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The Biomechanical Evaluation of Shelf Acetabuloplasty in the Setting of the Iatrogenic Dysplastic Hip

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Faculty Disclosure Information

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Introduction

- ✓ Hip arthroscopic surgery (AS) provides good clinical outcomes across patients including high level athletes.

Memon et al., 2019

- ✓ Developmental dysplasia of the hip (DDH) is known as a risk factor of poor clinical outcomes after hip AS.

Parvizi et al., 2009; Ross et al., 2014; Larson et al., 2016; Ruzbarsky et al., 2022

- ✓ Patients with DDH also have concomitant femoroacetabular impingement (FAI) or labral tears.
  →**Simultaneous treatment for those pathologies is crucial.**

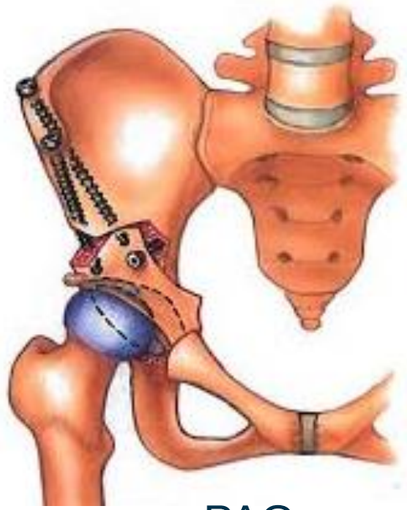
Domb et al., 2014; Domb et al., 2015

Introduction

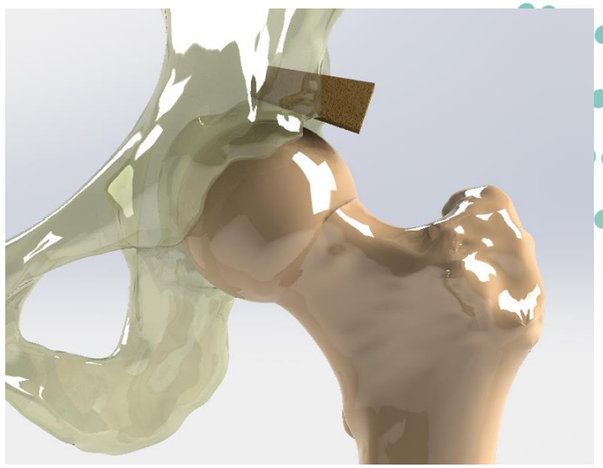
- ✓ Periacetabular osteotomy (PAO) and Shelf acetabuloplasty have been reported as hip AS combined procedures for DDH with concomitant hip pathologies.

Uchida et al., 2014; Domb et al., 2015; Cho et al., 2020

- ✓ Shelf acetabuloplasty is the surgical technique to transplant an autologous bone graft extra-articularly to extend the acetabulum coverage.



PAO

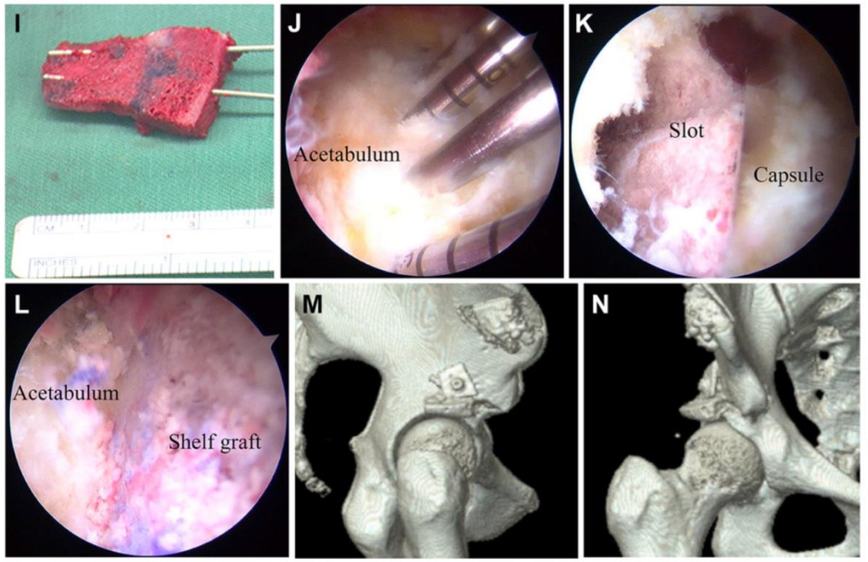


Shelf

Introduction

- ✓ To make the shelf procedure less invasive, Uchida et al. modified this surgery to the endoscopic procedure and reported good clinical outcomes and a high return-to-sport.

