

Humeral Head Autograft Compaction for Glenoid Preparation in Anatomic Total Shoulder Arthroplasty. A Technical Note from the LaTour Study Group

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This technical note describes a surgical method for enhancing glenoid component fixation in anatomic total shoulder arthroplasty (TSA) by employing autograft from the humeral head. The technique emphasizes cancellous compaction without extensive reaming, optimizing bone preservation and providing structural stability. Clinical implementation of this method has demonstrated promising outcomes with reduced radiolucent line progression and durable glenoid fixation. This report outlines the procedural steps, potential challenges, and advantages of this bone-conserving approach. This reproducible autograft compaction method may enhance glenoid fixation and implant stability in TSA.

Keywords: Glenoid reconstruction, Loosening, Complication, Graft harvesting.

<https://doi.org/10.70885/hmsj.2025.07.001>

Introduction

Achieving stable fixation of the glenoid component in anatomic total shoulder arthroplasty (TSA) remains challenging, particularly given concerns over long-term loosening associated with bone-cement interfaces. The glenoid component is widely regarded as the weak link in TSA due to the high incidence of loosening over time [1]. Evans et al., in a long-term imaging study, reported that no glenoid component implants remained radiographically intact beyond 20 years postoperatively, as all glenoid components showed evidence of loosening at this time [2]. However, the clinical significance of these findings can vary, and not all components require revision. This stark reality underscores the need for innovative techniques that address this vulnerability, ensuring greater durability and reducing the risk of revision surgery.

Preservation of subchondral bone and the use of cancellous compaction techniques have been highlighted as key factors in mitigating loosening risks. Dominique Gazielly introduced a surgical approach utilizing cancellous compaction with

autografts harvested from the humeral head, offering enhanced fixation and reduced cement reliance [3]. This technique incorporates minimal reaming to preserve bone stock, followed by the compaction of humeral head grafts into the keel slot [3]. By prioritizing the glenoid component's stability, this method addresses the core mechanical challenge of TSA longevity.

Several techniques have been previously described to optimize glenoid fixation, including those incorporating autologous grafts and bone-preserving strategies. In particular, the foundational work by Dominique Gazielly has laid the groundwork for the cancellous compaction method [3]. This manuscript builds upon those concepts and aims to serve as a practical, step-by-step guide for surgeons. As such, it complements prior research by providing a detailed procedural reference and visual educational resource tailored for both trainees and practicing surgeons seeking to implement this technique.

Surgical Technique

Surgical Indication

The indications for this approach are broad but must be carefully considered (**Table 1**). Surgical pearls and pitfalls, advantages and disadvantages are presented in **Tables 2 and 3**, respectively. Patients with adequate bone stock in the glenoid (greater than 90% backside contact and no penetration through the glenoid vault) [4]—such as those with

Walch A1 or A2 classifications—stand to benefit the most. Conversely, cases involving severe bone loss or complex deformities may necessitate alternative strategies, such as glenoid implant with a wedge to restore version, structural autografts or allograft placed in the defect or reverse TSA using augmented baseplates or bone grafts.

Table 1. Possible indications and contraindications for Glenoid Preparation with Humeral Head Autograft

Indication	Contraindication
Symptomatic primary or secondary osteoarthritis with minimal glenoid deformity (Walch A1, A2 and B1)	Severe glenoid bone loss (Walch B2, B3, C or type D)
	Massive, irreparable rotator cuff tears or fatty muscle degeneration
	Revision surgery with previous humeral component

Table 2. Surgical pearls and pitfalls for Glenoid Preparation with Humeral Head Autograft

Pearls	Pitfalls
Ream the glenoid carefully to preserve subchondral bone integrity	Excessive glenoid reaming can increase the risk of component loosening /subsidence
Humeral head provides local source of cancellous bone	Poor bone quality in osteoporotic patients may yield graft inadequate volume or quality
Introduce morselized bone graft into the keel slot and impact, doing this 3-4 times	Inadequate impaction of the graft can lead to micromotion at the bone-implant interface
Use minimal cement only at the keel, impact the cement two to three times to ensure proper interdigitation, avoiding impaction on the final cement placement	Avoid complete cementation of the glenoid component

Table 3. Advantages and disadvantages of Glenoid Preparation with Humeral Head Autograft

Advantages	Disadvantages
Preserve the native glenoid bone stock	May be insufficient in patients with significant glenoid erosion or deformity
Local source of cancellous bone and avoids the morbidity of additional graft harvest sites	Quantity and quality of cancellous bone may vary depending on patient age and bone health
No donor-site morbidity	Incomplete graft compaction or improper technique may result in micromotion and instability
Decrease the risk of thermal necrosis and cement induced loosening	Bone graft alone may not provide adequate primary mechanical stability without supplemental fixation
May improve load distribution and peak stresses at the bone implant interface	

