ISAKOS CONGRESS 2023

Boston Massachusetts June 18–June 21

Utility of Talus Osteochondral Allograft Augmentation for Varying Size of Hill-Sachs Lesion: A Cadaveric Study

Phob Ganokroj, MD[1,2], Alexander Garcia, BS[1], Justin Hollenbeck, MSc[1], Bradley W. Fossum BS[1], Annalise M. Peebles, BA[1], Ryan J. Whalen, BS, CSCS[1], Peter S. Chang, MD[3], CAPT Matthew T. Provencher, MD, MBA, MC, USNR (ret.)[1,3]

[1] The Steadman Philippon Research Institute, Vail, CO, [2] Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

[3] The Steadman Clinic, Vail, CO

THE STEADMAN CLINIC AND STEADMAN PHILIPPON RESEARCH INSTITUTE

U.S. OLYMPIC & PARALYMPIC NATIONAL MEDICAL CENTER

ISAKOS CONGRESS 2023

Boston
Massachusetts
June 18–June 21

Disclosures:

Presenter: Phob Ganokroj, MD reported nothing to disclose

Co-author:

- Alexander Garcia, BS reported nothing to disclose
- Justin Hollenbeck, MSc reported nothing to disclose
- Bradley W. Fossum BS, reported nothing to disclose
- Annalise M. Peebles, BA, reported nothing to disclose
- Ryan J. Whalen, BS, CSCS, reported nothing to disclose
- Peter S. Chang, MD, reported nothing to disclose

Matthew T Provencher, MD, MBA, FAAOS have something to disclose: Submitted on: 08/25/2022

AAOS: Board or committee member; American Orthopaedic Society for Sports Medicine: Board or committee member; American Shoulder and Elbow Surgeons: Board or committee member; Arthrex, Inc: IP royalties; Paid consultant; Arthroscopy: Editorial or governing board; Arthroscopy Association of North America: Board or committee member; Arthrosurface: IP royalties; Elsevier, Inc.: Publishing royalties, financial or material support; International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine: Board or committee memberJoint Restoration Foundation (Allosource): Paid consultant; Knee: Editorial or governing board Orthopedics: Editorial or governing board; San Diego Shoulder Institute: Board or committee member; SLACK Incorporated: Editorial or governing board; Publishing royalties, financial or material support Society of Military Orthopaedic Surgeons: Board or committee member

Background

- **Engaging Hill-Sachs lesions (HSLs),** a significant risk for failure of surgical repair of recurrent anterior shoulder instability.
- **Humeral head reconstruction** of the HSL with **fresh osteochondral allograft (OCA)** has been proposed as a treatment for large HSLs.
- Talus OCA, a promising graft source due to its high congruency with a dense cartilaginous surface
- **Single or multiple OCA plugs** were introduced for filling the large defect instead of a large graft cut → technically easier and for arthroscopic purposes.
- Limited study on utility of talus OCA for varying size of HSLs

Objective/Hypothesis

- This study aims **to study the surface geometry of talus OCA plug augmentation for the management of anterior shoulder instability with varying sizes of HSL** with the hopes of arthroscopic adaptation of this technique.
- We hypothesize that **talus OCA augmentation with single or multiple OCA talus plugs can restore the bone curvature and surface area** of the shoulder relative to the native state.

Methods

- Seven fresh-frozen cadaveric shoulders
- A **repeated-measures experimental** design
- A three-dimensional plastic model was created by *the actual patients' CT-scan with the varying size of HSL as small-, medium- and large HSL*
- Three plastic resin HSLs (small, medium, and large) were created with the 3D printer (Ultimaker3, Ultimaker, Utrecht, NL) and converted to the cadaveric model