Uchida et al., 2014; Uchida et al., 2018; Uchida et al., 2021



Due to a lack of evidence from biomechanical studies, the stabilizing effect of shelf acetabuloplasty remains a topic of controversy.

Purpose/Hypothesis

Purpose:

To biomechanically investigate the effects of shelf acetabuloplasty in the setting of acetabular dysplasia through a robotic sequential sectioning study.

Hypothesis:

The dysplastic hip would have decreased stability compared to the native hip and that shelf acetabuloplasty would improve hip stability.

Materials and Methods

Study design

10 fresh-frozen human cadaveric hips

Specimens were dissected down to the hip capsule and mounted on the robot

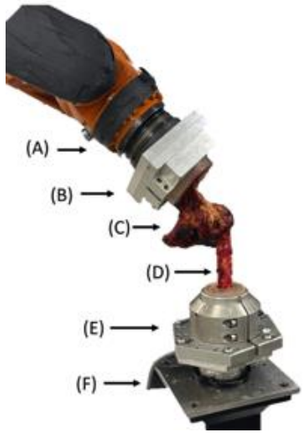
Each specimen underwent biomechanical testing in 4 states:
1) Native,
2) Capsular repair,
3) Acetabular dysplasia model
4) Shelf acetabuloplasty

3 range of motion tests:
1) 5-Nm flexion,
2) 5-Nm abduction,
3) 5-Nm internal rotation at 75° flexion

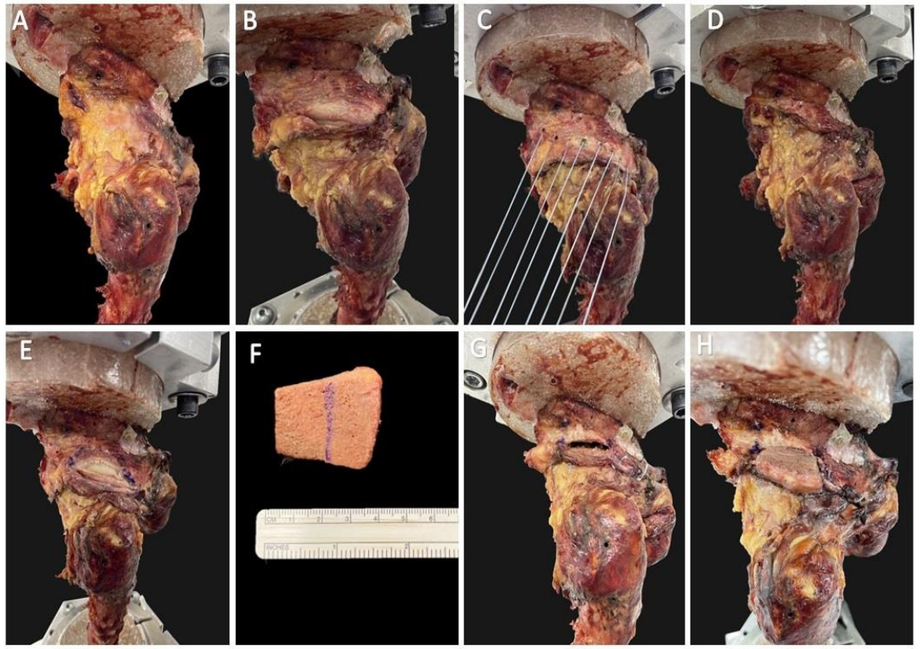
1 destruction test:
1) 88 N lateral drawing.

Biomechanical testing set up for a human cadaveric hip.

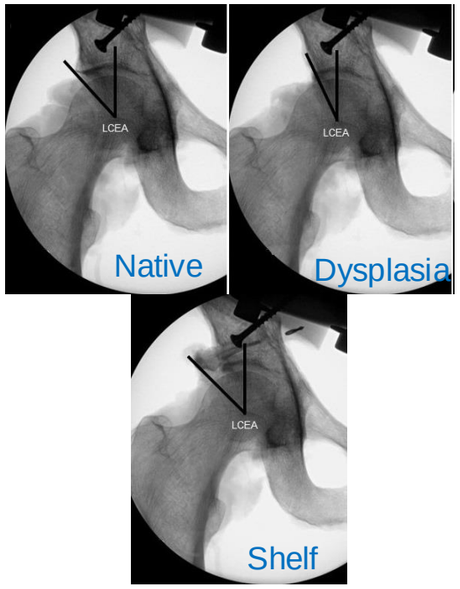
The pelvis was fixed in a custom fixture attached to the KUKA KR-60 robotic arm.