Preoperative Planning

Preoperative evaluation begins with advanced imaging, including anteroposterior radiographs (**Figure 1**) and computed tomography (**Figure 2**), to assess glenoid morphology and determine the suitability of the compaction technique. Three-dimensional (3D) preoperative planning software is routinely used to enhance the accuracy of glenoid assessment, allowing for precise evaluation of version, inclination, and bone volume (**Figure 3**). This approach is most appropriate for patients with Walch A1 or A2 glenoids, which offer sufficient bone stock for autograft compaction. For severe bone loss, as seen in Walch C or B2 types, alternative reconstruction techniques may be necessary.

Patient Positioning and Anesthesia

Patients are positioned in the beach-chair configuration under general anesthesia, supplemented with an interscalene block to optimize postoperative pain control.

Approach and Exposure

The procedure begins with a standard deltopectoral approach, providing excellent exposure to the glenohumeral joint. Preservation of surrounding neurovascular structures, including the anterior circumflex vessels, is critical during soft tissue dissection. The humeral head is resected and carefully set aside for subsequent autograft harvesting (**Figure 4A**).

Glenoid Preparation

Minimal Reaming

To preserve subchondral bone integrity, reaming is restricted to removing the articular cartilage without excessive removal of underlying bone (**Figure 5**). A cannulated, size-matched reamer corresponding to the preselected glenoid guide is placed over a centrally positioned guide pin. Reaming is performed manually or with power assistance under direct visualization, using low rotational speed and minimal pressure to avoid excessive bone removal. No custom jigs are required beyond the standard guide provided in the instrumentation set.

Cartilage removal is verified both visually and tactilely, using a probe or curette to ensure no residual soft cartilage remains. Special care is taken to avoid penetrating into cancellous bone, maintaining the subchondral plate to support subsequent autograft compaction. A convex-backed polyethylene glenoid component is typically chosen to ensure optimal congruence with the native anatomy.

Autograft Harvesting

Around 10-20 cc of cancellous bone is harvested from the resected humeral head using Stille Luer rongeur and curettes, ensuring an adequate volume of graft material (**Figure 4B**). The bone chips are manually prepared to achieve consistent particle size, promoting uniform compaction during grafting (**Video 1**).

A keel slot or peg holes are created using precision instruments, such as a punch or reamer, matched to the dimensions of the selected glenoid component (**Figure 6**). The prepared cancellous autograft is then densely packed into the keel slot or peg holes and compacted using the standard pegged glenoid punch, which serves as a tamper to uniformly distribute the graft. Compaction adequacy is assessed by both tactile feedback—specifically, increasing resistance during impaction—and visual confirmation that the slot is fully filled without voids, ensuring optimal load distribution and mechanical support (**Figure 7A–7C, Video 1**). This procedure is repeated until the entire humeral head has been grafted. Finally, the glenoid component is implanted, with a minimal amount of cement applied to the peg region to ensure stable fixation without compromising bone viability (**Figure 8A and 8B**). Similarly, the cement is pressurized manually two to three times using the pegged glenoid punch to ensure optimal interdigitation with the cancellous bone, avoiding impaction on the final cement placement.

Prosthesis Implantation

The humeral and glenoid components are inserted according to the manufacturer's guidelines, ensuring compatibility with the compacted autograft. Intraoperative imaging may be used to confirm proper alignment and fixation.

Following the preparation and placement of the glenoid component, attention is turned to the subscapularis tendon. Our preferred method involves repairing the tendon with side-to-side sutures using non-absorbable material [5]. When the long head of the biceps tendon (LHB) is still present, additional strength is provided by utilizing a pediculated LHBT autograft for augmentation [6]. The LHBT is first tenodesed to the upper border of the pectoralis major. Its proximal segment is then released while remaining in its bicipital groove to ensure vascularity. The LHBT is positioned at the rotator interval and sutured to the subscapularis with non-absorbable sutures, effectively reinforcing the repair. This approach enhances both the mechanical strength and biological environment of the repair, promoting optimal healing [6].

Closure and Postoperative Care

The surgical site is closed in layers, ensuring adequate soft tissue coverage. Postoperative management includes immobilization with a sling for four weeks [7], this is followed by a gradual recovery of the range of motion, initially through passive exercises progressing to active movements over the following six months. Strengthening exercises are initiated thereafter, as tolerated [8].

