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What I have learned in over a decade about acetabuloplasty and pincer impingement

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Acetabuloplasty definition

Rim trimming, also called acetabuloplasty, is performed to create a bleeding bed of bone to **facilitate labral healing** to the acetabular rim after refixation **and for the treatment of pincer impingement.**

Pincer definition etiology and subtypes

- Two distinct types of FAI: Cam and rim or pincer impingement.
- Pincer impingement is believed to result from **abnormal extensión/contact** (Bony prominence) of the anterior and/or posterior walls or acetabular roof relative to the center of the femoral head, causing an abutment of the acetabular rim against the femoral head-neck junction.
- The term pincer impingement was defined in **2003 by Ganz** [(1).]
- This type of impingement can occur as a result of several distinct **structural abnormalities**.
- Pincer impingement harder to diagnose that Cam.
- Significant controversy surrounding the diagnosis and treatment of this disorder and its associated conditions.
- In clinical practice, **isolated pincer impingement is rare**. In one epidemiologic study (Beck et al) of 149 hips with impingement, 26 (17.4%) had isolated cam impingement, 16 (10.7%) had isolated pincer impingement, and 107 (71.8%) had combined cam-pincer impingement [(2)].

Causes of Pincer Lesions

1-Idiopathic
2-Developmental

- Retroverted acetabulum (Focal/Global)
- Coxa profunda (coxa profunda coexisted with a spectrum of acetabular morphologies and orientations)
- Os acetabuli
- Protrusio acetabuli

- Chronic residual dysplasia of the acetabulum (Dysplasia and borderline displasia can also have concomitant pincer or cam lesions)

3-Traumatic

Post-traumatic deformity of the acetabulum

4-Iatrogenic

Overcorrection of retroversion in dysplastic hips

Potential pincer lesion mimics include DISH and ankylosing spondylitis, which do not produce impingement.

Pincer Subtypes

1-Focal Overcoverage

- Acetabular retroversion (True retroversión)
- Focal anterior over-coverage (Cephalad retroversión)
- Focal labral ossification
- Os acetabuli / Rim fractures
- Extra-articular pathology may contribute to a relative overcoverage of the femoral head, often in the form of a prominent anterior inferior iliac spine

2-Global Overcoverage

- Coxa Profunda (Coxa profunda is **a nonspecific radiographic finding**, seen in a variety of hip disorders and asymptomatic hips)
- Protrusio Acetabuli
- Global labral ossification

Key Point: Coxa Profunda

- Radiographically, coxa profunda is the finding of an acetabular fossa medial to the ilioischial line.
- Coxa profunda had been defined as a sign of general overcoverage but recent studies have shown that **coxa profunda should not be used to define a pincer deformity**. [3,4] The relative position of the acetabular fossa to the pelvis may not be indicative of acetabular coverage.

Consequences of Pincer FAI: Damage pattern

- Pincer-type (Rim impingement) femoroacetabular impingement is characterized by a repetitive **impaction type of injury** between the prominent acetabular rim and the femoral head-neck region. Persistent anterior abutment with chronic leverage of the head in the acetabulum.
- Labrum affected primarily, cystic changes and mucoid degeneration and tears. (Crushing of the acetabular labrum).
- The initial injury site is **typically anterosuperior** and to the labrum.
- Narrow and minor peripheral acetabular cartilage affected.(Linear impact).
- As the condition progresses, dystrophic ossification can develop in the injured labrum, and the prominent acetabular rim begins acting like a fulcrum,

leveraging the femoral head posteroinferiorly and causing more significant chondral injury in the **''contrecoup''** region of the posterior-inferior acetabulum.

- Indentation line at head/neck junction.
- With **focal overcoverage**, only **specific movements will be limited**.
- With **global overcoverage**, as in acetabular profunda or protrusio, a **more global loss of motion** may be observed.

Acetabulum Anatomy

Ilium, ischium, and pubic bones come together at the triradiate cartilage, which, in addition to the acetabular cartilage, forms the acetabulum. Fusion occurs between 13 and 18 years of age.

Anterior Wall configurations: A study of Maruyama et al [(5)] denoted four configurations along the anterior Wall: **Curved, angular, irregular, or straight**.

Acetabular Morphology [(6)]

- The outer acetabular bony rim is shaped in a regular wave-like manner with **three constant prominences and two depressions**.
- The prominences are anterosuperior (1.50 rim location clock-like),anteroinferior (4.40), and posteroinferior (7.50).
- The depressions are at the anterior wall (3.20) and along the posterosuperior wall
- The articular surface was smaller in women than in men.

The acetabular opening plane is orientated with no gender differences in

- In 19° +/- 6° for Acetabular tilt
- In 21° +/- 5° for Version (opening plane)
- In 48° +/- 4° for Inclination

Diagnosis/Imaging

Radiographic parameters of pincer-type femoroacetabular impingement

Key Points

- It is important to confirm that the radiograph is **properly centered** over the pelvis, and that there is **no abnormal tilt**.
- Radiographic indices provide index of suspicion: **Sometimes insensitive** indicator of acetabular impingement.
- **Many of the measurements** now associated with pincer impingement are observed in a significant percentage of the **asymptomatic population**.
- Parameters reported in the literature are variable and include the **crossover sign, ischial spine sign, posterior wall sign, lateral center-edge angle, acetabular**

index, acetabular rim osseous apposition, acetabular protrusio, anterior center-edge angle, and acetabular inclination and coxa profunda.

