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Acetabular Labral Tears: Resection vs. Repair

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In the past decade, significant advances have been made in the diagnosis and treatment of non-arthritic intra-articular hip pathologies, including acetabular labral tears. Tears of the acetabular labrum have been identified as a source of hip pain and mechanical symptoms, and as a possible instigator of premature hip degeneration. Arthroscopic management of labral tears has evolved from simple resection of the torn labral portion to advanced repair techniques for tears associated with large bony deformities. While arthroscopic technology has evolved to allow the labrum to be repaired, scientific evidence demonstrating the benefits of labral repair over resection have lagged.

In the past decade, significant advances have been made in the diagnosis and treatment of non-arthritic intra-articular hip pathologies, including acetabular labral tears. Tears of the acetabular labrum have been identified as a source of hip pain and mechanical symptoms, and as a possible instigator of premature hip degeneration[1]. Arthroscopic management of labral tears has evolved from simple resection of the torn labral portion to advanced repair techniques for tears associated with large bony deformities. While arthroscopic technology has evolved to allow the labrum to be repaired, scientific evidence demonstrating the benefits of labral repair over resection have lagged. The purpose of this review article is three-fold. First, available biomechanical evidence will be presented to evaluate whether the labrum has an anatomic or biomechanical role that could be restored by repair after it is torn. Second, vascularity and technical issues will be addressed to assess the feasibility of repair. Lastly, outcomes following labral resection and repair will be compared.

Structure and Function of the Acetabular Labrum

The acetabular labrum is a triangular fibrocartilage that, along with the transverse acetabular ligament, encircles the periphery of the acetabulum. In addition to containing nerve fibers thought to contribute to nociception and proprioception of the hip joint[2], the labrum is also thought to enhance hip stability through several mechanisms. First, the labrum increases the surface area and volume of the acetabulum[3], thus creating additional anatomic coverage of the femoral head. Second, similar to the meniscus of the knee, the high circumferential tensile stiffness of the labrum offers further stability[4]. Lastly, the low permeability of the labral tissue has been shown to seal a layer of pressurized synovial fluid within the joint, which may contribute to joint lubrication[4,5].

In several in vitro studies, resection of the labrum has been shown to have detrimental consequences. Ferguson et al showed a 40% quicker rate of cartilage consolidation in the absence of a labrum. They further demonstrated that resection of the labrum causes the femoral head to lateralize, shifting the load bearing surface of the joint shifts to the acetabular rim, thereby causing increases in femoroacetabular contact pressures[6]. Although some have suggested that labral resection may lead to premature osteoarthritis, one in vivo study failed to show the relationship at 24 months after labral resection[7].

Acetabular Labral Tears

Acetabular labral tears are a possible source of hip pain and mechanical symptoms. Lage et al noted in 1996 that the etiology of labral tears in a series of patients was: trauma (18.9%), degeneration (48.6%), idiopathic (27.1%), and congenital (5.4%)[8]. However, over the last decade since this study, increased awareness of morphologic abnormalities of the hip, notably femoroacetabular impingement (FAI), has identified an additional significant cause of labral tears. Two recent studies showed that labral tears rarely occur in the absence of bony abnormalities, specifically dysplasia and FAI[9,10]. Hence, labral tears are now thought to primarily result from the following mechanisms: trauma[11-18], sports injury[19,20], dysplasia[21-23], femoroacetabular impingement[21,23-26], capsular laxity[27-29], and degeneration[30-32].

Labral tears are a possible cause of hip pain and mechanical symptoms. The pain is typically groin pain, and most commonly has an insidious onset[33,34]. On examination, the patients may have a Trendelenberg gait[34] and described provocative maneuvers include: impingement test (flexion and internal rotation) [33-38], and axial compression with 90 degrees of flexion and slight adduction[35]. Radiographic work-up for patients with symptoms of labral tears should include standard AP views of the pelvis and hip, as well as a cross-table lateral x-rays to evaluate for associated bony pathology. Additionally, magnetic resonance imaging and possibly, magnetic resonance arthrography should be performed to evaluate for labral tears and chondral injuries.

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Management of Labral Tears – Can they be Repaired?