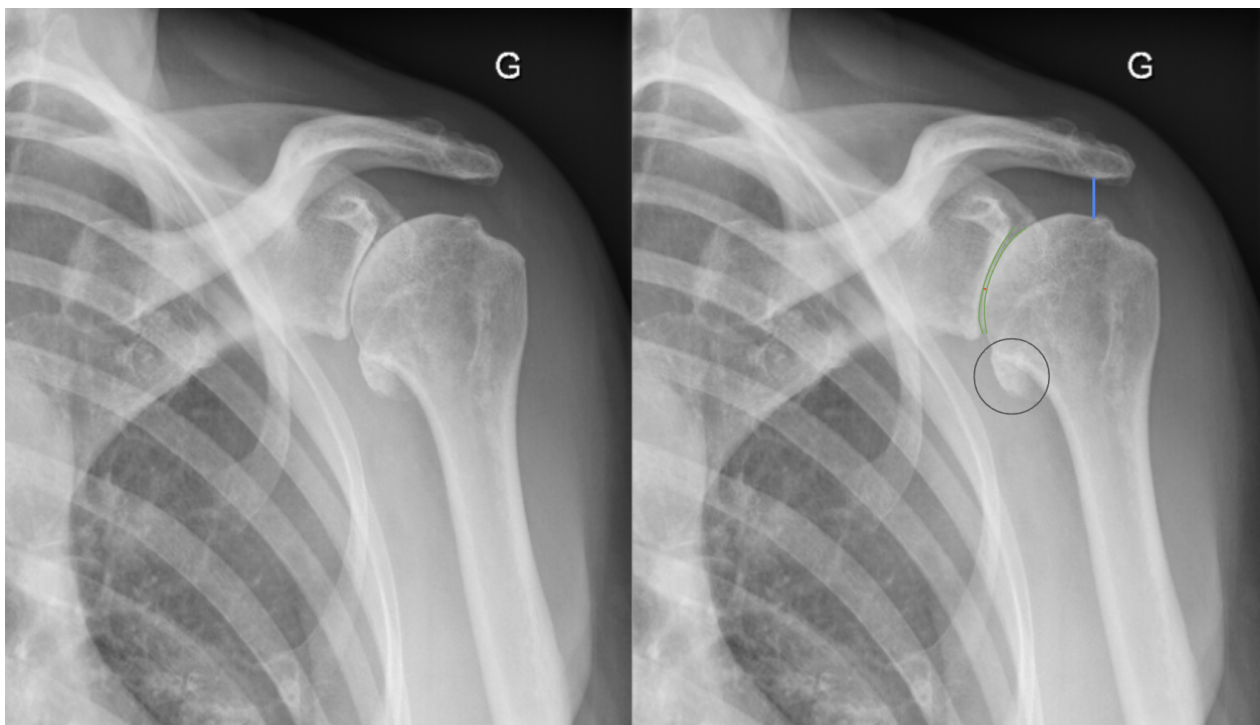


Figure 1. Preoperative true anteroposterior (AP) radiograph of the left shoulder demonstrating advanced glenohumeral osteoarthritis (significant joint space narrowing [red line], subchondral sclerosis [green curved lines], and osteophyte formation [black circle]), there is no radiographic evidence of rotator cuff arthropathy (superior migration of the humeral head [blue line]).



Figure 2. Axial CT scan of the left shoulder demonstrating a Walch type A1 glenoid, characterized by a centered humeral head with minor concentric erosion of the glenoid surface.

