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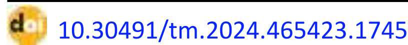

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Research Article

Evaluation of the of Non-Repairable Short External Rotator Muscles in Patients Undergoing Surgery via the Kocher-Lange beck Approach

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Abstract

Introduction: The Kocher approach is the most commonly used technique for treating fractures in the posterior wall and column of the acetabulum. This approach requires cutting the short external rotator muscles. In many cases, it becomes impossible to repair these muscles due to inadequate tissue quality, as the pressure from the fractured bone fragments may damage them. This study aims to assess the limitations in internal and external hip rotation compared to the intact side and to evaluate changes in clinical symptoms using the Harris Hip Score (HHS).

Methods: The study involved 30 patients with acetabular fractures who underwent surgery at Taleghani Hospital between March 2021 and September 2022. Only the Kocher approach was utilized for the surgeries. The assessment tools included a goniometer to measure the internal and external rotation of the hip and the Harris Hip Score questionnaire. Patients were evaluated six months after their surgery.

Results: All patients in the study were men, with an average age of 36 ± 2 years. The most common type of fracture observed was the posterior wall fracture, which accounted for 60% of the cases. The results revealed no statistically significant difference in the external rotation between the operated and intact hip. However, there was a significant difference in the internal rotation of the operated hip compared to the intact hip. The average score on the HHS questionnaire was 89.56, indicating a satisfactory outcome.

Conclusion: The degree of external rotation in the hip is not solely reliant on the short external rotator muscles; other muscles, such as the gluteus maximus, sartorius, and psoas, also influence it. However, damage to the external rotator muscles, if not repaired, can reduce hip internal rotation. The HHS was also recorded at 89/56, which falls within the acceptable range and did not indicate a statistically significant decrease.

Keywords: Hip Fracture, Trauma, Piriformis Muscle, Acetabulum, Sciatic Nerve.

Introduction

Acetabular fractures are among the most common types of hip fractures [1]. Performing surgery for these fractures requires a thorough understanding of the anatomy of the posterior pelvis and significant experience and skill on the part of the surgeon. One of the main reasons for extended surgical time is the complexity involved in identifying the muscles and exploring the vessels and nerves in this area [1]. The

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Kocher approach is the preferred and most widely used method for addressing fractures of the posterior wall and posterior column of the acetabulum, traditionally performed with the patient in a prone position [2]. Acetabular fractures typically occur when the femoral head strikes the acetabulum [3]. The fracture pattern usually depends on the hip position at the time of injury [4-5]. Additionally, these fractures are associated with up to 50% of other injuries [6,7].

The sciatic nerve is the most commonly injured nerve; its recovery is usually partial. Complete or near-complete sensory and motor recovery of the tibial branch can be expected, but peroneal nerve damage does not return well [8-9]. Three main radiographs are necessary to diagnose the fracture [2]: 1-AP 2-Int oblique 45° → Obturator view and 3-Ext Oblique 45° → iliac view.

Computed tomography (CT)- generated images have several potential benefits [10-11]. Bowel gas, obesity, or intraabdominal/intrapelvic contrast material do not affect the quality of the images.

The Kocher–Langenbeck approach is ideal for posterior wall and column fractures.

The short external rotator muscles are harmed in this approach. The first step during deep dissection is the identification of the short external rotator muscles (piriformis, gemellus superior and inferior, obturatorius externus, and internus) and the course of the sciatic nerve.

Usually, it is not possible to repair these muscles optimally due to the initial damage caused by the fracture and the shortness of their tendons. Thus, these muscles will be dysfunctional.

This study aims to determine the limitations in internal and external hip rotation compared to the opposite (intact) side and the change in the HHS in clinical symptoms, which is an essential challenge for orthopedic surgeons worldwide.

Classification of Acetabular Fractures

Judet et al. were the first to propose a systematic classification of acetabular fractures, which Letournel later published as a thesis in 1961 [12]. This classification was based on the anatomical patterns of the fractures. Over time, Letournel modified and refined this classification [13]. It includes ten distinct categories, divided into five elementary and five associated types. The five elementary fracture patterns are the posterior wall, posterior column, anterior wall, anterior column, and transverse [1].