As described above, the labrum has several known anatomic and biomechanical roles, which include enhancing hip stability and providing nociception and proprioception of the hip joint. As a result, the concept of repairing rather than resecting torn labral tissue seems logical to offer the best opportunity to restore a normal functioning hip joint. There are two issues that arise in assessing the feasibility of repairing the labrum. First, the labrum is relatively avascular, and like the repaired meniscus, healing is often difficult or impossible to due vascularity. Second, repairing the labrum is technically difficult. Although arthroscopic techniques have been described for labral repair[39-42], this is a very technically demanding procedure, and described open techniques are quite morbid for the average patient with non-arthritic hip disease. This next section will address the feasibility of repair, including the intrinsic healing capacity of the labrum as well as technical issues.

Similar to the meniscus of the knee, the entire adult labrum has poor vascularity[43]. The blood supply to the acetabular labrum enters from the capsule. Blood vessels have been detected in the peripheral one-third of the labrum, with the inner articular portion being avascular[43, 44]. Fortunately, a large percentage of labral tears, particularly those associated with FAI, are located at the base of the labrum near the capsular insertion. One recent study showed that the avascular labral tip is not involved with early FAI, which provides the opportunity for repairing the labrum in early disease stages[45]. In one in vivo sheep study assessing the healing potential of the repaired labrum, gross healing was noted at 12 weeks. Upon histological review, labral healing occurred via fibrovascular scar formation from the adjacent capsule, or the exposed bony attachment of the labrum[46]. Similarly, a recent study evaluated findings upon second-look arthroscopy after open surgical dislocation for FAI with labral refixation or resection[47]. The authors found that all re-attached labra were stable and in all cases with resected labra, the joint capsule was adherent to the acetabular rim with adjacent synovitis.

Beyond the vascularity issues, acetabular labral repair is technically difficult. A complete description of the surgical procedure is beyond the scope of this paper, but several approaches, describing both arthroscopic[39-42] and open[48] techniques have been described. One of the major technical issues with the arthroscopic approach is avoidance of articular penetration with the suture anchors. A recent study described optimal placement for suture anchors to avoid this consequence and facilitate placement within the bone. The authors recommended that extracapsular anchor insertion is 2.3-2.6 mm from the acetabular rim with a target angle of 10 degrees[49].

Outcomes of Labral Repair and Labral Resection

Surgery for acetabular labral tears should primarily relieve pain and mechanical symptoms. Although the function (or lack thereof) of the acetabular labrum has been debated, it is now recognized that the labrum has a significant role in joint stability, with disruption possibly leading to early joint degeneration. Therefore, the goals of surgery for acetabular labral tears should also include restoration of the function of the labrum and delay or prevention of associated joint degeneration.

Few basic science studies have been performed comparing labral repair and resection. One recent cadaveric study examined cartilage strain in 4 labral states: intact labrum, labral tear, labral repair, and labral resection. They showed that labral resection had significantly higher cartilage strains (mean and maximum), when compared to labral repair ($p=0.02$)[50].

Several studies have been performed over the last decade to evaluate outcomes following partial resection for labral tears[34, 35, 51-58]. More recently, early outcomes following labral repair and refixation after FAI debridement have been presented[48, 59, 60].

Outcomes following partial labral resection are highly variable (Table I). The percentage of good to excellent results following partial resection ranges from 21%-91%[34, 35, 51-58]. In a recent study with minimum 10 year follow-up of labral resection, the median improvement from pre-operative modified Harris Hip Score (MHHS) to 10 year follow-up was 29 points (from 52 to 81). Patients in this series with pre-arthroscopy arthritis tended to have worse outcomes, with 7 out of 8 eventually converted to a total hip arthroplasty. Eighty-three percent of patients without pre-operative arthritis continued to show improvement at 10 year follow-up[58]. Although this long-term study shows that outcomes following labral resection can be quite favorable for patients without arthritis, there are vast discrepancies in other published outcome studies. This can be explained in several ways. First, several studies have shown that patients with pre-operative arthritis or chondral injury tend to do poorer than those without arthritis or chondral injury[34, 51-53, 58]. Others have suggested that patients with a disability claim status or an atraumatic onset of hip pain may also have worse outcomes[56, 58]. Finally, in the last decade, significant advances have been made in the recognition and treatment of associated hip pathologies, including FAI. Studies performed ten years ago were typically isolated small debridement arthroscopies, whereas current treatments can include FAI debridement and chondral resurfacing. This makes direct comparison of recent outcomes studies with decade-old studies nearly impossible, as isolated labral resections are less commonly performed today.