- Coxa profunda is not a useful marker of pincer-type femoroacetabular impingement because we commonly observe this finding in a wide variety of hip disorders as well as in patients without hip pathology.

Imaging of the hip to assess for pincer impingement should begin with plain x-rays, including well-centered anteroposterior (AP) pelvis, Dunn lateral, and false-profile views.

- The AP pelvis x-ray is reviewed for findings of acetabular retroversion, including a cross-over sign, ischial spine sign, and posterior wall sign.
- The lateral center-edge angle (LCEA) and Tönnis angle can be calculated, with respective values of **greater than 40 degrees and less than 0 degrees** being indicative of overcover-age.
- Findings of coxa profunda or protrusio may also be identified, with the cotyloid fossa or femoral head extending medial to the ilioischial line, respectively.
- The Dunn lateral view is largely used for identification of concomitant cam lesions, with an **alpha angle greater than 50 to 55 degrees** suggestive of this pathology.
- The false-profile view is used to identify the anterior center-edge angle and any potential posterior acetabular rim impingement or joint space narrowing.
- **New methods** to evaluate disorders are being developed, such as the **anterior rim angle, anterior wall angle, and anterior margin ratio**[7] .

Key Point: Differentiating between cephalad retroversión (Focal retroversión) versus true retroversión (Global acetabular retroversión)

- Both the crossover sign and prominence of the ischial spine sign are useful in diagnosing and measuring retroversion. The posterior wall sign is particularly important for guiding treatment in the setting of acetabular retroversion. This sign is present when the center of rotation of the femoral head is lateral to the contour of the posterior wall, and indicates a lack of posterior coverage.
- **True retroversión**: Crossover sign +, posterior Wall sign + (posterior wall medial to centre of femoral head), prominent ischial sign +
- **Cephalad retroversión**: Crossover sign +, posterior Wall sign -, prominent ischial sign .

Radiographic Reference Values for Acetabular coverage [8]

- Lateral center-edge angle: 23º to 33º
- Anterior center edge angle: 20º
- Medial center-edge angle: 35º to 44º
- Acetabular arc: 61º to 65º
- Extrusion index: 17% to 27%
- Acetabular index: 3º to 13º
- Sharp angle: 38º to 42º
- Negative crossover sign
- Positive posterior wall sign
- Anterior femoral head coverage: 15º to 26º

- Posterior femoral head coverage: 36º to 47º
- Craniocaudal coverage:70º to 83º

Key points

- An LCE angle of **greater than 40º** indicated **overcoverage or pincer FAI** while an LCE angle of **less than 25º** defined **acetabular undercoverage** or displasia.
- **Acetabular index** between 0º and 10º was considered normal, while an index of **less than 0º indicated pincer** impingement and an index of **greater than 10º** indicated acetabular **displasia**.
- The lateral center edge angle (LCEA) and the anterior center edge angle (ACEA) are commonly used to assess acetabular coverage of the femoral head. There are two distinct methods found in the literature to obtain these angles, specifically, measuring to the most lateral bone edge versus the sclerotic lateral sourcil edge. **On average, the bone LCEA was 4º greater than the sourcil LCEA. The bone ACEA was, on average, 10º greater than the sourcil ACEA.** [(9)] Further investigation is needed to determine which measurement method is a more accurate representation of acetabular coverage.

MRI: Magnetic resonance imaging

May help to delineate the extent of labral pathology present. In addition, more cartilage-sensitive imaging sequences (eg, delayed gadolini-um-enhanced magnetic resonance imaging of cartilage or T2 mapping with T1rho) may help to identify associated injury to the articular cartilage.

Computed tomography scanning

- Although plain film radiographs are good for evaluating the morphology of the acetabulum and the proximal femur in patients with FAI , 2-dimensional(2D) and 3DCT scans can provide even more information that is less subject to variable positioning and individual interpretation.
- **Computed tomography scanning** will provide **better visualization** of the acetabular rim, allowing for calculation of acetabular version, typically done at the 1-, 2-, and 3-o'clock positions to look for focal overcoverage or true retroversion, as well as classification of the AIIS based on morphology. In addition, it allows better characterization of the cam-type lesion and femoral version while also revealing any associated rim fractures or os acetabuli lesions.
- Preoperative 3-dimensional computed tomography **can help template** anterior and/or posterior **rim resection**.
- Axial CT images maybe used to directly measure the **acetabular version**,which has been described to be **17º** (standard deviation[SD] +- 5º) **in men and 21**º(SD +- 6º) **in women**, when measured through the deepest part of the acetabula, parallel to the line through the posterior aspect of the acetabula. Acetabular versión maybe grossly estimated by the crossover sign but is more precisely measured based on clock-face position using CT imaging.
- Acetabular version angle is **normally 5º, 10º, and 15º at 1 o'clock, 2 o'clock,**

and 3 o'clock, respectively.