The related patterns consist of a combination of basic or individual patterns with an added fracture component. The five identified fracture patterns are as follows:

- the posterior column and posterior wall
- the anterior column or wall in combination with a posterior hemi-transverse fracture
- transverse fracture with a posterior wall fracture
- T-shaped fracture
- both-column fracture

Posterior Wall Fractures

Posterior wall fractures are the most common acetabular fracture, accounting for approximately 25%. The obturator oblique radiograph demonstrates the size and multi-fragmentary nature of the fracture [14-16].

Posterior Column Fractures

Fractures of the posterior column involve detachment of the entire ischioacetabular segment from the innominate bone and represent 3% to 5% of acetabular fractures [14-16].

Transverse Fractures

Transverse fractures comprise 5% to 19% of acetabular fractures. They are the only elementary fracture pattern that breaks the anterior and posterior border of the innominate bone [14-16].

Posterior Column and Posterior Wall Fractures

The posterior column and posterior wall fracture combine the two elementary fracture patterns that comprise 3% to 4% of fractures [14-15].

Transverse and PosteriorWall Fracture

Combining the elementary transverse and posterior wall fracture patterns, comprising approximately 20% of all fractures [14-16].

Kocher–Langenbeck Approach

The Kocher–Langenbeck approach is ideal for posterior wall and column fractures [17].

Typically, (about 84% of the time), the sciatic nerve runs deep into the piriformis muscle, appearing in the buttock at the inferior border of this muscle [18]. Therefore, it is essential to recognize the normal potential variability in the relationship between the sciatic nerve and the piriformis muscle. The skin incision is centered over the greater trochanter [19]. The proximal branch of the incision is directed toward the

posterior superior iliac spine, ending approximately 6 cm short of this bony landmark [17].

Distally, the incision extends approximately 15 cm along the mid-lateral aspect of the thigh. The fascia lata is sharply incised, and the gluteus maximus muscle is bluntly divided toward the posterior superior iliac spine. The innervation of the gluteus maximus muscle comes from the inferior gluteal nerve, which runs from posterior to anterior in the muscle. Therefore, the splitting of this muscle should stop as soon as the first nerve trunk is met, approximately at the midpoint between the greater trochanter and the posterior superior iliac spine. Otherwise, the muscle fibers anterior to the dissection will be reinnervated.

Next, the gluteus Maximus muscle insertion into the femur is released. This allows posteromedial muscle retraction without excessive stretch on the inferior gluteal nerve. The sciatic nerve is then located along the posterior surface of the quadratus femoris muscle and traced proximally to the piriformis muscle. The short external rotators and piriformis tendons are divided and tagged with sutures to assist with retraction. Gentle retraction of the short external rotators allows visualization of the posterior column and retro-acetabular space but provides only limited protection of the sciatic nerve.

Finally, transecting the short external rotators must be performed at least 1.5 cm from the greater trochanter to avoid injury to the ascending branch of the medial femoral circumflex artery [19]. Dissection caudal to the inferior gemellus on the femur must be avoided to preserve the blood supply to the femoral head.

Harris Hip Score (HHS)

The HHS has been used for many hip pathologies, such as pertrochanteric fractures, intracapsular femoral neck fractures, impingement syndrome, and cases of revision surgeries [20].

The HHS questionnaire studies patients clinically and functionally.

Patients are scored on a 0–100 scale based on the degree of pain, function, and range of motion. The HHS requires a surgeon to grade patients' pain (44 points), mobility and walking (47 points), joint movement (5 points), and absence of deformity (4 points), with lower scores indicating more significant disability [21]. A total HHS below 70 points was considered a poor result,70 to 80 fair, 80 to 90 good, and 90 to 100 excellent [22].

Methods

This study presents a descriptive cross-sectional analysis of an acetabular fracture treated using open reduction and internal fixation with the Kocher-Langenbeck approach. Conducted between 2021 and 2022, the study received approval from the Research Ethics Committee at Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1402.290).

Participants

Patients were admitted to the trauma center and, after initial stabilization, underwent preoperative investigations. These included X-rays of the pelvis with both hips taken in AP, lateral, and Judet views. Additionally, a CT scan with 3D reconstruction was performed on all patients before surgery. Demographic information about the patients was extracted from hospital records. Further data were gathered during a patient visit through a questionnaire and physical examination. The assessment involved measuring both hips' internal and external rotation using a goniometer while the patient was seated actively. Plain radiography was conducted to diagnose HO, and the HHS questionnaire was completed.

