

# Prevalence of Acetabular Labral Tears and Sublabral Sulci: a Cadaveric Study

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**Objective:** The objective of the present study was to evaluate the prevalence and location of acetabular labral tears and sublabral sulci in cadaveric hips.

**Material and Method:** Fifty hips of 25 embalmed cadavers with the mean age of 55 years (range, 18-85 years) were studied. All labral lesions were documented in their morphologic features, size and anatomic locations.

**Results:** Thirty-eight labral tears were found in 33 (66%) of 50 hips with the mean length of 17 mm (range, 8-36 mm). Twenty-two (58%) tears were located in the anterosuperior quadrant and 13 (34%) tears were identified in the posterosuperior quadrant. Thirty-one (82%) tears were detachments of the labrum from the bony acetabulum. Eight sublabral sulci were seen bilaterally in 8 hips of 4 cadavers (16%). Of these, 4 (50%) were located anterosuperiorly, 2 (25%) anteroinferiorly and 2 (25%) posteroinferiorly.

**Conclusion:** The acetabular labral tears were common findings with a high prevalence. They were most commonly located in the anterosuperior quadrant of the acetabulum. Sublabral sulci are anatomic variants that can be found bilaterally in different quadrants of the hips.

**Keywords:** Acetabular Labrum, Labral tears, Sublabral sulcus, Prevalence

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The acetabular labrum is a fibrocartilaginous structure that is attached to the acetabular rim and is in continuity with the transverse acetabular ligament inferiorly over the acetabular notch. The labrum increases the volume of the acetabulum by 33% and contributes 22% to the articulating surface of the hip<sup>(1)</sup>. It has biomechanical importance in maintaining the suction seal effect, enhancing hip joint stability and reducing peak cartilage stresses during weight-bearing<sup>(2-4)</sup>.

Acetabular labral tears are a common etiology of hip pain and contribute to the development of degenerative hip disease<sup>(5)</sup>. Some conditions have been identified as causes of labral tears: trauma, femoro-acetabular impingement, capsular laxity/hip hypermobility, developmental dysplasia of the hip and hip degeneration<sup>(6)</sup>. Most labral tears reported from the Western countries are located in the anterior portion of

the labrum<sup>(1,7-15)</sup>. However, posterior labral tears were more common in Japanese patients<sup>(16-18)</sup>.

Acetabular labral tears have been diagnosed with increasing frequency because imaging and arthroscopic techniques have been improved. Magnetic resonance (MR) arthrography has been used to identify lesions of the acetabular labrum with high accuracy<sup>(19)</sup>. Sublabral sulci are normal anatomic variants that can be mistaken for labral tears and this may result in unnecessary surgery. These sulci have been found in both anterior<sup>(14, 15)</sup> and posterior<sup>(8, 15)</sup> parts of the labrum. The purpose of the present study was to evaluate the prevalence and location of acetabular labral tears and sublabral sulci in cadaveric hips.

## Material and Method

Fifty hips were harvested from 25 embalmed cadavers provided by the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University. The average age of donors was 55 years (range, 18-85 years) and fifteen of them (60%) were male. A history of hip function or symptoms before death was not available. The hip capsule was carefully incised at the mid-portion of the femoral neck to preserve the labrum.

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The femoral head was then dislocated after cutting the ligamentum teres at its femoral insertion.

All labral lesions were documented in their morphologic features, size and anatomic locations. Labral tears were classified into 2 types according to the classification described by Seldes et al<sup>(1)</sup>. Type 1 labral tears were detachments of the labrum from the bony acetabulum. Type 2 labral tears included the tears within the labral substance. A sublabyrinthal sulcus was characterized by a well-defined cleft separating the labrum from the adjacent articular cartilage<sup>(14)</sup>. It was distinguished from type 1 labral tears by the normal appearance of the involved labral segment.

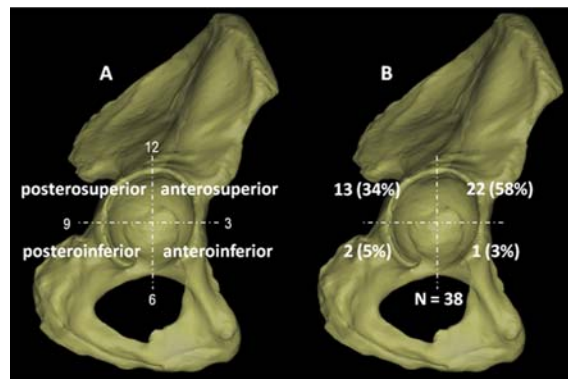
Anatomic locations of labral lesions were described by a quadrant method and a clock face system (Fig. 1A). The 6 o'clock position was located at the middle of the transverse acetabular ligament<sup>(20)</sup>, which corresponded to the midpoint of the acetabular notch<sup>(21,22)</sup>. The numbers of clock face locations in the left hips were mirrored and presented as the right hips, so the 3 o'clock position was located anteriorly in all hips.