Preliminary results following labral repair/refixation are limited, and the few published studies have compared outcomes with retrospective labral resection control groups (Table I)[48, 59, 60]. Espinosa et al compared outcomes following labral refixation and labral resection following open surgical dislocation for FAI, with a minimum two-year follow-up[61]. The authors showed equivocal subjective outcome results at one-year follow-up; however, at two-years post-operative, the labral refixation group had 80% excellent results, compared to 28% excellent results in the labral resection group. Similarly, the labral refixation group did not report any poor outcomes compared to 4% of the labral resection group. In addition, there was less radiographic evidence of osteoarthritis progression at both one and two years in the labral refixation group[61]. In another recent study, Larson and Giveans compared outcomes following labral refixation and labral resection after

TABLE I. Outcomes Following Treatment of Acetabular Labral Tears.

Study	No. of Patients	Mean Follow-up	Mean Age	Treatment	Results	Other
Fitzgerald, CORR 1995[52]	55	53 months (4-216)		Labral debridement (arthrotomy and arthroscopy)	89% symptom free, 13% had no improvement	No improvement related to chondral damage, 15 had repeat surgery (bursitis, hardware removal, repeat tear)
Farjo et al, Arthroscopy 1999[53]	28	34 months (13-100 months)	41 (14-70)	Labral debridement	Good 46% Poor 54%	Outcome worse in arthritis (71% good results in pts without arthritis, 21% good results in pts with arthritis)
Hase et al, Arthroscopy 1999[35]	8	2.9 years (15 mos-68 mos)	28.7 (13-67)	Labral debridement	Symptom free	
Santori and Villar, Arthroscopy 2000[54]	58	3.5 years (24-61 months)	36.7 years (8-70)	Labral debridement	67.3% pleased with the results, 32.7% not satisfied; MHHS (pre-op 49.6, 3.5 years 73.6)	Not associated with chondral lesions
O'Leary et al, Arthroscopy 2001[55]	22	30 months	x33.6 years (11-65)	Labral debridement	Resolution of mechanical symptoms and pain relief in 91%	
Potter et al, AJSM 2005[56]	33	25.7 months (13-55)	34.6 years (21-56)	Labral debridement	39% had good to excellent results, 70% very or somewhat satisfied	Disability status associated with poor outcomes; no difference based on chondromalacia or age
Burnett et al, JBJS Am 2006[34]	66	16.4 months (12-47)	38 (15-64)	Labral debridement	MHHS (62-83), 94% subjective improvement, 11% had persistent symptoms	6 of 7 with persistent symptoms had chondral injury
Freedman et al, Arthroscopy 2006[57]	24	24.1 months (12-55)	37.1 (21-56)	Labral debridement	67% somewhat or very satisfied	Chondral injury, age, mechanism of injury not associated with outcome
Espinosa et al, JBJS 2006[61]	60	2 years	30 years (20-40 years)	Resection and Refixation following FAI treated with open surgical dislocation	Both groups showed improvement in Tonnis and Merle D'Aubigne at 1 year; at 2 years labral resection group (28% excellent, 48% good, 20% moderate, 4% poor), labral repair (80% excellent, 14% good, 6% moderate); more radiographic OA in labral resection vs. repair at 1 and 2 years	
Larson and Giveans, Arthroscopy 2009[59]	75	Resection: 21.4 mos Refixation: 16.5 mos	Resection: 31 years Refixation: 27 years	Resection and refixation following arthroscopic treatment of FAI	1 year: both groups improved, MHHS better in refixation than resection (94.3 vs. 88.9) Most recent f/u: Resection: 66.7% good to excellent Refixation: 89.7% good to excellent	
Byrd, Arthroscopy 2009[58]	29	Minimum 10 years	46 years (17-84)	Labral debridement	MHHS (pre-op 52, 10 year 81)	31% converted to THA at mean 63 months, arthritis associated with poor outcome, traumatic event associated with better outcome
Streich et al, KSSTA 2009[51]	50	34 months (24-48)	33 years (15-49)	Labral debridement, chondroplasty	Reduction of pain (VAS 6 pre-op, 4 post-op) Larson improvement (55.7 vs 68.2) MHHS improvement (59.8 vs 72.2)	Significant relationship between grade of cartilage lesion present and outcome
Philippon et al, JBJS Br 2009[60]	112	2.3 years (2.0-2.9)	40.6 years	Resection and Refixation following arthroscopic treatment for FAI	Multivariate analysis indicated labral repair predicted better outcome than resection	