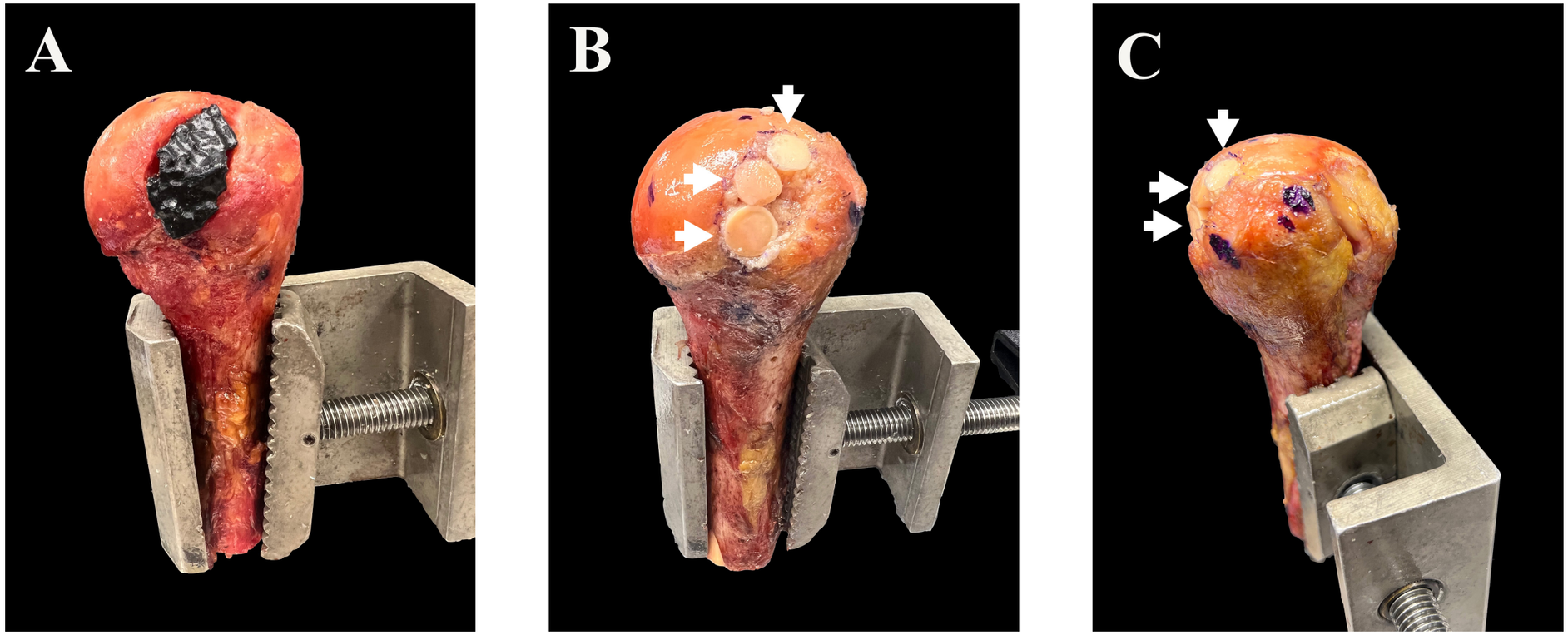
Right humerus cadaver and a 3D plastic mold model. The HSL defect **(small HSL)** will be created using a combination of an oscillating saw, bur, and rasp to achieve the precise defect size and shape

Methods

- **Single surgeon** created the HSL with the help of **plastic mold** to precisely reproduce the *corresponding size, location, and volume*
- Next, the talus OCA augmentation was performed by harvesting the talus allograft using the OAT system with the sizes *varying from 8, 10 and 12-mm diameter*
- OCA plug was filled in the **most medial and superior aspect of the HSL** starting from small, medium- and large-HSLs

Right humerus cadaver demonstrated the AP view of the humerus after **talus OCA bone plugs** (arrowheads) for filling **the HSL bone defect (medium-HSL)**