## Results

Thirty-eight labral tears were found with the mean length of 17 mm (range, 8-36 mm). Thirty-three (66%) of 50 hips had at least one labral tear (28 hips with single tear and 5 hips with two labral tears). The mean age of the hips with labral tears was 57 years (range, 32-85 years). Fifteen (60%) donors had labral tears in both hips and 3 (12%) donors had unilateral labral tears. Most of the labral tears (31 lesions, 82%) were detachments of the labrum from the bony acetabulum (Seldes type 1, Fig. 2). The remaining tears (7 lesions, 18%) were found within the labral substance (Seldes type 2, Fig. 3).

Acetabular labral tears were most commonly identified in the anterosuperior quadrant (22 tears, 58%), followed by the posterosuperior quadrant (13 tears, 34%) as shown in Fig. 1B. With a clock face system, labral tears were most commonly found at the 12 and 1 o'clock positions (Fig. 4).

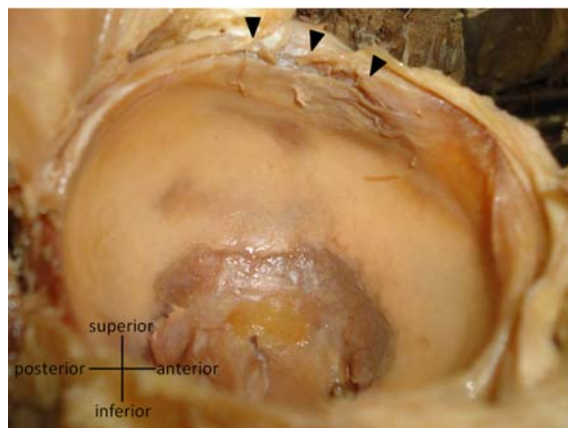
Eight sublabyrinthal sulci were found in 8 hips of 4 male cadavers with a mean age of 37 years (range, 18-66 years). All sulci were bilateral lesions and occurred in the same quadrant of the paired hips. The average size of sulci was 13 mm (range, 9-21 mm). Four (50%) of these lesions were located in the anterosuperior quadrant of the acetabulum, followed by the antero-inferior (2 lesions, 25%) and postero-inferior (2 lesions, 25%) quadrants (Fig. 5). No labral tear was found in the



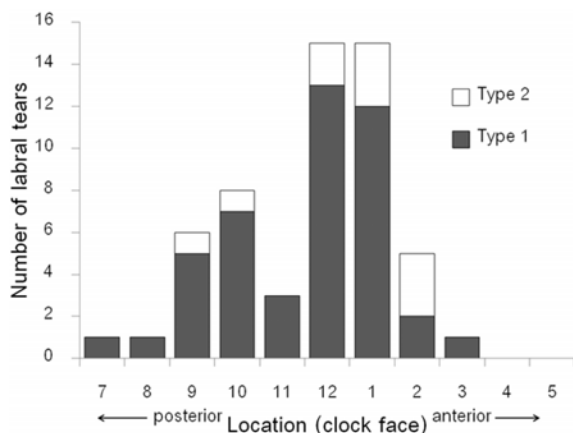
**Fig. 1** Description of locations of labral lesions. (A) A quadrant method and a clock face system. The 6 o'clock position was located at the midpoint of the acetabular notch. (B) Acetabular labral tears were commonly found in the anterosuperior quadrant, followed by the posterosuperior quadrant



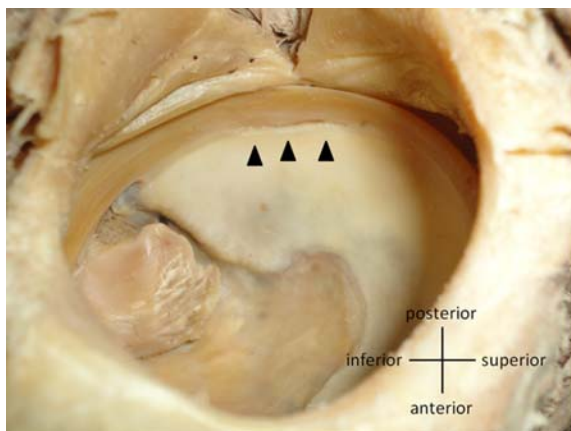
**Fig. 2** Type 1 labral tears (arrow heads) were defined as detachments of the labrum from the acetabular rim



