only those patients who completed the two years follow-up. Patients who improved their symptoms with the rehabilitation program and did not require surgery were excluded from the present study. Survival of the arthroscopic process was considered to be the time elapsed from the arthroscopic procedure to the performance or indication of total hip arthroplasty.

RESULTS

The results at two years are good or excellent in 36 of 44 patients. Eight patients who had a poor result underwent total hip arthroplasty, ranging between 8 months and 2 years after hip arthroscopy. Seven out of these eight patients were Tennis 2. All patients performed a follow-up of two years. All patients achieved a maintained or higher level of activities except one patient who voluntary changed his sports activities.

None of the patients had any major complications. Three patients had haematoma in the anterior portal, which were resolved in less than two weeks after the surgery. Two patients had transitory neurologic injuries. The evaluation of radiographic results showed a correction of femoroacetabular impingement (Figure 1 and 2).

The other 36 patients showed improvement in their levels of pain, as measured by the VAS scale: pain 7.32 (range 3-10) before surgery compared to 2.05 (range 0-3) two years later (Figure 3). Their average Hip Outcome Score for activities of daily living was 2.07 before surgery and 3.41 afterwards, and for sports activities 0.81 and 2.21 respectively. Both improvements are statistically significant (Figure 4). The modified Harris Hip Score improved from 42.05 to 84.82 (Figure 5) and WOMAC improved in pain (9.11 to 1.41), stiffness (3.23 to 0.35) and functional capacity (40.65 to 7.35) (Table 1) (Figure 6).

The SF-36 scores for quality of life improved in mental as well as physical health (Figure 7).

All data were evaluated by SPSS 16.0 version with statistically significant differences in all parameters.

DISCUSSION

Femoral and acetabular derangements can lead to degenerative arthropathy of the hip. Femoroacetabular impingement of the hip can cause progressive degenerative changes of the articular cartilage and early arthritis^[27]. Several reports have proposed surgical solutions to correct these abnormalities^[1,2,7,28,29].

Table 1 Outcome Score. Postoperative score refers to the two-year follow-up score.

Questionnaire	Mean score pre	Mean score post
Vas (0-10)	7.3 (3-9)	2.06 (0-3.5)
Mhhs (0-100)	42.05 (3.3-81.4)	84.82 (65-100)
Hos Daily Life Activities (0-4)	2.07 (1.1-3.6)	3.41 (2.4-3.9)
Hos Sport (0-4)	0.81 (0-1.9)	2.21 (0.3-3.9)
Womac Pain (0-20)	9.11 (1-17)	1.41 (0-7)
Womac Stiffness (0-8)	3.23 (0-7)	0.35 (0-2)
Womac Function (0-68)	40.65 (13-60)	7.35 (1-25)
Sf-36 Physical	30.86 (SD 9.01)	45.19 (SD 9.05)
Sf-36 Mental	54.42 (SD 11.52)	56.47 (SD 6.81)

VAS: Visual Analogue Scale; mHHS: modified Hip Harris Score; HOS: Hip Outcome Score. Postoperative score refers to the two-year follow-up score.

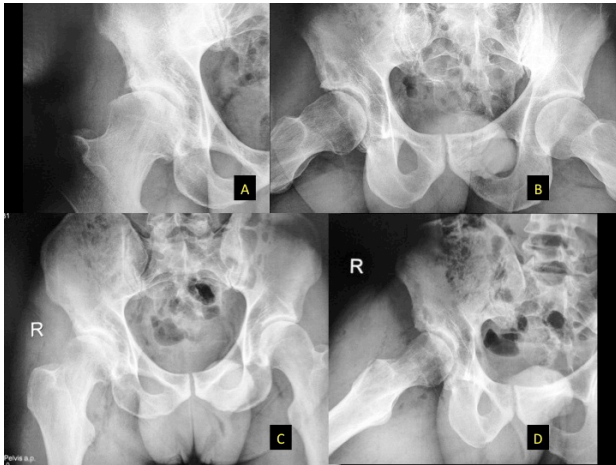


Figure 1 X-ray of a case with Tönnis I. A: Frontal view with slight narrowing of femoroacetabular space. B: Axial view with abnormal alpha angle. C and D: Frontal and axial postoperative view with correction of impingement and alpha angle corrected.