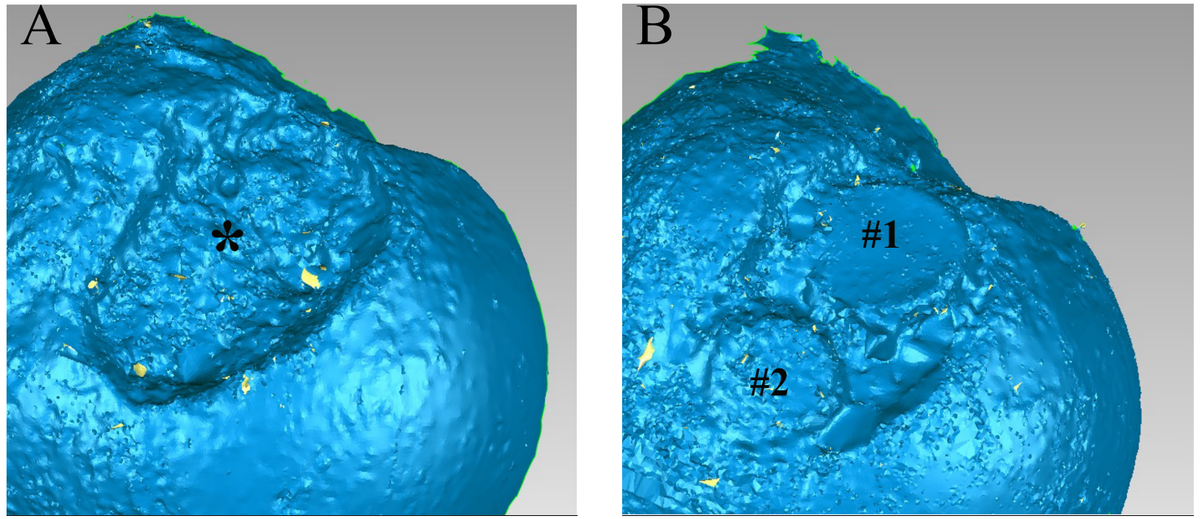
Methods



The right humerus cadaver demonstrated A) **the large HSL defect** was created with the guidance from the **three-dimensional plastic mold**; the anteroposterior view (B) and lateral view (C) of the humerus after **talus OCA bone plugs (arrowheads)** for filling the HSL bone defect.

Methods: Surface Analysis

- **Surface laser scan** analysis was performed.
- **Surface congruency** was calculated as the average absolute error and root mean squared error in the distance.
- A one-way repeated measures ANOVA was performed to evaluate the effects of the difference in HSL size and associated talus OCA

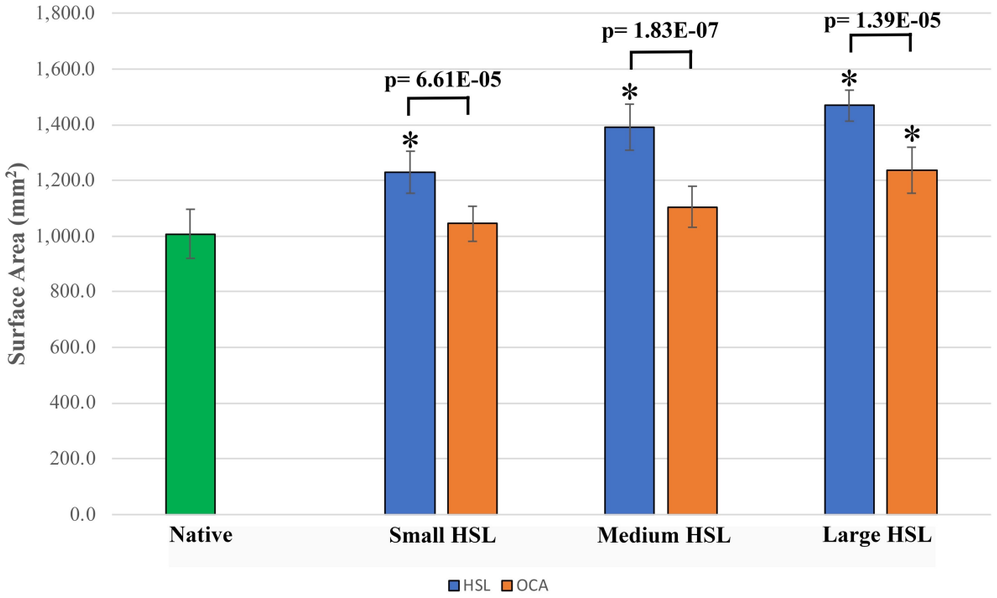


The surface analysis of the laser scan data and processed using a custom MATLAB showed