Key Point: Femoral torsion

- CT scans also enable surgeons to evaluate the morphology of the proximal femur and the amount of femoral torsión by using the posterior condylar axis of the distal femur.
- **Normal femoral version** angle ranges between **15º and 20º** of anteversion.
- Femoral anteversion >30º is consistent with instability.
- Larger acetabular anteversion angles >30º can also predispose the patient to instability.
- Combined versión of the acetabulum and the femur **(McKibbin index)** should be considered when evaluating a patient with prearthritic hip pain. **McKibbin index** is the sum of the **femoral version angle** and **the acetabular version angle measured at 3 o'clock.**
- **A normal McKibbin index ranges between 30º and 60º.**
- **A McKibbin** index **>60º** predisposes the hip to **instability**, while a McKibbin **index <30º** predisposes the hip to **impingement**.
- Patients with a McKibbin index between **15º and 30º can be treated arthroscopically**, while lower ranges **(<15º) are amenable to an open procedure** to derotate the femur.
- Patients with a mild to **high McKibbin index (45–60º) can be treated arthroscopically** with minimal capsular cuts.
- Patients with a McKibbin index **greater than 60º** can be treated with a **derotational osteotomy and/or periacetabular osteotomy** [(10)].

Gender Differences and implications

- Leunig et al. analyzing pelvic magnetic resonance imaging characteristics in an asymptomatic population, **failed to show any statistically significant differences** in acetabular depth, a measure of global acetabular overcoverage, **between men and women** [(11)].
- In a study of Tannenbaum et al [(12)] the mean global and focal **acetabular anteversion was greater in women**, and the prevalence of focal cephalad retroversion in the 1-o'clock position was not significantly different compared with men. Acetabular retroversion and anterior overcoverage are not more prevalent in women in the anterosuperior acetabulum, where femoroacetabular impingement most commonly occurs.
- Other **dynamic factors** may also **contribute to pincer impingement occurring more frequently in women**. For instance, women are generally more flexible than men and more commonly participate in activities that stretch their hips to greater extremes of motion, such as yoga, gymnastics, and dance. Thus, over time, these women may experience **increased dynamic capsular laxity allowing for superphysiological motion, which may eventually cause pincer FAI from excessive and repetitive hip flexion, rather than focal anterior or global acetabular overcoverage.** Although men showed more retroversion than women, it is possible that women with retroversion are actually more predisposed to the development of pincer FAI than men with retroversion because of other pathophysiological mechanisms. It has been shown that the

angle of lordosis in normal individuals ranges from approximately 20º to 60º . Furthermore, on average, **women show more lordosis than men**. Thus it is possible that the increased lordosis in female lumbar spines may cause women with retroverted acetabula to be more predisposed to having pincer-type FAI than men when loading the hip in deep flexion.

Key point: Pelvic tilt and lumbar lordosis can be affected by core strengthening exercises.

- Radiographic **signs of femoroacetabular impingement** are associated with **Decreased Pelvic Incidence** (PI) [13] .
- Individuals with decreased pelvic incidence may attempt to compensate for this by increasing pelvic tilt to maintain normal sagittal alignment of the spine. However, in individuals with tight hamstrings, this may be a potentially maladaptive response. Likewise, individuals with increased PI may attempt to decrease pelvic tilt in efforts to restore normal sagittal spinal balance, which may place excessive tension on the quadriceps tendon. In both instances, **core strengthening and stretching exercises of the respective muscle groups may be advisable.**

Diagnosis. Imaging: Arthroscopy

Arthroscopic parameters of pincer-type femoroacetabular impingement

- Arthroscopic parameters **some times more sensitive** than radiographic parameters [14] .
- Presence of anterior labral pathology (or impending labral failure).
- **Labral flattening, areas of intralabral cystic changes, ossification or calcification**, os acetabuli, posterior acetabular linear chondral wear, a linear groove or pincer divot at the femoral headneck junction.
- Labral tear and delamination **with capsular edema** : "Sub-Spine Impingement"
- **Contre coup lesion** (labral fraying and chondral wear posteriorly.
- Peripheral labral **bruising/ecchymosis** consistent with pincer-type femoroacetabular impingement.
- **Difficulty with anterior portal** placement despite adequate distraction. Hindrance from bony lip.
- Bone extending over damaged labrum: Normally should reveal capsular reflection. An **acetabular rim extending** well beyond the labrochondral junction **(>3 to 5mm) are consistent** with pincer-type impingement.
- If imaging studies show pincer-type pathology but intraoperative findings do not confirm the pathology, bony resection is not clearly indicated.
- Dysplasia: Labral tears and chondral lesions are anteromedial.
- FAI: Labral tears and chondral lesions are anterolateral.

Surgical approach

- **Pincer: Surgical aims:** The goals of surgical intervention are **to eliminate the cause of the abutment** between the femoral head-neck junction and the

acetabular rim (Normalization of femoral head coverage and /or normalization of acetabular versión), and **to repair any labral or articular damage** that has occurred.

- **Patient selection very important:** Reasonable patient expectations.
- Rim: Two different procedures: **Rim or roof trimming and rim or roof reorientation.**
- **Various treatment options**: Open surgical dislocation, a limited open direct anterior approach, or an all arthroscopic approach. The goals of treatment are the same. Deciding between open and arthroscopic surgery depends on the degree of deformity, the location of the abnormality, and the comfort level and experience of the surgeon.
- **Arthroscopic management** should only be performed in situations where the anatomy of the acetabulum does not require major bony correction.
- Situations in which **open surgery is preferable** include severe hip dysplasia, severe acetabular retroversion, posterior instability, proximal femoral rotational abnormalities, severe global pincer impingement, and severe extraarticular ischiofemoral or trochanteric pelvic.