Inclusion criteria:

1- Unilateral acetabular fracture

2- Acetabular fractures include:

Posterior wall

Posterior column

Wall and posterior column

Transverse

transverse and posterior wall Exclusion criteria:

1- History or evidence of arthritis in the hip joint

2-Acetabular fractures that require an approach other than Kocher.

3- Any history of hip problems, including limitation of hip joint movements or chronic hip pain

4-comminution fractures of the acetabulum

5-Patients who have evidence of heterotopic ossification in the control graph after six months 6- Patients who were suspected of having screws inside the joint.

7-Patients who have an infection at the surgical site.

Before the surgery, the fracture type and preferred surgical approach were determined using plain radiography and a CT scan. The patients included in the study were categorized into five main groups based on

their fracture types, and the Kocher approach was utilized to repair the fractures.

Follow up

After performing the surgery and visiting the patients for a certain period, after six months of follow-up, all patients undergo physical examinations to determine the active range of motion of the hip (with orthopedic ruler in a sitting position) and complete the HHS questionnaire and pelvic X-ray. Also, the amount of internal and external hip rotation on the opposite(intact) side was measured.

Statistical analysis

SPSS software version 24 was used for data analysis. Mean ±SD was used to display quantitative variables with a normal distribution, and frequency (%) was used to display qualitative variables. The Kolmogrov-smirnov and Shapiro-wilk tests were used for assessing the normal distribution of data. The Wilcoxon Signed Ranks Test analyzed quantitative continuous variables with a normal distribution. The Mann-Whitney statistical test also measured quantitative variables with a non-normal distribution. P.value ≤0.05 was regarded as significant.

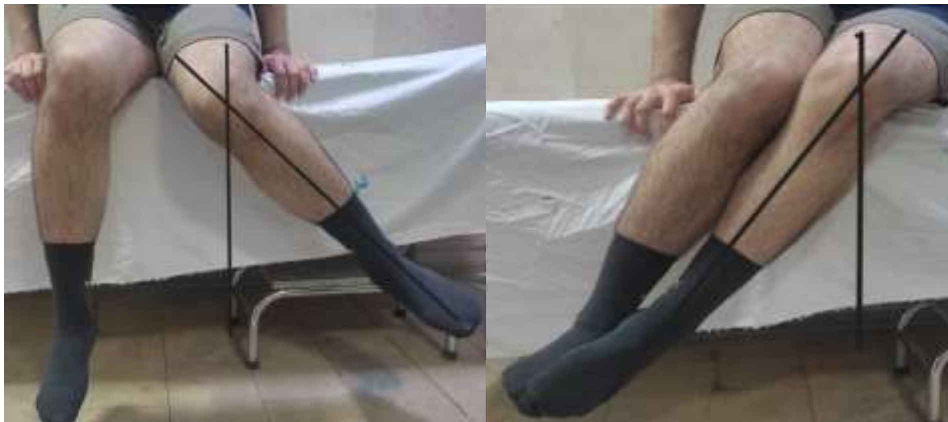

Figure 1: Measurement technique of hip rotation range of motion. IR: internal rotation, ER: external rotation [23]

Results

The study involved 30 male patients who underwent surgery using the Kocher-Langenbeck approach. After six months of follow-up, five patients were excluded from the study: two due to infections at the surgical site, two because of heterotopic ossification, and one due to concerns about an intra-articular screw. Ultimately, the study included 25 patients. Additionally, two patients experienced peroneal nerve defects following surgery; however, one patient’s peroneal nerve fully healed in less than six months.

The average age of the patients in the study was 36 years (±2), with ages ranging from 14 to 64 years. Acetabular fractures were classified into five categories, with the most common type being posterior wall fractures, which accounted for 60% of the cases.

The Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that our data across all three sections—internal rotation, external rotation, and HHS—were not normally distributed (p-value < 0.001). Consequently, we employed the Mann-Whitney statistical test.

The average external rotation of the operated hip was 38.00 ± 4.33 degrees, with a minimum of 25 degrees and a maximum of 40 degrees.