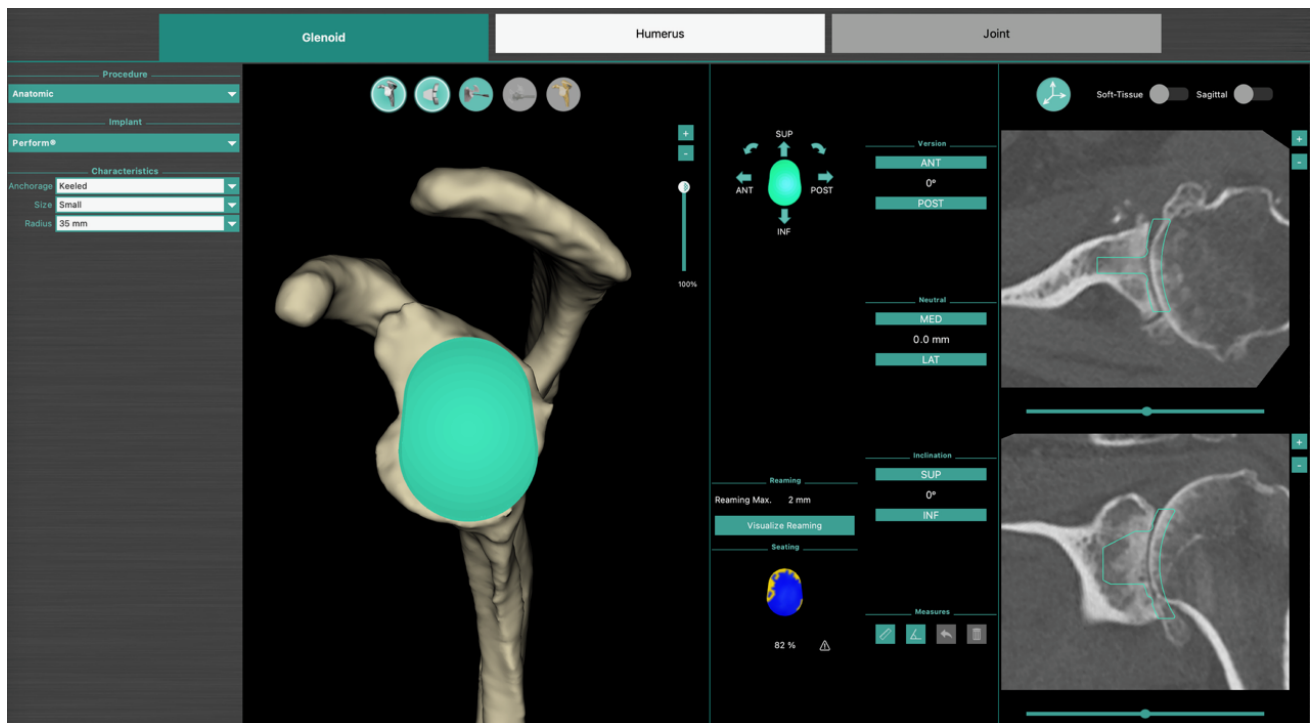


Figure 3. Preoperative planning of the glenoid component in an anatomic TSA. The software allows for assessment of glenoid morphology, optimal component positioning, reaming depth, and seating percentage. In this case, a keeled small glenoid implant with a 35 mm radius was selected, with neutral version and inclination.

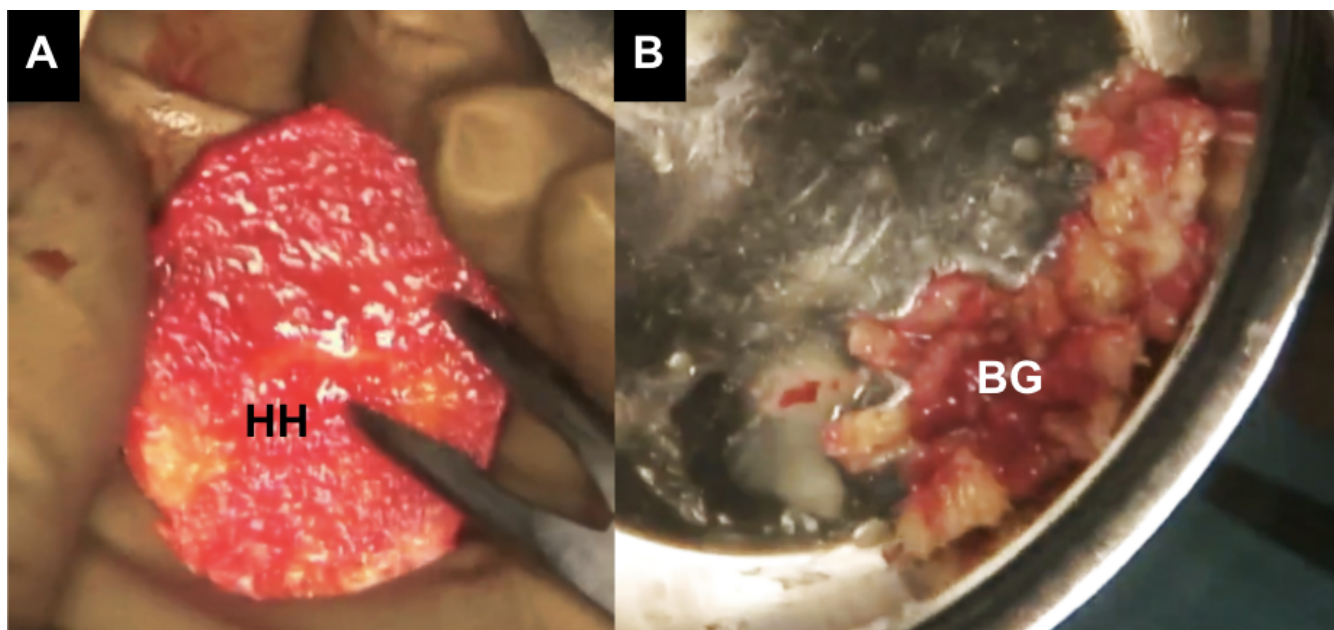


Figure 4. Harvest and preparation of autologous cancellous bone graft from the humeral head. A) Humeral head (HH) preparation. B) Cancellous bone graft (BG) has been fragmented and collected in a sterile container, ready for use.