arthroscopic treatment of FAI[59]. One-year post-operatively, both groups demonstrated subjective improvement, but the labral refixation group had significantly better MHHS when compared to the labral resection group (94.3 vs. 88.9). At most recent follow-up, 66.7% of the labral resection group reported good to excellent outcomes, compared to 89.7% of the labral refixation group. Philippon et al performed a multivariate analysis of outcomes following FAI treatment and found labral refixation to be an independent predictor of better outcome when compared to labral resection[60].

Although these three studies may indicate better outcomes in patient undergoing labral refixation as compared to resection, there needs to be some caution in interpreting the available data. Similar to the difficulties interpreting labral resection data over time, these comparative studies are also limited in that they each use retrospective data for labral resection control groups to compare to more recent labral refixation/repair groups. The major limitation in these studies is that advancement of techniques over time, particularly with debridement techniques for FAI, cannot be accounted for.

In conclusion, current studies indicate that labral refixation may offer patients better outcomes than labral resection[48, 59, 60] and can possibly delay osteoarthritis progression[61]. However, prospective randomized control studies are needed to better elucidate whether labral repair is truly superior to labral resection.

Conclusions

The function of the acetabular labrum has been debated, but several studies over the last decade have defined its role in joint stability, nociception, and proprioception[2-5]. In vitro removal of the labrum has been shown to alter joint mechanics, with subsequent risk for cartilage injury and premature arthritis[6]. With advancements in imaging and arthroscopic techniques, acetabular labral tears are now commonly recognized as a source of pain and mechanical symptoms in young patients. Although labral repair is becoming increasingly popular as a treatment alternative to labral resection, there has been limited scientific evidence examining the necessity and feasibility of labral repair, and outcomes comparing labral repair and resection. The purpose of this review article was to examine the available evidence, and to identify areas that need future research.

In summary, the labrum clearly has a defined physiological and biomechanical role that repair theoretically could restore. Although some studies have shown healing following repair[46, 47], and one study showed decreased cartilage strain in repaired specimen[50], it is not clearly known whether a sutured labrum is a functional labrum. Further in vitro and in vivo studies are needed to determine whether normal hip mechanics are restored following repair and, most importantly, if premature arthritis can be delayed or prevented. Secondly, although the labrum is relatively avascular, tear patterns tend to occur in areas of relative vascularity; therefore, healing is possible with repair, particularly of tears near the base of the labrum[45]. Lastly, although outcomes data are limited, particularly of repaired labra, early evidence suggests that labral repair may have superior outcomes when compared to labral resection[48, 59, 60]. Available data comparing outcomes of labral resection and repair are obscured by limitations in study design, and prospective control trials are needed to better ascertain these suggested superior outcomes of labral repair.