The average internal rotation of the operated hip was 35.60 ± 6.97 degrees, ranging from a minimum of 15 degrees to a maximum of 40 degrees. The average external and internal rotation for the intact (contralateral) hip was 38.50 ± 1.00 degrees. The average HHS score among the studied patients was 89.56, ranging from a minimum of 66 to a maximum of 97.

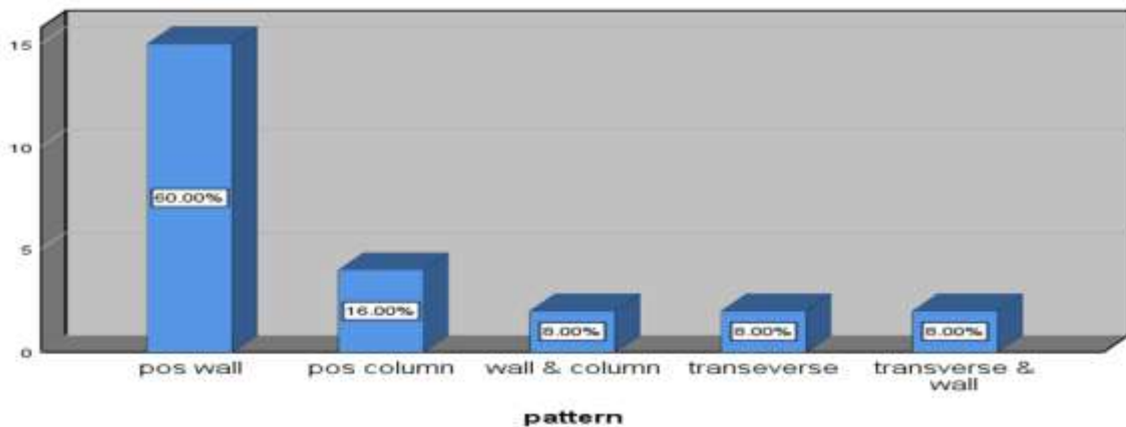

Figure 2: pattern of acetabular fracture.

Table 1: Descriptive statistics of hip rotation measurement and HSS score.

		N	Mean	Std.Deviation	Minimum	Maximum	HSS Mean±SD
operated hip	Internal rotation	25	35.60	6.970	15	40	89.56±8.347
	External rotation	25	38.00	4.330	25	40	
Intact hip	External rotation	25	38.50	1.000	35	40	
	Internal rotation	25	38.50	1.000	35	40	

Table 2: The Mann-Whitney test .

	Normal int.rotation	Normal ext.rotation	Normal-HHS
Z	-2.751[a]	-2.060[a]	-4.380[a]
Asymp.sig	.002[b]	.06[c]	.06[d]

a. Based on negative ranks.

b. The Mann-Whitney test result indicated a significant difference compared to the hip on the opposite side (p-value=0.002).

c. The Mann-Whitney test result indicated no significant difference compared to the hip on the opposite side (p =0.06).

d. The Mann-Whitney test result indicated no statistically significant difference in the HHS score compared to the normal level of HHS=100 (p =0.06).

Discussion

The main goal of our study was to assess the impact of not repairing the Short External Rotator Muscles on hip rotation. The secondary goal was to evaluate the anticipated decrease in the HHS.

The findings presented in this section do not support the theory linking muscle weakness to limitations in rotation. While there are many studies on repairing short external muscles, few have specifically examined the functional changes that occur, regardless of whether the muscles were repaired.

Most studies on short muscle repair focus on patients who have undergone THA, leaving a gap in knowledge regarding patients with acetabular fractures. Therefore, this study quantitatively analyzed the impact of not repairing the muscles during the six-month post-surgery period, specifically through active rotation assessment.

The effect of not repairing the short external rotator muscles in this study on hip external rotation was insignificant; that is, there was no effect on hip external rotation.

In many previous studies, SER tendon repair failed after a short post-operative period.

Paul et al. reported that 43% of repaired piriformis tendons and 57% of repaired conjoined tendons showed a gap distance in the MRI post-operation, indicating the failure of the muscle repairs [24]. Also, Thomas et al. reported that 70% of repairs to the short external rotator muscles were unsuccessful [25].

However, Stangl-Correa et al. reported a lower failure rate of short external rotator tendon reinsertions with successful intraoperative repair than previously reported [26]. Additionally, Eilander et al. found no correlation between tendon detachment and hip rotation [27].