**Fig. 3** Type 2 labral tears (arrow heads) were defined as the tears within the labral substance



**Fig. 4** Distribution of acetabular labral tears described with a clock face system



**Fig. 5** A sublabral sulcus (arrow heads) in the posterosuperior quadrant of the acetabulum. It was defined as a well-defined cleft separating the labrum, which had normal appearance, from the adjacent cartilage

hips with sublabral sulci.

## Discussion

In the present study, acetabular labral tears were common findings in cadaveric hips with a prevalence of 66%. Labral tears were frequently found in the anterosuperior quadrant of the acetabulum. Most tears were detachments of the labrum from the acetabular rim or Seldes type 1. Sublabral sulci were not uncommon findings with a prevalence of 16%. They were found bilaterally in the anterosuperior, anteroinferior and posteroinferior quadrants of the acetabulum.

Although high prevalence of labral tears was demonstrated in the present study, it was lower than previous cadaveric studies that reported a prevalence

range from 88 to 96%<sup>(1,7,12)</sup>. The lower average age (55 years) of cadavers in the present study could be one explanation. Byers et al studied 365 cadaveric hips from the patients with an age range from 9 to 89 years. They found that 88% of hips from the patients older than 30 years of age had labral detachments from the articular cartilage and the prevalence of detachments increased with age<sup>(7)</sup>. In the present study by McCarthy et al, 93% of cadaveric hips (50 of 54), with the average age of 78 years, had at least one labral lesion<sup>(12)</sup>. The highest prevalence (96%) was reported by Seldes et al in which 53 of 55 hips, with the mean age of 78 years, had labral tears<sup>(1)</sup>.

The anterosuperior quadrant was the most common location of labral tears in the present study which was consistent with previous studies of cadaveric hips<sup>(1,12)</sup>, surgical findings<sup>(8-10,15)</sup> and MR arthrography<sup>(14)</sup>. One contributing factor to this finding is lower biomechanical properties of the labrum in this region<sup>(23)</sup>. The anterosuperior labrum has a lower compressive elastic modulus than the posterosuperior and the posteroinferior quadrants and a lower tensile modulus compared with the anteroinferior labrum<sup>(23)</sup>. Histologically, the anterior chondrolabral junction has a sharp and abrupt transition zone with collagen fibers that are arranged parallel to the chondrolabral junction, whereas posterior fibers run perpendicular to this junction creating a more gradual and interdigitated transition zone<sup>(24)</sup>. It was hypothesized that the anterior labrum may be a relative hypovascular area resulting in compromised remodeling and healing capacity<sup>(12)</sup>. However, Kelly et al demonstrated that vascularity patterns were not different in the anterior, superior, anterior, and inferior labrum<sup>(25)</sup>.

Repetitive stresses to the labrum can lead to labral tears. The anterior labrum is subjected to higher stresses than other regions because the femoral head has the least bony constraint anteriorly and joint stability depends on the labrum and capsuloligamentous complex instead. In addition, this area sustains significant forces during daily activities<sup>(26)</sup>. This hypothesis may also explain the higher prevalence of posterior labral tears reported in Japanese patients<sup>(16-18)</sup> who regularly squat or sit on the floor. This motion with deeply flexed hips might increase stress to the posterior labrum<sup>(16)</sup>.

Normally, the acetabular labrum merges with the adjacent hyaline articular cartilage of the acetabulum through a transition zone of 1 to 2 mm<sup>(1)</sup>. Sublabral sulci are normal anatomic variants that have been described in MR arthrography<sup>(8,14,15)</sup>, hip arthros-

copy<sup>(8,14,15,27,28)</sup> and open surgery<sup>(14)</sup>. However, sublabral sulci were not documented in other cadaveric studies of labral pathology<sup>(1,7,12)</sup>. Sublabral sulci in the present study were found bilaterally with a prevalence of 16%. They were identified in the anterosuperior (50%), anteroinferior (25%) and posteroinferior (25%) quadrants of the acetabulum. A prospective study by Saddik et al revealed 30 sublabral sulci in 27 (22%) of 121 patients who underwent hip arthroscopy due to clinical suspicion of labral tears<sup>(15)</sup>. In their study, sublabral sulci were most commonly found in the posteroinferior quadrant (46%), followed by the anterosuperior (40%), anteroinferior (7%) and posterosuperior (7%) quadrants. Sixty-eight percent of patients with sulci had labral tears<sup>(15)</sup>, a different finding than the present study that did not identify both lesions in the same hip.