Indications for Arthroscopic Management of Pincer Lesions

- Isolated pincer lesions with anterosuperior (Focal) overcoverage
- Anterosuperior pincer lesions with treatable Cam lesions
- Absence of additional untreatable mechanical factors

Kelly B. Santander Hip Meeting 2011

Contraindications for arthroscopic rim resection

- >50% joint space narrowing or joint space narrowing with MRI evidence of bipolar grade 4 changes.
- **Protrusio acetabuli with a large notch** and relatively deficient articular cartilage volumen.
- **Severe acetabular retroversión.**
- Low volumetric acetabulum and displasia (Corrective pelvic osteotomies should be considered.

KEY Point: Indications: Controversies: Global retroversión/Protusio

1)What is the best treatment option for global acetabular retroversión (True retroversión)

- **Key point**: A recent study [15], reports a high prevalence of the crossover sign and/or posterior wall sign in asymptomatic hips **(37%)** indicating that these are not necessarily pathognomonic for ‘‘pincer-type’’ impingement and/or posterior instability and might be a normal variant rather than pathologic in a significant number of cases.
- **RPAO**: Symptomatic global retroversion of the acetabulum, has traditionally been treated with reverse periacetabular osteotomy (RPAO), which improves posterior undercoverage and eliminates the anterior pincer lesion. This has been shown to have positive patient outcomes at up to 10-year followup [16,17]

- **HIP Arthroscopy**: In a recent study Domb B et al [18], demonstrates that hip arthroscopy alone, without changing the overall orientation of the acetabulum can successfully treat femoroacetabular impingement associated with a globally retroverted acetabulum at a minimum of 2-year follow-up. Benjamin Domb´s algorithm in a patient with a globally retroverted acetabulum.

  -Young patients with an **LCEA >21º** with a Tönnis grade <1 who have failed nonoperative management and **do not demonstrate posterior instability** on examination are recommended for **hip arthroscopy**. The author is now performing capsular closure on all these patients unless unexpected arthritic change is encountered.

  -Young patients who are **dysplastic (LCEA <20º) or demonstrate clinical signs of posterior instability, hip arthroscopy is considered contraindicated** and anteverting PAO advocated.

  -If radiographs indicate **Tönnis grade 2 or more** , then **nonoperative** management is offered until hip arthroplasty is indicated

Key point: An anteverting or reverse periacetabular osteotomy (RPAO) instead of arthroscopic rim trimming may be required in some severe cases of acetabular retroversion to avoid iatrogenic global hip instability. Experts who perform both procedures state that the latter open procedure may be indicated in the relative minority of patients who exhibit retroversion combined with frontal-plane displasia.

2) What is the best treatment option for protusio acetabuli

Protusio acetabuli definition

- Femoral head overlap or extension medial to the ilioischial line or medial acetabular wall extension past this line of **3 mm or more in male** patients and **6 mm or more in female** patients [19].
- Leunig et al. [20] define acetabuli protrusio as the femoral head being close, at, or medial to the ilioischial line; the acetabular roof being negatively tilted; and the center of the femoral head being medial to the anterior and posterior acetabular walls .
- Any of these acetabular dysmorphisms may coexist with acetabular retroversion and/or cam morphology.

Treatment: Protrusio presents a difficult treatment dilemma

- **Open surgery**: Clasically protusio has been treated open with surgical dislocation, rim resection, pelvic or femur osteotomy, or hip arthroplasty, depending on multiple patient factors.
- **Arthroscopy still controversial**

  -Matsuda [19] indicated that select patients with acetabular protrusio may respond well to arthroscopic acetabuloplasty with labral repair or debridement, shifting protrusio from the list of contraindications to possible indications for hip arthroscopy. He reported a case of arthroscopic acetabuloplasty in a patient with preoperative center-edge angles of 46º and 56º. **His stated goal was to reduce the center-edge angle to 35º.** Rim resection is greater than that required in more focal cases, both in rim width and in acetabular perimeter. “Whereas we often may resect 2 to 5 mm of anterosuperior rim in focal pincer cases, coxa profunda and protrusio acetabuli may require rim trimming of 10 mm or more (estimated by comparison with bur width) from the **midanterior to**

midposterior rim".

-Marc Safran et al [21]: In a small case series (4 hips), arthroscopic acetabuloplasty showed reduced symptoms and improved function in 3 patients with mild to moderate protrusio aged younger than 40 years at a mínimum of 2.5 years' follow-up. Patients complained of groin pain and their symptoms were reproduced with flexion and/ or flexion-adduction-internal rotation of the hip. Thus **the goal** of the surgery was not to perform a global acetabuloplasty or resection of the entire acetabular **rim**, but just the **anterior and lateral acetabulum.** Longer follow-up is necessary to determine whether arthroscopic acetabuloplasty alone is an adequate treatment for patients with this clinical entity or whether the biomechanical aspects also require alteration.