The lack of effectiveness in the hip's external rotation may stem from the involvement of several muscles at the front and back of the thigh, including the gluteus maximus, sartorius, psoas, and quadratus femoris. Weakness in these muscles' strength (SER) and the external rotation of the thigh can be compensated for by other muscles, leading to a minimal impact on functional outcomes. Additionally, the short external rotator muscles are anatomically small and have a limited range of motion.

This study found that the failure to repair the short external rotator muscles significantly affected hip internal rotation, as indicated by statistical data. It was observed that internal rotation of the hip joint decreased due to this lack of repair; however, it is essential to note that these muscles do not directly contribute to internal rotation. Therefore, the limitation in this movement is not a result of damage to the external rotator muscles. Instead, damage to the joint's surface could restrict internal rotation. Additionally, the first movement typically affected in cases of hip arthritis is internal rotation. Fibrosis resulting from soft tissue damage behind the joint may also contribute to the reduction in internal rotation of the hip, although further studies are needed to confirm this.

The patients included in the study achieved excellent or good results, with an average score of 89.56 according to the Harris Hip Score, which aligns with findings from previous research. However, the study has several limitations:

1. The sample size and the follow-up period were limited, leaving the long-term effects unclear.
2. The study type.
3. The subjects were exclusively male, which may limit the generalizability of the findings to the broader population.

The results indicate that the posterior approach (Kocher technique) damages the short external rotator of the hip, although it does not impair the hip's external rotation function.

Conclusion

The hip's external rotation is not solely dependent on the short external rotator muscles, as other muscles, such as the gluteus maximus, sartorius, psoas, and quadratus femoris, also contribute to this movement. In contrast, the internal rotation of the hip was diminished when the external rotator muscles were damaged and not repaired. Furthermore, the HHS score was 89/56, which falls within the acceptable range and did not exhibit a statistically significant decrease.

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Conflict of Interest Disclosures

The authors declare no conflict of interest.

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There was no funding source to declare.

Authors' Contributions

R.Z.: conceptualization, writing and reviewing, project administration, supervision

S.T.: experiments design, data analysis, provision of study materials and equipment, study validation, data presentation, draft preparation,

S.M.M.: conceptualization, data handling, experiments design, data analysis, provision of study materials and equipment, study validation, supervision, data presentation, draft preparation, study consultation, writing and reviewing, project administration

A.A: study validation, data presentation, draft preparation, study consultation

M.M: data handling, experiments design, provision of study materials and equipment, consultation

Ethical Statement

The approval from the Research Ethics Committee at Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1402.290) was received.

References

1- Tornetta III P, Ricci W, McQueen MM. Rockwood and Green's fractures in adults. Lippincott Williams & Wilkins; 2019 Feb 22.

2- Warner SJ. Prone Versus Lateral Positioning for Posterior Acetabular Fracture Surgery. Journal of Orthopaedic Trauma. 2023 Jan 1;37(1):e51-2.

3- Rasi AM, Zandi R, Qoreishi M, Habibollahzadeh A. Magnetic resonance imaging assessment of hip abductor after total hip arthroplasty using a direct lateral approach. Archives of Bone and Joint Surgery. 2020 Jan;8(1):83.

4- AlRousan FM, Almigdad AK, Jwinate MN, Moh'dkheir AA, Alsarhan FY, Al-Qudah OM. A review of acetabular fracture patterns, etiologies, and management in Jordan. Saudi medical journal. 2023 Jun;44(6):607.

5- Andersen RC MD, O'Toole RV, Nascone JW, et al. Modified Stoppa approach for acetabular fractures with anterior and posterior column displacement: Quantification of radiographic reduction and analysis of interobserver variability. J Orthop Anglen JO, Burd TA, Hendricks KJ, et al. The "gull sign": A harbinger of failure for internal fixation of geriatric acetabular fractures. J Orthop Trauma. 2003; 17:625–634.

6- Archdeacon MT, Kazemi N, Guy P, et al. The modified Stoppa approach for acetabular fracture. J Am Acad Orthop Surg. 2011; 19:170–175.

7- Arbash M, Alzobi OZ, Salameh M, Alkhayarin M, Ahmed G. Incidence, risk factors, and prognosis of sciatic nerve injury in acetabular fractures: a retrospective cross-sectional study. International Orthopaedics. 2024 Jan 9:1-8.