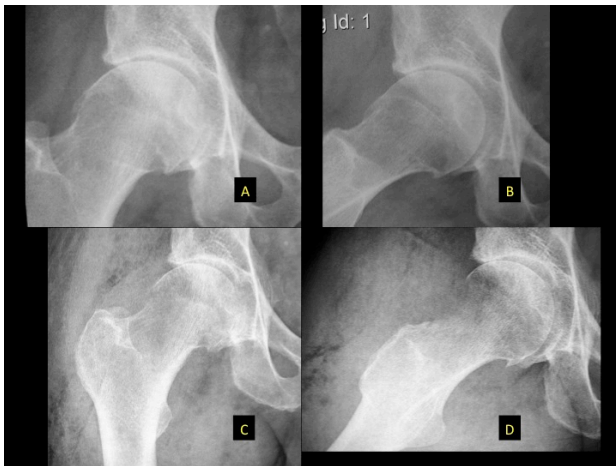


Figure 2 X-ray of a case with Tönnis II. A: Frontal view with advanced narrowing of femoroacetabular space. B: Axial view with abnormal alpha angle. C and D: Frontal and axial postoperative view with correction of impingement and alpha angle corrected.

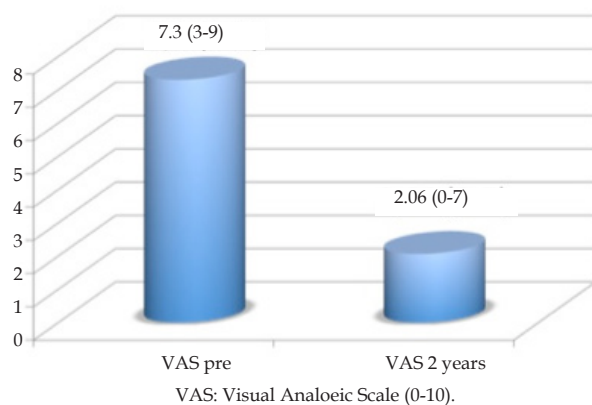


Figure 3 On a scale that ranges from zero (absence of pain) to ten (the maximum conceivable pain), the patients in our series show a reduction of pain from an average of 7.3 to 2.1 in the two years of follow-up. We included the whole series. The two patients who had total hip arthroplasty (THA) are included in these figures.

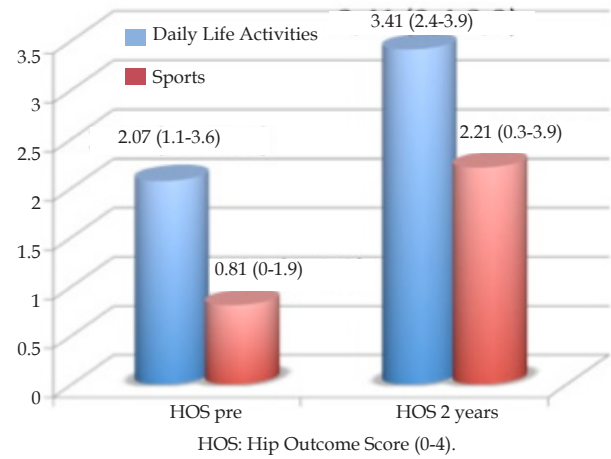


Figure 4 Hip Outcome Score (HOS) has two subscales that range from zero (a very poor quality of life) to four (normal) both in activities of daily living (ADL) and in sports. Our data show an improvement in ADL from 2.07 before surgery to 3.41 afterwards and in sports from 0.81 to 2.21 respectively on a scale of 4. The two patients who had THA are included in these figures.

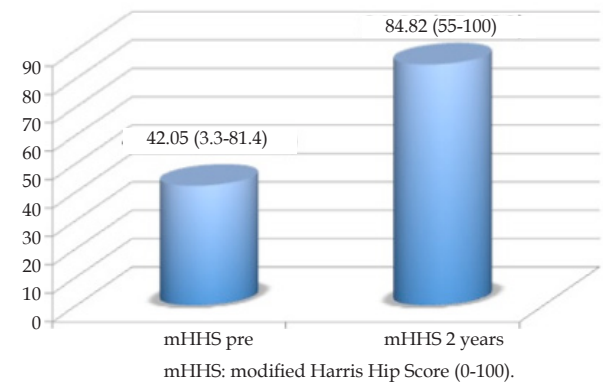


Figure 5 The modified Harris Hip Score ranges from zero (poor quality of life) to 100 (normal life). Our patients had statistically significant improvement from an average of 42.05 points before surgery to 84.82 afterwards. The two patients who had THA are included in these figures.