- **Acetabular rim triming alone**
  - A recent 10 year follow up study [22] has stated that circumferential acetabular **rim trimming alone** through a surgical hip dislocation in hips with protrusio acetabuli are at **increased risk for failure**. Compared with classic pincer hips, hips with protrusio showed a substantially **reduced survival (51% versus 83%).** From a biomechanical perspective, acetabular rim trimming only addresses the dynamic FAI pathomechanism. The pathologically increased size of the lunate surface in protrusio hips can be addressed with this technique. **However, it does not address the medial overload of the joint,** which is typically a result of the negatively tilted acetabular roof.
  - A number of cases of protrusio present with a **large acetabular fossa "medial dysplasia.**" and normal or decreased/deficient overall acetabular articular cartilage surface area [23]. The abnormal forces in this situation are localized to the medial aspect of the joint rather than the rim. Simulated rim resections and finite element models have shown **increased medial joint stress after global rim resections** in this situation [20]. Leunig et al [20] recommended a more tailored surgical treatment of protrusio surgical hip dislocation with trimming of the acetabular rim with an **optional valgus intertrochanteric osteotomy** if a medial shift of the femoral head is present and in hips with extension of the acetabular fossa in the weightbearing zone (**High fossa**), a **reversed redirectional PAO** is indicated.

Key points

- Arthroscopic management of protrusio acetabuli should be undertaken with caution because the amount of rim resection and subsequent dynamic evaluation can be difficult with an arthroscopic approach. Entering a deep socket and performing **posterior rim resection** is technically difficult but **can be done arthroscopically.**
- Technically, a **global rim resection** is demanding arthroscopically but definitely **feasible with experience**.
- The bigger question, however, may regard the **most appropriate treatment rather than the approach.**

- Although acetabuloplasty does address the impingement component of this problem, it does not address the biomechanical complexities of protrusio acetabuli.
- Some patients may also benefit from osteochondroplasty of the head-neck junction or relative lengthening of the femoral neck with trochanteric advancement to increase the femoroacetabular clearance. Depending on the morphology, a **femoral-sided osteotomy (ie, valgus intertrochanteric osteotomy) or a pelvis-sided osteotomy (ie, a reverse PAO) may be appropriate and can be performed in the same surgery**.
- Long-term followup for all of these surgeries is necessary to determine the efficacy of these procedures in maintaining hip function and potentially delaying the degenerative process .

Key point: Recent study: Size and shape of the lunate Surface in different types of Pincer impingement [24]

- Theoretically, **rim trimming would only be indicated if the lunate surface is oversized.** A reorientation procedure would be correct in pincer hips with acetabular malorientation.
- Hips with **retroversion had a decreased size and deep hips had normal size of the lunate surface**. Both had a normal shape of the outer acetabular rim.
- **Protrusio hips had an increased size and a prominent outer acetabular rim.** In all **three types of pincer hips the acetabular fossa was increased**. In contrast to hips with protrusio acetabuli, retroverted and deep hips do not have an increased size of the lunate surface. **Acetabular rim trimming in retroverted and deep hips should be performed with caution**. Based on this results, acetabular reorientation would theoretically be the treatment of choice in retroverted hips.

Arthroscopic Management of Pincer Impingement

A)Goal of the procedure: To perform adequate rim resection and preservation or repair of viable labral tissue.

B)Technical pearls

- **Preserve the labrum chondra-labral junction if posible** before acetabular rim resection so that after the acetabular rim has been resected, the labrum can be reattached with suture anchors to a base of bleeding cancellous bone. The suction-seal (Important to maintain stability) of the hip and the resultant fluid film lubrication are dependent on an intact labrum.
- Arthroscopic rim trimming for femoroacetabular impingement can be technically **challenging to perform with precision**. **Over-resection** can lead to hip instability and even iatrogenic dislocation. **Under-resection** may leave residual impingement.

C) Arthroscopic options depending on the pathology present

- Acetabular rim resection with labral **debridement**.

- Remove the bone with the labrum included: **Rim and labrum resection**.
- Remove the bone behind the labrum **without detach**: Acetabular rim resection with labral preservation and repair. (Without labral take down)
- **Detach the labrum** and remove the bone. Acetabular rim resection with labral takedown and repair.

Acetabular rim resection and labral debridement/resection

- Indication: When the labrum is found to have **extensive damage**, with multiple cleavage planes and calcification that precludes repair.
- Capsular Elevation.
- Exposure of Rim lesion.
- Debridement of non-viable tissue.
- Rim Resection.
- Preservation of viable / stable labral tissue.

Acetabular rim resection with labral preservation and repair. Rim Resection without Labral Takedown (Thomas Sampson Technique)

- Indication: Intact labrochondral junction/Smaller pincer lesions.
- Acetabular rim is resected with labral attachments preserved.
- **Refixation** of the labrum with suture **anchors vs no anchors vs transosseus.**
- After rim trimming without labral takedown, repair with anchors is often necessary to prevent abnormal labral mobility and consequent failure at the watershed zone.

Acetabular rim resection with labral takedown and repair

- Indication: Large pincer lesions/Disruption of the labrochondral junction
- Labrum can be liberated at the chondrolabral junction with an intra-articular blade to expose the acetabular rim for resection with a burr.
- Allows resection of excess acetabular articular cartilage (transition zone) to avoid medialization of labrum over the rim (loss of the seal)
- Typically trim to the labrochondral junction
- **Refixation using suture anchor vs no anchor vs transosseous**.