A) the HSL defect (*) and B) **an improvement in surface area and congruence after** the talus OCA augmentation with bone plug (#1 and #2)

Results

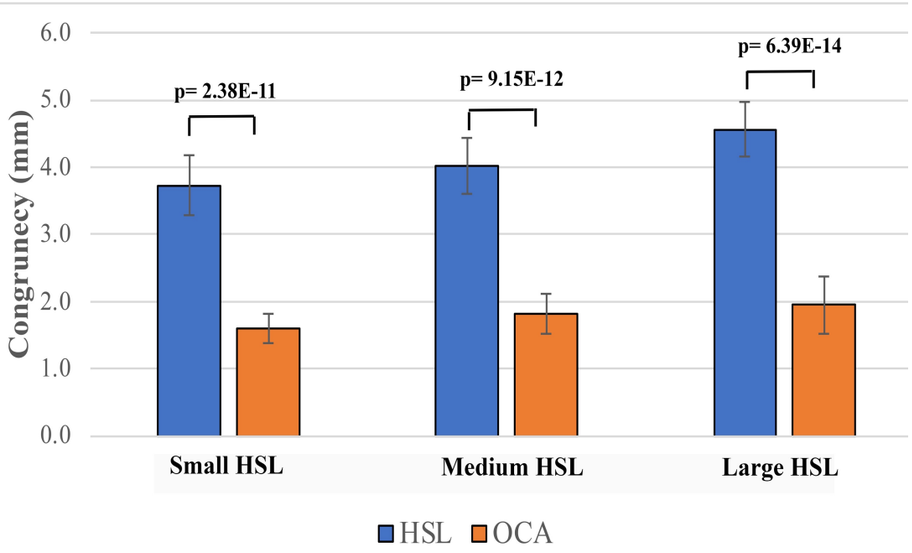
Testing states	SA (mm^2) (Mean ± SD)	SA post-OCA (mm2) (Mean ± SD)	[a]P
Native	1,007 ± 88	-	-
Small HSL	1,230 ± 54*	1,044 ± 82	<0.001
Medium HSL	1,391 ± 81*	1,104 ± 73	<0.001
Large HSL	1,469 ± 75*	1,235 ± 63*	<0.001



- **Surface area (SA) analysis** of the humeral head with the large- (1,469 ± 75 mm^2), medium- (1,391 ± 81 mm^2), and small- (1,230 ± 54 mm^2) HSLs exhibited significantly higher SA than the native state (1,007 ± 88 mm^2 with $p < 0.001$ for all sizes).
- However, there was **no significant difference** in SA between the native state and after talus augmentation **for small** (1044 ± 82 mm^2) and **medium HSLs** (1104 ± 73 mm^2) with p=0.965 and p=0.212, respectively

Results

Testing states	Congruency (mm) (Mean ± SD)	Post-OCA (Mean ± SD)	[b]P
Small HSL	3.73 ± 0.41	1.60 ± 0.42	<0.001
Medium HSL	4.02 ± 0.41	1.82 ± 0.31	<0.001
Large HSL	4.57 ± 0.45	1.95 ± 0.23	<0.001



Talus OCA augmentation yielded improved congruency across small- (3.73 ± 0.41 mm to 1.60 ± 0.42 mm), medium (4.02 ± 0.41 mm to 1.82 ± 0.31 mm), and large-size (4.57 ± 0.45 mm to 1.95 ± 0.23 mm) of HSLs with $p < 0.001$ for all sizes.