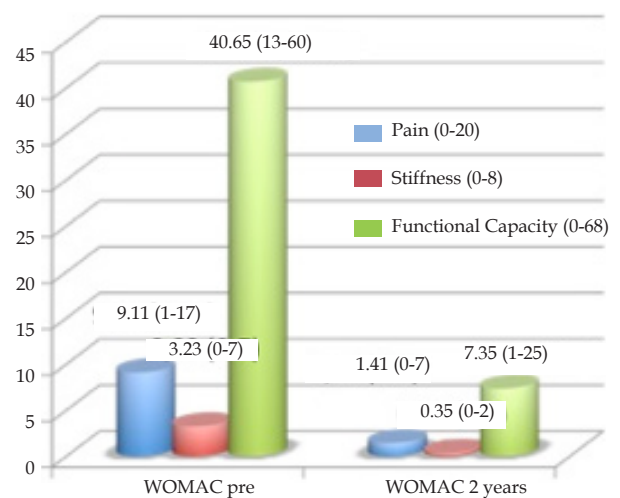


Figure 6 The WOMAC Index was significantly improved in all the scales. On a scale of zero to 20 (20=maximum) the pain was reduced from 9.1 before surgery to 1.41 afterwards. On a scale of eight for stiffness (8=maximum) the stiffness lessened from 3.23 to 0.35 respectively. The functional capacity scale ranges from 68 points (maximum alteration of the function) to zero (normal function); in our series, the preoperative stiffness was 40.65 preoperatively and 7.35 postoperatively. The two patients who had THA are included in these figures.

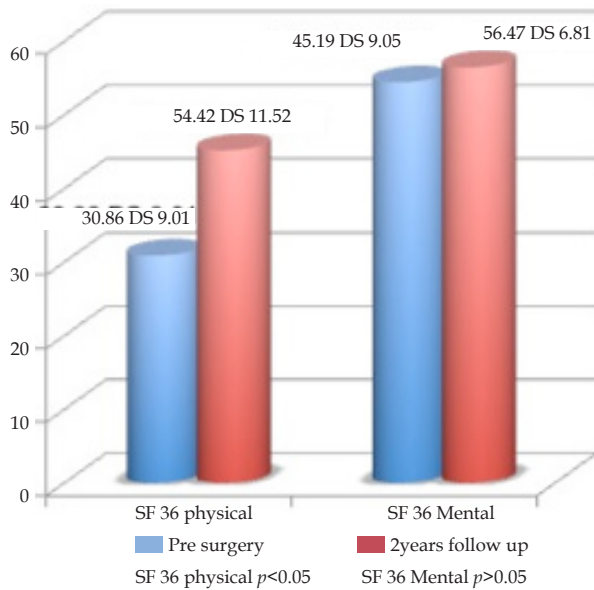


Figure 7 The scales of Short Form 36 show significant differences in the improvement of quality of life both in the mental and the physical scale. The two patients who had THA are included in these figures.

In patients in whom degenerative changes are observed preoperatively or in those who have a high degree of osteoarthritis, open surgery has shown poor results in patients with high degree of osteoarthritis and even those with degenerative changes observed preoperatively^[1,2,15,28,29].

Several studies have shown that during hip arthroscopy chondral damage are usually observed to be worse than the preoperative assessment. The presence of clinical findings of arthritis is a poor prognostic indicator, 88% of these patients were converted to hip arthroplasty at a mean of 63 months^[5,8,9].

Beaulé *et al* did not find a direct correlation between the degree of chondropathy and the results following surgical correction of femoroacetabular impingement^[30].