Surgical procedure



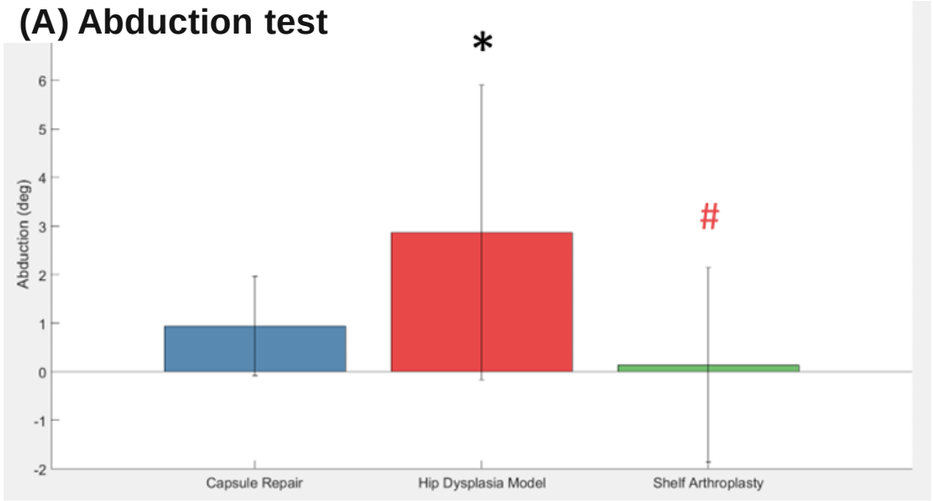
Fluoroscopic image



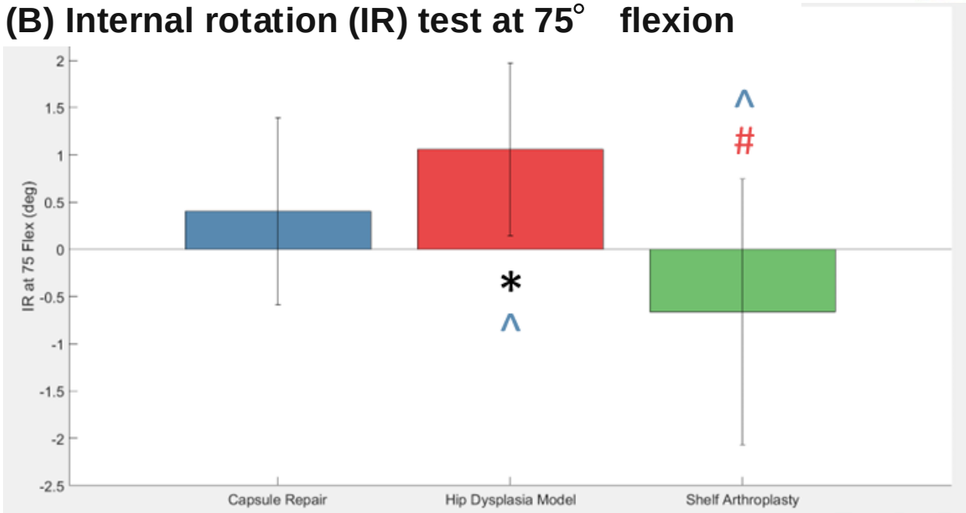
A) Native state.
B) Capsule was detached from its acetabular rim.
C) Transosseous tunnels were created.
D) Capsule was repositioned with four sutures.
E) Labrum was detached and osteotomy was performed to achieve an LCEA of 15-20 degrees to establish the acetabular dysplasia model.
F) Harvested shelf bone graft (5 mm in height x 30 mm in width x 35 mm in length) from the iliac crest.
G) Slot (5 mm in height x 25 mm in width x at least 20 mm in depth) was created in the ilium.
H) Shelf bone graft was inserted into the slot to achieve an LCEA of 35 - 40 degrees, as confirmed by fluoroscopy.