References

1. **McCarthy JC, Noble PC, Schuck MR, Wright J, Lee J.** The Otto E. Aufranc Award: The role of labral lesions to development of early degenerative hip disease. *Clin Orthop Relat Res.* 2001 Dec(393):25-37.
2. **Kim YT, Azuma H.** The nerve endings of the acetabular labrum. *Clin Orthop Relat Res.* 1995 Nov(320):176-81.
3. **Tan V, Seldes RM, Katz MA, Freedhand AM, Klimkiewicz JJ, Fitzgerald RH, Jr.** Contribution of acetabular labrum to articulating surface area and femoral head coverage in adult hip joints: an anatomic study in cadavera. *Am J Orthop (Belle Mead NJ).* 2001 Nov;30(11):809-12.
4. **Ferguson SJ, Bryant JT, Ito K.** The material properties of the bovine acetabular labrum. *J Orthop Res.* 2001 Sep;19(5):887-96.
5. **Ferguson SJ, Bryant JT, Ganz R, Ito K.** The acetabular labrum seal: a poroelastic finite element model. *Clin Biomech (Bristol, Avon).* 2000 Jul;15(6):463-8.
6. **Ferguson SJ, Bryant JT, Ganz R, Ito K.** The influence of the acetabular labrum on hip joint cartilage consolidation: a poroelastic finite element model. *J Biomech.* 2000 Aug;33(8):953-60.
7. **Miozzari HH, Clark JM, Jacob HA, von Rechenberg B, Notzli HP.** Effects of removal of the acetabular labrum in a sheep hip model. *Osteoarthritis Cartilage.* 2004 May;12(5):419-30.
8. **Lage LA, Patel JV, Villar RN.** The acetabular labral tear: an arthroscopic classification. *Arthroscopy.* 1996 Jun;12(3):269-72.
9. **Wenger DE, Kendell KR, Miner MR, Trousdale RT.** Acetabular labral tears rarely occur in the absence of bony abnormalities. *Clin Orthop Relat Res.* 2004 Sep(426):145-50.
10. **Guevara CJ, Pietrobon R, Carothers JT, Olson SA, Vail TP.** Comprehensive morphologic evaluation of the hip in patients with symptomatic labral tear. *Clin Orthop Relat Res.* 2006 Dec;453:277-85.
11. **Lieberman JR, Altchek DW, Salvati EA.** Recurrent dislocation of a hip with a labral lesion: treatment with a modified Bankart-type repair. Case report. *J Bone Joint Surg Am.* 1993 Oct;75(10):1524-7.
12. **Rashleigh-Belcher HJ, Cannon SR.** Recurrent dislocation of the hip with a "Bankart-type" lesion. *J Bone Joint Surg Br.* 1986 May;68(3):398-9.
13. **Dameron TB, Jr.** Bucket-handle tear of acetabular labrum accompanying posterior dislocation of the hip. *J Bone Joint Surg Am.* 1959 Jan;41-A(1):131-4.
14. **Mormor M, Matityahu A.** Surgical treatment of an acetabular fracture and labral tear with suture anchors in a 10-year-old child. *Orthopedics.* 2009 Nov;32(11):854.
15. **Chun KA, Morcuende J, El-Khoury GY.** Entrapment of the acetabular labrum following reduction of traumatic hip dislocation in a child. *Skeletal Radiol.* 2004 Dec;33(12):728-31.
16. **Kim YT, Ninomiya S, Tachibana Y, Tanabe T, Yano Y.** Acetabular labrum entrapment following traumatic posterior dislocation of the hip. *J Orthop Sci.* 2003;8(2):232-5.
17. **Paterson I.** The torn acetabular labrum; a block to reduction of a dislocated hip. *J Bone Joint Surg Br.* 1957 May;39-B(2):306-9.
18. **Shea KP, Kalamchi A, Thompson GH.** Acetabular epiphysis-labrum entrapment following traumatic anterior dislocation of the hip in children. *J Pediatr Orthop.* 1986 Mar-Apr;6(2):215-9.
19. **Mason JB.** Acetabular labral tears in the athlete. *Clin Sports Med.* 2001 Oct;20(4):779-90.
20. **Dy CJ, Thompson MT, Crawford MJ, Alexander JW, McCarthy JC, Noble PC.** Tensile strain in the anterior part of the acetabular labrum during provocative maneuvering of the normal hip. *J Bone Joint Surg Am.* 2008 Jul;90(7):1464-72.
21. **Leunig M, Podeszwa D, Beck M, Werlen S, Ganz R.** Magnetic resonance arthrography of labral disorders in hips with dysplasia and impingement. *Clin Orthop.* 2004 Jan(418):74-80.
22. **Haene RA, Bradley M, Villar RN.** Hip dysplasia and the torn acetabular labrum: an inexact relationship. *J Bone Joint Surg Br.* 2007 Oct;89(10):1289-92.
23. **Chegini S, Beck M, Ferguson SJ.** The effects of impingement and dysplasia on stress distributions in the hip joint during sitting and walking: a finite element analysis. *J Orthop Res.* 2009 Feb;27(2):195-201.
24. **Sink EL, Zaltz I, Heare T, Dayton M.** Acetabular cartilage and labral damage observed during surgical hip dislocation for stable slipped capital femoral epiphysis. *J Pediatr Orthop.* Jan-Feb;30(1):26-30.