A labroligamentous sulcus is another anatomic variant that can be found at the anteroinferior and posteroinferior part of the acetabulum where the transverse acetabular ligament and labrum join<sup>(29)</sup>. In the present study, 2 sulci were found anteroinferiorly and 2 posteroinferiorly, but none of them were located at the labroligamentous junction.

It is important to distinguish between sublabral sulci and labral tears on MR images to prevent unnecessary surgery. The sulci do not extend through the full thickness of the labral base<sup>(14)</sup>. Moreover, sublabral sulci are not associated with abnormal signal intensity of the labrum, cartilage lesions, osseous abnormalities and perilabral cysts<sup>(14)</sup>. In this cadaveric study, sublabral sulci were differentiated from type 1 labral tears by the normal appearance of the involved segment of the labrum. During hip arthroscopy, a labral tear can be identified as a cleft at the chondrolabral junction in association with labral abnormalities, which include labral fraying, hemorrhagic appearance of the labrum, or signs of attempted healing. The torn labrum is also unstable with abnormal displacement on probing<sup>(14,15)</sup>.

There were several limitations of the present study. Radiographic evaluation was not performed, so osteoarthritis grading, measurements of femoro-acetabular impingement and hip dysplasia were not obtained. However, the specimens had no significant morphologic abnormalities such as severe dysplasia. In addition, the condition of the articular cartilage was not documented.

### Conclusion

The acetabular labral tears were a common

finding with a high prevalence. They were most commonly located in the anterosuperior quadrant of the acetabulum. Sublabral sulci are anatomic variants that can be found bilaterally in different quadrants of the hips.

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### Potential conflicts of interest

None.

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## ความชุกของการฉีกขาดของ acetabular labrum และ sublabral sulcus

นวพันธ์ วอกลาง, พิสิฏฐ์ เลิศวานิช

**วัตถุประสงค์:** เพื่อหาความชุกและตำแหน่งของ acetabular labrum ที่มีการฉีกขาดและ sublabral sulcus ในศพดอง  
**วัสดุและวิธีการ:** ในการศึกษานี้ได้ทำการตรวจข้อสะโพกทั้งสองข้างของศพผู้บริจาค 25 ร่าง ซึ่งมีอายุเฉลี่ย 55 ปี (18 – 85 ปี) เพื่อตรวจหารอยโรคของ acetabular labrum โดยได้บันทึกลักษณะ ขนาด และตำแหน่งทางกายวิภาคของรอยโรค

**ผลการศึกษา:** มีการฉีกขาดของ acetabular labrum 38 รอยโรคในข้อสะโพก 33 ข้อ คิดเป็นความชุก 66% โดยรอยฉีกขาดมีความยาวเฉลี่ย 17 มิลลิเมตร (8-36 มิลลิเมตร) พบการฉีกขาดของ acetabular labrum ในตำแหน่ง anterosuperior จำนวน 22 รอยโรค (58%) รองลงมาคือ ด้าน posterosuperior จำนวน 13 รอยโรค (34%) รอยฉีกขาดจำนวน 31 รอยโรค (82%) เป็นการแยกตัวของ acetabular labrum ออกจากกระดูกขอบเบ้าสะโพก ส่วน sublabral sulcus พบได้ 16% โดยพบในข้อสะโพกทั้งสองข้างของศพ 4 ร่าง ตำแหน่งที่พบ sublabral sulcus ได้แก่ ด้าน anterosuperior จำนวน 4 รอยโรค (50%) ด้าน anteroinferior จำนวน 2 รอยโรค (25%) และด้าน posteroinferior จำนวน 2 รอยโรค (25%)

**สรุป:** การฉีกขาดของ acetabular labrum เป็นความผิดปกติที่พบได้บ่อย ส่วนใหญ่เกิดพยาธิสภาพในด้าน anterosuperior ของเบ้าสะโพก ส่วน sublabral sulcus เป็นภาวะที่พบได้ในข้อสะโพกทั้งสองข้างพร้อมกัน และเกิดได้ในหลายตำแหน่ง

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