Results: Average change from native in each test

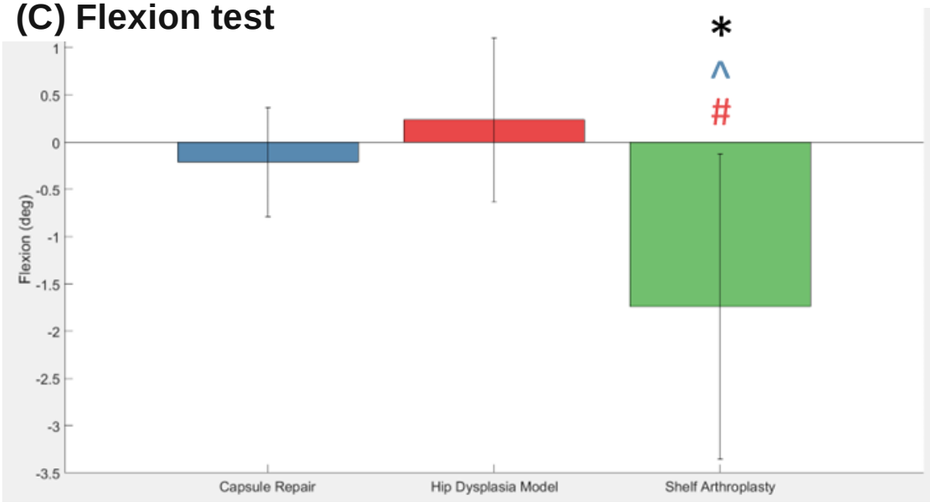
(A) Abduction test



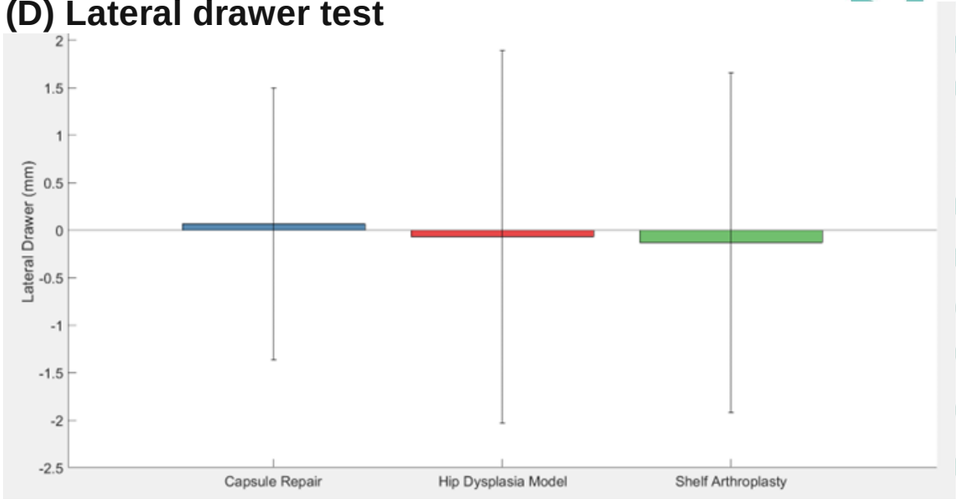
(B) Internal rotation (IR) test at 75° flexion



(C) Flexion test



(D) Lateral drawer test



Average change from native in each test.
Error bars represent 1 standard deviation.
*: Significant from native,
#: Significant from acetabular dysplasia model,
^: Significant from Capsule Repair

Summary of Results

✓ **Capsule repair:**
No significant differences compared to native in any test.

✓ **Hip dysplasia:**
Increased abduction (+2.3°, p=0.003) and IR at 75°flexion (+0.9°, p=0.017) compared to native.

✓ **Shelf acetabuloplasty:**
Restored native abduction and IR at 75° flexion but reduced hip flexion (-1.7°, p=0.003).

Discussion

Our study

Shelf acetabuloplasty restored hip stability in terms of abduction and internal rotation to a level similar to that of native hips.

Fu et al. performed a cadaveric study and demonstrated that Shelf acetabuloplasty was effective in relieving hip joint stress compared to the DDH model.

Fu et al., 2014

Shelf acetabuloplasty may be an effective procedure both for reducing hip joint stress and enhancing stability.

Discussion

Our study

The flexion angle was significantly decreased from the native by shelf acetabuloplasty, suggesting the occurrence of anterior impingement.

- ✓ Impingement would occur if the shelf bone graft is too low or too large.

  Summers et al., 1988

- ✓ Shelf bone graft resorption would occur if the graft was placed >6mm above the joint space.

  Ramdhan et al., 2020

Future research to investigate the optimal shelf graft position is warranted.

Conclusion

Shelf acetabuloplasty restored hip stability in terms of abduction and internal rotation to a level similar to that of native hips.

References

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