-Rim resection in 2016: Typically is done without labral takedown. Labral takedown for larger rim resections.
-Redmond and colleagues [25] compared the two techniques **(with and without) and found no difference in outcomes.**

D) Arthroscopic access pearls: Problems and solutions

- Portal: For anterior and anterosuperior (3 to 1 o'clock) lesions, the anterolateral portal is often used for viewing, while the anterior portal is the working portal.
- In cases of **significant retroversion or overhang**, portal placement may need to be placed **1 to 2 cm distal** to the standard positions to allow easier access into the hip joint.
- Where **the lesion is far posterior** (coxa profunda or posterior overcoverage) , a

separate **posterolateral portal** may be necessary for bony work, while viewing through the anterolateral portal [26]

- **Reduce excessive posterior wall to neutral** (aligned with centroid of femoral head). Assess rim reduction with fluoroscopic templating technique.
- Use **distraction only when it is necessary** to work in the central compartment.
- It is more difficult to enter the central compartment of the hip as a result of the overcoverage and/or suboptimal distraction. **Alternatively, arthroscopy may start in the peripheral compartment (M. Dients´s technique), or with a capsulotomy-first approach described by Sampson.**
- Posterior extension or posteriorly based cam lesions in the presence of pincer-type impingement are difficult to access arthroscopically and these patients may be better served with an open surgical dislocation.

Key point: Accessible zones

- Anterosuperior pincer lesions can be precisely addressed, posterosuperior lesions are more difficult to fully resect.
- A cadaveric investigation[27] (without fluoroscopic assistance) has shown **relative accuracy in determining arthroscopic acetabular resection arcs (not widths) for the anterosuperior region but more variance and an underestimation of similar resection arcs when performed for posterosuperior rim trimming** and a lack of accuracy in resection of acetabular bone by arthroscopic rim-trimming procedure of **about 19 degrees**, but this study was performed in specimens without pincer deformity and therefore lacked this important intraoperative sign to help in the arthroscopic orientation of the bone resection.

E) Rim trimming of Pincer lesions. Arthroscopic Acetabuloplasty. Technical pearls

- Rim trimming is a surgically **induced volumetric reduction**.
- **Two important components** to take into account: **Arc and with** of the resection.
- 5.5mm/4 mm round burr to remove bone from acetabular rim and the anterior wall to eliminate the crossover sign and create a smooth transition from the anterior to posterior wall. Avoid overresection and introduction of iatrogenic instability.
- Assess the rim resection with **intraoperative fluoroscopy** confirming appropriate version with the anterior wall lying medial to the posterior wall and a gradually convergence of the 2 walls superiorly
- Interchange of portals. Use suture to pull labrum out of way.
- Use **osteotome to remove a portion** of the pincer lesion **near the rectus indirect** head so as not to injure the tendon.
- **Intermittent release of traction** during rim resection allows for a better evaluation of acetabular coverage.
- The **area** of focal pincer resection is generally **dictated by the length of labral pathology**. This typically extends from the 9:30 to 12:00 position for the right hip but there is significant variability between patients.
- The **amount of rim** resection carried out, which is **typically 3 to 5-6 mm**, is primarily based on intraoperative extension of the rim beyond the labrochondral

junction. Typically resect to the end of rim chondrosis. Important to consider the pre-op center-edge angle to avoid overresection.

- The rim **resection should begin and end gradually** with the deepest resection at the center of the pincer lesión. Inferomedial and superolateral excision defined by transition to healthy labrum.

F) Labrum. Technical Pearls

- Selective **debridement** of damaged labrum exposes impinging bone.
- Tears with instability at the base should be **repaired**. Peripheral fraying of the labrum should be debrided.
- Labral **reconstruction**: Indications: Segmental labral defect, severe intrasubstance damage, diminutive labral remnant after debridement (Insufficient labral tissue is considered to be less than 2 to 3 mm because it lacks the surface area to heal and repair may not create a sufficient fluid seal.
- **1 anchor for every 1 cm** of labral detachment.
- Consider **double loaded anchors if capsular deficiency**.
- Translabral sutures may be used in thicker portions of the labrum when the objective is to minimize labral eversion.
- **Smaller anchors** may be necessary, especially at the thinner portions of the acetabular wall **(3 and 9 o'clock).**
- The drill guide/Anchors should be positioned as close as possible to the acetabular rim to effect anatomic repair. A more distal portal (**DALA**: Distal anterolateral portal) minimizes the risk of joint penetration while permitting anchor placement close to the rim margin.
- In general, the anterolateral portal allows the insertion of anchors in the superolateral aspect of the acetabulum. For the insertion of anterior-most anchors (beyond the 2 o'clock position, or zone 1), the midanterior portal should be used.
- The posterior positions can all be safely drilled with a relatively good bone margin using the PL portal.
- The use of **curved drills** has been shown to provide a safer angle of anchor insertion than a straight guide when placed through the DALA portal at the 2 and 3 o'clock positions [(28)]
- Stay in the bone. Watch the acetabular articular surface during anchor placement.
- Place a **nitinol guidewire down the drilled anchor** hole to ensure that the distal end of the drill hole is still in the bone. This is important in the anterior acetabulum where the bone is thin and a protruding anchor can irritate the iliopsoas tendón.
- **Transosseous Acetabular Labral repair without anchors: Indications** [(29)]
    1. **Thinner portions** of the acetabular wall **(3-o'clock position**) the acetabular safety angle is smallest at the 3-o'clock position.
    2. Dysplastic hip and narrow acetabular rim.
    3. **Penetration into the joint** by the drill while creating a tunnel.
    4. Patients with acetabular chondral lesions treated with microfractures (no further cartilage damage with the intra-articular drill).
    5. Economic issues in developing countries: low-cost method without anchors