25. **Tannast M, Goricki D, Beck M, Murphy SB, Siebenrock KA.** Hip damage occurs at the zone of femoroacetabular impingement. *Clin Orthop Relat Res.* 2008 Feb;466(2):273-80.
26. **Johnston TL, Schenker ML, Briggs KK, Philippon MJ.** Relationship between offset angle alpha and hip chondral injury in femoroacetabular impingement. *Arthroscopy.* 2008 Jun;24(6):669-75.
27. **Philippon MJ.** The role of arthroscopic thermal capsulorraphy in the hip. *Clin Sports Med.* 2001;20(4):817-29.
28. **Philippon MJ.** Debridement of acetabular labral tears with associated thermal capsulorraphy. *Oper Tech Sports Med.* 2002;10:215-8.
29. **Philippon MJ, Schenker ML.** Athletic hip injuries and capsular laxity. *Op Tech Orthop.* 2006;2005(15):261-6.
30. **Lecouvet FE, Vande Berg BC, Malghem J, Lebon CJ, Moysan P, Jamart J, et al.** MR imaging of the acetabular labrum: variations in 200 asymptomatic hips. *AJR Am J Roentgenol.* 1996 Oct;167(4):1025-8.
31. **Cotten A, Boutry N, Demondion X, Paret C, Dewatre F, Liesse A, et al.** Acetabular labrum: MRI in asymptomatic volunteers. *J Comput Assist Tomogr.* 1998 Jan-Feb;22(1):1-7.
32. **Abe I, Harada Y, Oinuma K, Kamikawa K, Kitahara H, Morita F, et al.** Acetabular labrum: abnormal findings at MR imaging in asymptomatic hips. *Radiology.* 2000 Aug;216(2):576-81.
33. **Leunig M, Werlen S, Ungersbock A, Ito K, Ganz R.** Evaluation of the acetabular labrum by MR arthrography. *J Bone Joint Surg Br.* 1997 Mar;79(2):230-4.
34. **Burnett RS, Della Rocca GJ, Prather H, Curry M, Maloney WJ, Clohisy JC.** Clinical presentation of patients with tears of the acetabular labrum. *J Bone Joint Surg Am.* 2006 Jul;88(7):1448-57.
35. **Hase T, Ueo T.** Acetabular labral tear: arthroscopic diagnosis and treatment. *Arthroscopy.* 1999 Mar;15(2):138-41.
36. **Ikeda T, Awaya G, Suzuki S, Okada Y, Tada H.** Torn acetabular labrum in young patients. Arthroscopic diagnosis and management. *J Bone Joint Surg Br.* 1988 Jan;70(1):13-6.
37. **Suenaga E, Noguchi Y, Jingushi S, Shuto T, Nakashima Y, Miyanishi K, et al.** Relationship between the maximum flexion-internal rotation test and the torn acetabular labrum of a dysplastic hip. *J Orthop Sci.* 2002;7(1):26-32.
38. **Troelsen A, Mechlenburg I, Gelineck J, Bolvig L, Jacobsen S, Soballe K.** What is the role of clinical tests and ultrasound in acetabular labral tear diagnostics? *Acta Orthop.* 2009 Jun;80(3):314-8.
39. **Murphy KP, Ross AE, Javernick MA, Lehman RA, Jr.** Repair of the adult acetabular labrum. *Arthroscopy.* 2006 May;22(5):567 e1-3.
40. **Philippon MJ, Schenker ML.** A new method for acetabular rim trimming and labral repair. *Clin Sports Med.* 2006 Apr;25(2):293-7, ix.
41. **Kelly BT, Weiland DE, Schenker ML, Philippon MJ.** Arthroscopic labral repair in the hip: surgical technique and review of the literature. *Arthroscopy.* 2005 Dec;21(12):1496-504.
42. **Weigel DP, Callaghan JJ.** Use of anchor sutures to repair labral avulsions of the hip: a brief report. *Iowa Orthop J.* 1997;17:141-3.
43. **Kelly BT, Shapiro GS, Digiovanni CW, Buly RL, Potter HG, Hannafin JA.** Vascularity of the hip labrum: a cadaveric investigation. *Arthroscopy.* 2005 Jan;21(1):3-11.