Horisberger reported on 20 patients that underwent arthroscopy for degenerative changes of the hip classified as Tennis grades 1 and 2 and Outerbridge grade 2^[3], concluding that over 50% had total hip arthroplasty eventually performed. When this study was analyzed in more depth we concluded that the authors underestimated the severity of the cartilaginous degeneration preoperatively due to the limitations in the cartilaginous evaluation in the imaging studies in three-quarters of the patients. Furthermore, in their study the average age was greater than other studies (47.3 years)^[3]. In addition, the duration of symptoms the patient had was longer and at the time of arthroscopy the severity of degenerative change was more advanced. There is a direct correlation between the severity of the cartilaginous injury and the number of patients who were treated with total hip arthroplasty^[3]. For those who did not require a total hip arthroplasty there was an increased mobility, decreased pain and improved functional scores after hip arthroscopy. Byrd *et al* did show that there is a direct correlation between the results of labral debridement and severity of arthritis^[3,8,9].

Likewise, it has to be emphasized that there is a lack of studies evaluating the impact of the impingement correction in osteoarthritis. In addition, the correction of the FAI in cases of Tönnis III is not recommended due to the high number of patients who end up requiring an arthroplasty within a short period of time after performing the correction^[3].

Both Cam and Pincer type Femoroacetabular impingement have

been shown to cause articular cartilage degeneration^[1,2,6,27]. However, there is an existing lack of outcome studies evaluating the results of arthroscopic treatment of FAI. Ganz *et al* described an open technique for the decompression of the femoroacetabular impingement by means of dislocation of the hip^[7] and reported good results in the general population^[1,2]. On the other hand, other studies show that the arthroscopic approach results in less morbidity and allows patients, even professional athletes, to return to their physically demanding lifestyles^[6,27,31,32,33].

Phillipon *et al* reported that more than 90% of professional athletes returned to sports after arthroscopic treatment of hip chondral injuries. The degree of severity in almost half of these patients was Outerbridge grade 4^[6].

The results of this study showed that 81.8% of patients showed good and excellent results. There was a significant improvement in pain, stiffness, function and quality of life both in activities of daily life and in sports. This data was gathered prospectively. Eight patients had persistent pain and stiffness and had total hip arthroplasty within two years of the arthroscopy. There was no major complication as a result of surgery with three cases of minor complications resolved in less than two weeks. Javed *et al* published a series of 40 patients followed for 30 months with an average age older than 60 years old that had a high level of satisfaction and indicated that, if needed, they would undergo similar procedure on the contralateral side. The patients that underwent total hip replacement (7 patients) were at 12 months of the surgery^[14]. Patients who had a total hip replacement in the present study were between 8 months and 2 years of the surgery. In a study by Larson *et al*, patients with femoroacetabular debridement with minor joint space narrowing on preoperative radiographs had improved pain and function at short-term postoperative follow-up. Patients with advanced radiographic joint space narrowing did not improve the radiographic image. Larson concluded that these cases should not be considered for arthroscopic FAI correction^[12].

The present series introduces 21 cases of Tönnis 1 and 23 of Tönnis 2. The initial treatment of our patients (rehabilitation programme) improved the symptoms of some patients. The main part of Tönnis 1 patients improved enough to discontinue with any surgical procedure. The Tönnis 2 patients did not have enough improvement of their symptoms and generally agreed with hip arthroscopy. It is worth mentioning that the majority of patients who were converted to total hip arthroplasty were classified as Tönnis 2. Whereas only 1 out of 21 (4%) Tönnis 1 patients required the articular substitution, 7 of 23 (30%) Tönnis 2 patients had the total hip replacement. Therefore, the 2-mm limit suggested by Philippon *et al*^[6] must be taken into consideration when deciding the best surgical indication, making an important distinction between Tönnis 1 and 2 as their prognosis considerably differs (4% vs 30% total hip replacement in 2-year follow-up).

The use of PRGF demonstrated the improvement of pain, stiffness and functional capacity in some studies^[16,17]. We believe the instillation of PRGF into the joint at the end of surgery improves clinical results^[17]. PRGF has shown to improve cartilage healing as well as the resultant cartilaginous surface^[16,17].

On the other hand, Xie *et al* suggest in a recent review that although PRP may have the potential to fill cartilage defects, attenuating symptoms of osteoarthritis and improving joint function, authors state that given the current literature, the efficacy of PRP remains unpredictable given the heterogeneous type of reported studies^[34].