6. **Revision cases with loose or large anchors** in place.
7. **Anchor pullout**; above all in patients aged >50 years at risk of osteoporosis.
8. **Risk of extra-articular penetration** and soft-tissue irritation (psoas in medial anchors).

Methods of preoperative and intraoperative evaluation of arthroscopic acetabuloplasty

- The effects of acetabular rim trimming are difficult to visualize dynamically during arthroscopic acetabuloplasty.
- It is **essential to have a preoperative plan** developed by careful review of the diagnostic imaging, and to then be able to correlate that with intraoperative fluoroscopic images and direct visualization in order to assess the progression of rim resection.
- Knowing the **exact change in lateral and anterior CE angle** with amount of rim removal may help prevent overresection or underresection in pincer trimming.

Preoperative evaluation

Lateral center edge angle

- The amount of acetabular rim resection in millimeters has been shown to correlate with changes in the lateral center edge angle preoperatively and postoperatively: 1 mm of resection at the 12 o'clock position equaled 2.4º of change, and 5 mm of resection correlated with 5º of change [30].

Change in CE angle = 1.8 + (0.64 X mm of rim reduction) Philippon et al (AAOS, AANA 2009).

- 1mm rim reduction = 2.4º ↓ CE angle
- 2mm rim reduction = 3.1º ↓ CE angle
- 3mm rim reduction = 3.7º ↓ CE angle
- 4mm rim reduction = 4.4º ↓ CE angle
- 5mm rim reduction = 5.0º ↓ CE angle

Measurement was taken from the center of the cotyloid fossa to the 12 o'clock position of the lunate surface, opposite the transverse acetabular ligament.

Anterior center edge angle

- The lateral CE angle should not be extrapolated to reflect anterior acetabular coverage.
- Newer data suggest that it is beneficial to use the anterior center edge angle as opposed to the more traditional lateral center edge angle.
- The anterior CE angle decreased by approximately **2º (1.8º) per millimeter** of rim recessed. The anterior CE angle is a superior marker and predictably **decreases with rim recession at double the rate of the lateral CE** angle [31].

Key point:

- Anderson et al [32] noted that in the situation of combined impingement, the presence of a **cam lesion results in lateralization of the femoral head center during templating.** This causes a resultant underestimation of coverage using the lateral and anterior CE angles.

Controversies: How much

- The amount of rim trimming is dictated by the **severity of pincer impingement, which may be quantified by the degree of the center edge angle (Anterior and lateral) and the crossover sign.**
- Although the benefits of acetabular rim trimming have been well described, the **ideal amount of rim resection has not yet been established**.
- Previous authors [30,33] have described resection of anywhere from **1 to 9 mm** of bone from the acetabular rim, likely varying depending on the size and location of the acetabular deformity.
- A recent CT-based analysis of asymptomatic patients reported a **normal CEA value of 31°**, which may provide surgeons with an acceptable post-operative target [34]
- Aim: To resect the acetabular rim above 35º of CE or to produce an LCEA of 30º to 35º by formulas previously described but **it is not clear whether it is necessary to reduce the center-edge angle to "normal**. **May be the reduction in CEA is a more importan**t determinant of hip function than the magnitude of the preoperative or post-operative CEA[35].
- A recent study suggests that **excessive rim resection may lead to increased loads** in the hip joint and may predispose to premature joint degeneration[36]. Resecting **more than 4 to 6 mm** of the acetabular rim during hip arthroscopic surgery to address a pincer deformity may dramatically increase contact pressures by 3-fold at the acetabular base.
- Small changes in acetabular rim morphology, on the order of **0.5 mm or less can be the difference between symptomatic pincer-type FAI and the asymptomatic** state. Knowledge of the healthy, unaffected side in unilateral FAI may provide a better template for rim recession rather than broadly applying previously described anterior or lateral center-edge angle parameters[37].

Intraoperative evaluation

- Methods of assessing the amount of rim reduction have included estimating the resection width compared with **bur width** or estimating the remaining distance from distance from the nearest edge of the acetabular notch[30].
- Rim resection can be predictable and reproducible **gauged fluoroscopically** as described by **Larson and Wulf and Matsuda** reproducing the preop Xray on intra-operative fluoro image. [38,39].
- Relevant study: Buchler L et al [40] concluded that fluoroscopy is reliable for measurement of LCE angle and AI; however, **fluoroscopy leads to a more anteverted projection** of the acetabulum with significantly decreased total anterior coverage, significantly increased total posterior coverage, and underestimated signs of retroversion compared with standardised AP pelvis radiography. Surgeons should be mindful of this during hip preservation

surgery. **Fluoroscopy also failed to identify the presence of a crossover sign** in 30% and underestimated the retroversion index (9% vs. 13%).