8- Firoozabadi R, Kleweno C. Evaluation and management of acetabular fractures. In: Ricci WR, Ostrum RF, eds. Orthopaedic Knowledge Update: Trauma 5. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2016:403– 418.

9- Sinatra PM, Moed BR. CT-generated radiographs for acetabular fracture evaluation in the obese: Can they be used in lieu of plain radiographs? Clin Orthop Rel Res. 2014; 472:3362–3369.

10- Letournel E. Les fractures du cotyle, etude d'une serie de 75 cas. J Chir (Paris). 1961; 82:47–87.

11- AlRousan FM, Almigdad AK, Jwinate MN, Moh'dkheir AA, Alsarhan FY, Al-Qudah OM. A review of acetabular fracture patterns, etiologies, and management in Jordan. Saudi medical journal. 2023 Jun;44(6):607.

12- Letournel E. Acetabulum fractures: Classification and management. Clin Orthop Relat Res. 1980; 151:81–106.

13-Khoshabi K, Rasi AM, Zandi R, Omrani FA, Darestani RT, Athari M, Afzal S. Outcomes of the Modified Stoppa Approach in Acetabular Fracture Management: Incidence of Nerve Injuries. Archives of Bone and Joint Surgery. 2024;12(2):123.

14- Letournel E, Judet R. Fractures of the Acetabulum. 2nd ed. New York: Springer-Verlag; 1993.

15- Matta J. Fractures of the acetabulum: Accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J Bone Joint Surg Am. 1996;78A:1632–1645.

16- Mayo KA. Open reduction and internal fixation of fractures of the acetabulum: Results in 163 fractures. Clin Orthop Relat Res. 1994; 305:31–37.

17- GΔnsslen, Axel, Stephan Grechenig, Michael Nerlich and M. Mьller. "Standard Approaches to the Acetabulum Part 1: Kocher-Langenbeck Approach." Acta chirurgiae orthopaedicae et traumatologiae Cechoslovaca 83 3 (2016): 141-6.

18- Gray G. Anatomy of the Human Body. 28th ed. Philadelphia, PA: Lea & Febiger; 1970.

19- Helfet DL, Beck M, Gautier E, et al. Surgical techniques for acetabular fractures. In: Tile M, Helfet DL, Kellam JF, eds. Fractures of the Pelvis and Acetabulum. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2003:533– 603.

20. Kızkapan TB, Misir A, Eken G, Oguzkaya S, Özçamdallı M, Uzun E. Correlation between Harris, modified Harris hip, and Oxford hip scores of patients who underwent hip arthroplasty and hemiarthroplasty following hip fracture. Turkish Journal of Trauma & Emergency Surgery. 2022 Mar;28(3):308.

21- Longo UG, Ciuffreda M, Candela V, Berton A, Maffulli N, Denaro V. Hip scores: A current concept review. British Medical Bulletin. 2019 Sep 19;131(1):81-96.

22.Harris Hip Score (HHS) [Available from: https://www.orthopaedicscore.com/scorepages/harris_hip_score.html

23- Bhamare D, Ayare P, Khandge A, Shroff A, Herode P. Reliability of goniometry to determine the hip range of motion. International Journal of Orthopaedics. 2017;3(3):66-71.

24- Pellicci PM, Potter HG, Foo LF, Boettner F. MRI shows biologic restoration of posterior soft tissue repairs after THA. Clinical Orthopaedics and Related Research®. 2009 Apr 1;467(4):940-5.

25- StΔhelin T, Vienne P, Hersche O. Failure of reinserted short external rotator muscles after total hip arthroplasty. The Journal of arthroplasty. 2002 Aug 1;17(5):604-7.

26- Stangl-Correa P, Stangl-Herrera W, Correa-Valderrama A, Ron-Translateur T, Cantor EJ, Palacio-Villegas JC. Postoperative failure frequency of short external rotator and posterior capsule with successful reinsertion after primary total hip arthroplasty: an ultrasound assessment. The Journal of Arthroplasty. 2020 Dec 1;35(12):3607-12.

27- Eilander W, van der Velden E, van Harten M, van Kampen P, Hogervorst T. The short external rotators in the anterior approach hip arthroplasty: do the tendons heal or not? A prospective MRI study. Hip International. 2023 Sep;33(5):819-27.