Several limitations of our study must be considered when

reviewing the present study. First, ours is retrospective study with a relative small number of patients included and a lack of a control group. Future follow-up evaluation at five and ten years will give us more conclusive results. The series that femoroacetabular impingement was evaluated is large but not the osteoarthritic series treated with hip arthroscopy^[8,9]. Furthermore, not all the outcome instruments used are validated to Spanish. The WOMAC score has trans-cultural validity, and more recently so does HOS^[23] but the modified Harris Hip score do not have a validated translation in Spanish yet. For this reason it may be difficult to compare our results with other case series published, although this is a valid study if we compare pre and postoperative results of the same series.

We think that PRGF played a role in the cartilage restoration of these patients although the improvement of the score is mainly achieved by the arthroscopic procedure. It would be interesting to compare series with and without the use of PRGF.

CONCLUSION

This study showed good results in patients after arthroscopic debridement of the acetabular rim and femoral neck for femoroacetabular impingement and injection of plasma rich in osteoarthritic hips (Tönnis 1 and 2). This surgery in properly selected patients can improve patients' pain, stiffness and functional capacity for at least two years after surgery. It is unclear whether the surgery alone or the addition of plasma rich in growth factors was responsible for the results. Further research needs to be done to see what the effects of each are and if the results remain or deteriorate over time.

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

REFERENCES

- 1 Beck M, Kalthor M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. *J Bone Joint Surg Br* 2005; **87**: 1012-1018
- 2 Beck M, Leunig M, Parvizi J, Boutier V, Wyss D, Ganz R. Anterior femoroacetabular impingement: Part II. Midterm results of surgical treatment. *Clin Orthop Relat Res* 2004; **418**: 67-73
- 3 Horisberger M, Brunner A, Herzog RF. Arthroscopic treatment of femoral acetabular impingement in patients with preoperative generalized degenerative changes. *Arthroscopy* 2010 May; **26**(5): 623-629
- 4 McCarthy JC. The diagnosis and treatment of labral and chondral injuries. *Instr Course Lect* 2004; **53**: 573-577
- 5 Tanzer M, Noiseux N. Osseous abnormalities and early osteoarthritis: the role of hip impingement. *Clin Orthop Relat Res* 2004 Dec; **429**: 170-177
- 6 Philippon M, Schenker M, Briggs K, Koppersmith D. Femoroacetabular impingement in 45 professional athletes: associated pathologies and return to sport following arthroscopic decompression. *Knee Surg Sports Traumatol Arthrosc* 2007 Jul; **15**(7): 908-914
- 7 Ganz R, Gill TJ, Gautier E, Ganz K, Krugel N, Berlemann U. Surgical dislocation of the adult hip: a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br* 2001; **83**: 1119-1124
- 8 Byrd JW, Jones KS. Arthroscopic femoroplasty in the management of cam-type femoroacetabular impingement. *Clin Orthop Relat Res* 2009 Mar; **467**(3): 739-746
- 9 Byrd JW, Jones KS. Hip arthroscopy for labral pathology: prospective analysis with 10-year follow-up. *Arthroscopy* 2009 Apr; **25**(4): 365-368
- 10 Espinosa N, Rothenfluh DA, Beck M, Ganz R, Leunig M. Treatment of femoroacetabular impingement: preliminary results of labral refixation. *J Bone Joint Surg Am* 2006 May; **88**(5): 925-935
- 11 Guanche CA, Bare AA. Arthroscopic treatment of femoroacetabular impingement. *Arthroscopy* 2006 Jan; **22**(1): 95-106
- 12 Larson CM, Giveans MR, Taylor M. Does arthroscopic FAI correction improve function with radiographic arthritis? *Clin Orthop Relat Res* 2010 Dec 2
- 13 Lavigne M, Parvizi J, Beck M, Siebenrock KA, Ganz R, Leunig M. Anterior femoroacetabular impingement: part I. Techniques of joint preserving surgery. *Clin Orthop Relat Res* 2004 Jan; **418**: 61-66