- If bony resection is not appreciated on intraoperative fluoroscopic imaging despite attempts at appropriate positioning, then further **resection** should be **guided by direct arthroscopic visualization**, dynamic testing for impingement, and preoperative radiographic templating.

New tools:

- **Software planning** is the template for surgical correction in the hip. Computer navigation becomes a simple technical/technological exercise.
- **Future Research: Intraoperative** jigs to accomplish the solution determined by the planning.

Subtypes or Pincer type variants: Treatment options

A)Os acetabuli: Bony fragments: Treatment options

- Usually, the fragments may be **removed** to correct hip morphology if the **LCE is >25, and ACE >20** after resection. Two strategies:
  - Detach the labrum from fragment for later refixation.
  - Remove the fragment with the burr without a formal labral takedown.
- If acetabular volume is deficient or dysplastic without the fragment (ie, LCE: **< 20° to 25 and anterior center edge angle (ACE): < 15° to 20°**): a portion of the rim fracture is **removed and the remaining fragment is stabilized** with 1 or 2 cannulated screws (3.5 or 4 mm). The screws are typically 24 to 26 mm in length[41,42].
- Pearl: Anchor fixation for **labral repair in the surrounding zone** of the osteosynthesis, might bring some technical problems. Technical modification improving labrum lesion: **Addition of a suture to the screw** addresses both lesions as it simultaneously has the function of a screw and an anchor (**SOS: Suture on screw technique**).

B)Rim fragments : Small ossicles embedded in the labrum and focal labral calcifications

- Treatment: **Removal preserving the underlying labrum.**
- Excised with a burr or dissected out and removed with a grasper.

C)AIIS / Subspine Impingement

Definition: A prominent anteroinferior iliac spine may contribute to an extrarticular relative overcoverage: Extraarticular pincer. A recent study by Zaltz et al [43] demonstrated that a **variable AIIS (Anteroinferior iliac spine)** morphology may be responsable for the radiographic appearance of a cross over sign, rather tan true acetabular retroversion.

Classification : A classification system based on 3DCT reconstructions [44].

Characterization of the AIIS morphology begins with drawing a horizontal line on the ischium view, crossing at the most inferior aspect of the junction of the AIIS and the ilium wall.

- In **Type I**, the AIIS does not cross inferior to this horizontal line.
- In **Type II,** a portion of the AIIS crosses inferior to the horizontal line, however, not inferior to the anterosuperior acetabular rim.
- In **Type III**, a portion of the AIIS crosses inferior to the horizontal line and inferior to the anterosuperior acetabular rim.

Key point: Focal rim retroversion and subspine impingement can both result in a crossover sign and anterosuperior labral injury, but they require different corrective osteoplasties to treat the femoroacetabular impingement.

Etiologies of AIIS pathomorphology

- Apophyseal avulsions of the AIIS
- Rectus femoris avulsions with ossification
- Overcorrection after periacetabular osteotomy
- Developmental.

Technical Pearls

- The AIIS can be located by placing the bur on the acetabular rim and localizing it either by **palpation or via intraoperative fluoroscopic** images.
- Typically between **the 1:30 and 2:00** positions.
- It can be helpful to use intraoperative fluoroscopy with the C-arm directed in a **45ºtilt, to best mimic the false profile radiograph**.
- **Working off of traction** can also relieve tension from the rectus femoris, and allow for improved access to the AIIS.
- A thermal device can be used to define the AIIS anteriorly.
- A burr is then introduced through the midanterior portal and the AIIS is d**ecompressed** to a point above the acetabular sourcil, **typically 1 to 1.5 cm**. The **goal** for low AIIS osteoplasty is to resect the AIIS to 2 burr widths (using a 5.5-mm burr) above the acetabular rim, achieving an 11-mm clearance, creating a type I AIIS[45].
- Occasionally a more proximal decompression is required, and a **separate window** can be made through the rectus tendon with an arthroscopic knife to better preserve the anterior capsule and rectus origin.
- Subspine decompression **greater than 10 mm** significantly compromises the rectus femoris origin and should be avoided when performing AIIS [46].

Treatment of associated pathology: Special situations

1)Acetabular rim chondral defects

- Debridement of unstable cartilage and **reduce the size of acetabular chondral** lesion. Curette to prepare a smooth perpendicular border.
- Debridement should be deep enough to remove the calcified layer while maintaining the integrity of the subchondral plate.

- Arthroscopic awl used to make multiple microfractures in subchondral bone [47].

2)Triple Impingement

- Pincer-type pathology, labral pathology, and internal or psoas snapping hip have been termed by some surgeons as **''triple impingement**. In this situation, an intraarticular injection may give partial relief of the presenting pain, and a psoas bursal injection may give further relief confirming this association[48]. In this cases consider psoas release.
- **Focal labral bruising** further inferiorly **at the level of the psoas U (3:00 R hip)** may be consistent with psoas impingement. This may, however, be seen in the setting of **excessive femoral neck or acetabular anteversion and anterior instability,** and indiscriminate psoas release may lead to anterior instability.

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