Discussion

- **Utility of the talus OCA bone plugs** to fill small, medium, and large HSLs restored humeral head surface area and congruency across all tested models.
- Talus OCA provided ***limited benefit*** in restoring surface area for **large-size HSL**; however, can re-create the humeral head congruency to a near-normal state.
- This study use 3D model from **the young male patients**, the results cannot be fully generalized to the general population.
- Finally, this study presented the data in **time zero**. Additional in vivo studies may be beneficial to understand the effect of Talus OCA, such ***as graft healing, resorption, clinical outcomes, and risk of recurrent instability*** after this procedure.

Conclusion

- **Talus OCA plug** augmentation **restored surface area and congruency** across all tested HSLs in this cadaveric model, and the surface area was best improved with **the most common HSLs** – *small and medium.*
- **Talus OCA plug** provides a viable option for restoring congruity of the shoulder in patients with recurrent anterior glenohumeral instability and an HSL.
- Additional work is necessary to assess the **overall mechanics and healing in vivo.**

Reference

1. Cetik O, Uslu M, Ozsar BK. The relationship between Hill-Sachs lesion and recurrent anterior shoulder dislocation. *Acta Orthop Belg.* 2007;73(2):175-178.

2. Chan CM, LeVasseur MR, Lerner AL, Maloney MD, Voloshin I. Computer Modeling Analysis of the Talar Dome as a Graft for the Humeral Head. *Arthroscopy.* 2016;32(8):1671-1675.

3. Fox JA, Sanchez A, Zajac TJ, Provencher MT. Understanding the Hill-Sachs Lesion in Its Role in Patients with Recurrent Anterior Shoulder Instability. *Curr Rev Musculoskelet Med.* 2017;10(4):469-479.

4. Golijanin P, Peebles L, Arner JW, et al. Advanced 3-Dimensional Characterization of Hill-Sachs Lesions in 100 Anterior Shoulder Instability Patients. *Arthroscopy* 2021;37(11):3255-3261.

5. Griswold BG, Pare DW, Herzwurm ZP, et al. Utility of Allograft Talus as a Source for Grafting of Concurrent Humeral and Glenoid Defects Associated With Anterior Glenohumeral Instability: An Anthropometric Analysis. *Arthroscopy.* 2021;37(3):845-851.

6. Provencher MT, Ferrari MB, Sanchez G, et al. Current Treatment Options for Glenohumeral Instability and Bone Loss: A Critical Analysis Review. *JBJS Rev.* 2017;5(7):e6.

7. Provencher MT, Midtgaard KS, Owens BD, Tokish JM. Diagnosis and Management of Traumatic Anterior Shoulder Instability. *J Am Acad Orthop Surg.* 2021;29(2):e51-e61

8. Provencher MT, Sanchez G, Schantz K, et al. Anatomic Humeral Head Reconstruction With Fresh Osteochondral Talus Allograft for Recurrent Glenohumeral Instability With Reverse Hill-Sachs Lesion. *Arthrosc Tech.* 2017;6(1):e255-e261.

9. Saltzman BM, Riboh JC, Cole BJ, Yanke AB. Humeral Head Reconstruction With Osteochondral Allograft Transplantation. *Arthroscopy.* 2015;31(9):1827-1834.

10. Snir N, Wolfson TS, Hamula MJ, Gyftopoulos S, Meislin RJ. Arthroscopic anatomic humeral head reconstruction with osteochondral allograft transplantation for large hill-sachs lesions. *Arthrosc Tech.* 2013;2(3):e289-293.

11. Zhuo H, Xu Y, Zhu F, Pan L, Li J. Osteochondral allograft transplantation for large Hill-Sachs lesions: a retrospective case series with a minimum 2-year follow-up. *Journal of orthopaedic surgery and research.* 2019;14(1):344.