- 14 Javed A, O'Donnell JM. Arthroscopic femoral osteochondroplasty for cam femoroacetabular impingement in patients over 60 years of age. *J Bone Joint Surg Br* 2011; **93-B**(3): 326-331
- 15 Treviño-Garza O, Rivas-Fernández M, Marín-Peña O, Esteban-Ledezma R, Vilarubias-Guillament JM. Treatment of femoroacetabular impingement by a minimally invasive approach. Results at 2 years follow-up. *Acta Ortop Mex* 2009 Mar-Apr; **23**(2): 57-69
- 16 Kon E, Filardo G, Di Martino A, Marcacci M. Platelet-rich plasma (PRP) to treat sports injuries: evidence to support its use. *Knee Surg Sports Traumatol Arthrosc* 2011 Apr; **19**(4): 516-527
- 17 Wang-Saegusa A, Cugat R, Ares O, Seijas R, Cuscó X, Garcia-Balletbó M. Infiltration of plasma rich in growth factors for osteoarthritis of the knee short-term effects on function and quality of life. *Arch Orthop Trauma Surg* 2011 Mar; **131**(3): 311-317
- 18 Vaquerizo V, Plasencia MA, Arribas I, Seijas R, Padilla S, Orive G, Anitua E. Comparison of intra-articular injections of plasma rich in growth factor (PRGF-Endoret) versus Dolorane hyaluronic acid in the treatment of patients with symptomatic osteoarthritis: a randomized controlled trial. *Arthroscopy* 2013; **29**(10): 1635-1643
- 19 Anitua E. Plasma rich in growth factors: preliminary results of use in the preparation of sites for implants. *Int J Oral Maxillofac Implants* 1999; **14**: 529-535
- 20 Tönnis D, Heinecke A. Acetabular and femoral anteversion: relationship with osteoarthritis of the hip. *J Bone Joint Surg Am* 1999 Dec; **81**(12): 1747-1770
- 21 Outerbridge RE. The aetiology of chondromalacia patellae. *J Bone Joint Surg [Br]* 1961; **43-B**: 752-757
- 22 Martin RL, Kelly BT, Philippon MJ. Evidence of validity for the hip outcome score. *Arthroscopy* 2006 Dec; **22**(12): 1304-1311
- 23 Seijas R, Sallent A, Ruiz-Iban MA, Ares O, Marín-Peña O, Cuelar R, Muriel A. Validation of the Spanish version of the Hip Outcome Score: a multicentre study. *Health Qual Life Outcomes* 2014; **12**: 70
- 24 Alonso J, Regidor E, Barrio G, Prieto L, Rodríguez C, de la Fuente L. Valores de referencia de la versión española del cuestionario de salud SF-36 en la población. *Med Clin (Barc)* 1998; **222**: 410-416
- 25 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty: an end-result study using a new method of result evaluation. *J Bone Joint Surg [Am]* 1969; **51-A**: 737-735
- 26 Escobar A, Quintana JM, Bilbao A, Azkárate J, Guenaga JI. Validation of the Spanish version of the WOMAC questionnaire for patients with hip or knee osteoarthritis. Western Ontario and McMaster Universities Osteoarthritis Index. *Clin Rheumatol* 2002; **21**: 466-471
- 27 Kim KC, Hwang DS, Lee CH, Kwon ST. Influence of femoroacetabular impingement on results of hip arthroscopy in patients with early osteoarthritis. *Clin Orthop Relat Res* 2007 Mar; **456**: 128-132
- 28 Murphy S, Tannast M, Kim YJ, Buly R, Millis MB. Debridement of the adult hip for femoroacetabular impingement: Indications and preliminary clinical results. *Clin Orthop Relat Res* 2004; **429**:

- 178-181
- 29 Peters CL, Erickson JA. Treatment of femoro-acetabular impingement with surgical dislocation and debridement in young adults. *J Bone Joint Surg Am* 2006; **88**: 1735-1741
- 30 Beaulé PE, Le Duff MJ, Zaragoza E. Quality of life following femoral head-neck osteochondroplasty for femoroacetabular impingement. *J Bone Joint Surg Am* 2007; **89**: 773-779
- 31 Botser IB, Smith TW Jr, Nasser R, Domb BG. Open surgical dislocation versus arthroscopy for femoroacetabular impingement: a comparison of clinical outcomes. *Arthroscopy* 2011 Feb; **27**(2): 270-278
- 32 Farjo LA, Glick JM, Sampson TG. Hip arthroscopy for acetabular labral tears. *Arthroscopy* 1999 Mar; **15**(2): 132-137
- 33 Weiland DE, Philippon MJ. Arthroscopic technique of femoroacetabular impingement. *Op Tech Orthop* 2005; **15**: 256-260
- 34 Xie X, Zhang C, Tuan RS. Biology of platelet-rich plasma and its clinical application in cartilage repair. *Arthritis Res Ther* 2014; **16**(1): 204

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