44. **Petersen W, Petersen F, Tillmann B.** Structure and vascularization of the acetabular labrum with regard to the pathogenesis and healing of labral lesions. *Arch Orthop Trauma Surg.* 2003 Jul;123(6):283-8.
45. **Ito K, Leunig M, Ganz R.** Histopathologic features of the acetabular labrum in femoroacetabular impingement. *Clin Orthop.* 2004 Dec(429):262-71.
46. **Philippon MJ, Arnoczky SP, Torrie A.** Arthroscopic repair of the acetabular labrum: a histologic assessment of healing in an ovine model. *Arthroscopy.* 2007 Apr;23(4):376-80.
47. **Krueger A, Leunig M, Siebenrock KA, Beck M.** Hip arthroscopy after previous surgical hip dislocation for femoroacetabular impingement. *Arthroscopy.* 2007 Dec;23(12):1285-9 e1.
48. **Espinosa N, Beck M, Rothenfluh DA, Ganz R, Leunig M.** Treatment of femoro-acetabular impingement: preliminary results of labral refixation. Surgical technique. *J Bone Joint Surg Am.* 2007 Mar;89 Suppl 2 Pt.1:36-53.
49. **Hernandez JD, McGrath BE.** Safe angle for suture anchor insertion during acetabular labral repair. *Arthroscopy.* 2008 Dec;24(12):1390-4.
50. **Greaves LL, Gilbart MK, Yung AC, Kozlowski P, Wilson DR.** Effect of acetabular labral tears, repair and resection on hip cartilage strain: A 7T MR study. *J Biomech.* Mar 22;43(5):858-63.
51. **Streich NA, Gotterbarm T, Barie A, Schmitt H.** Prognostic value of chondral defects on the outcome after arthroscopic treatment of acetabular labral tears. *Knee Surg Sports Traumatol Arthrosc.* 2009 Oct;17(10):1257-63.
52. **Fitzgerald RH, Jr.** Acetabular labrum tears. Diagnosis and treatment. *Clin Orthop Relat Res.* 1995 Feb(311):60-8.
53. **Farjo LA, Glick JM, Sampson TG.** Hip arthroscopy for acetabular labral tears. *Arthroscopy.* 1999 Mar;15(2):132-7.
54. **Santori N, Villar RN.** Acetabular labral tears: result of arthroscopic partial limbectomy. *Arthroscopy.* 2000 Jan-Feb;16(1):11-5.
55. **O'Leary J A, Berend K, Vail TP.** The relationship between diagnosis and outcome in arthroscopy of the hip. *Arthroscopy.* 2001 Feb;17(2):181-8.
56. **Potter BK, Freedman BA, Andersen RC, Bojescul JA, Kuklo TR, Murphy KP.** Correlation of Short Form-36 and disability status with outcomes of arthroscopic acetabular labral debridement. *Am J Sports Med.* 2005 Jun;33(6):864-70.
57. **Freedman BA, Potter BK, Dinauer PA, Giuliani JR, Kuklo TR, Murphy KP.** Prognostic value of magnetic resonance arthrography for Czerny stage II and III acetabular labral tears. *Arthroscopy.* 2006 Jul;22(7):742-7.
58. **Byrd JW, Jones KS.** Hip arthroscopy for labral pathology: prospective analysis with 10-year follow-up. *Arthroscopy.* 2009 Apr;25(4):365-8.
59. **Larson CM, Giveans MR.** Arthroscopic debridement versus refixation of the acetabular labrum associated with femoroacetabular impingement. *Arthroscopy.* 2009 Apr;25(4):369-76.
60. **Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA.** Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. *J Bone Joint Surg Br.* 2009 Jan;91(1):16-23.
61. **Espinosa N, Rothenfluh DA, Beck M, Ganz R, Leunig M.** Treatment of femoro-acetabular impingement: preliminary results of labral refixation. *J Bone Joint Surg Am.* 2006 May;88(5):925-35.