Figure 5. A guide pin (white asterisk) is centrally positioned at the midpoint of the glenoid articular surface to ensure proper alignment of the glenoid component. A cannulated reamer is then introduced over the guide pin to ream the glenoid surface. This step involves the removal of residual cartilage and only the minimal amount of subchondral bone (white arrow) necessary to achieve a congruent surface that matches the geometry of the final all-polyethylene glenoid implant.

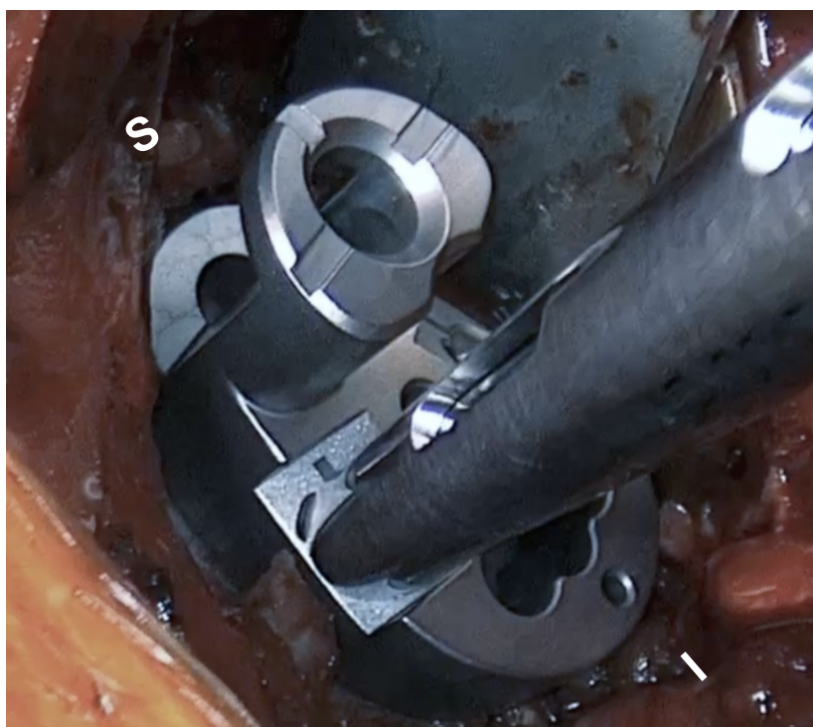


Figure 6. Pegged glenoid drill guide for glenoid reaming superior (S) and inferior (I) holes.

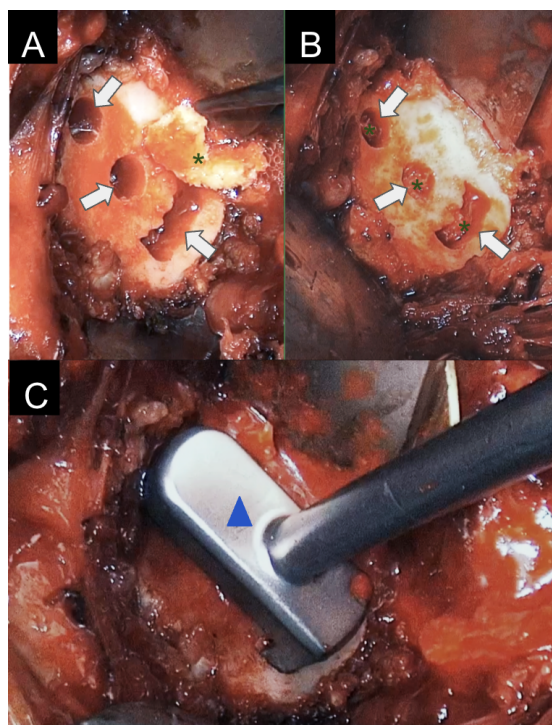


Figure 7. Intraoperative images showing autograft impaction into the peg holes of the glenoid. These sequential images illustrate the compaction of cancellous autograft. A and B) the surgeon is shown introducing morselized bone graft (green asterisks) into the peg holes (white arrows). C) The bone graft is densely compacted into the slot with a pegged glenoid punch (blue triangle).

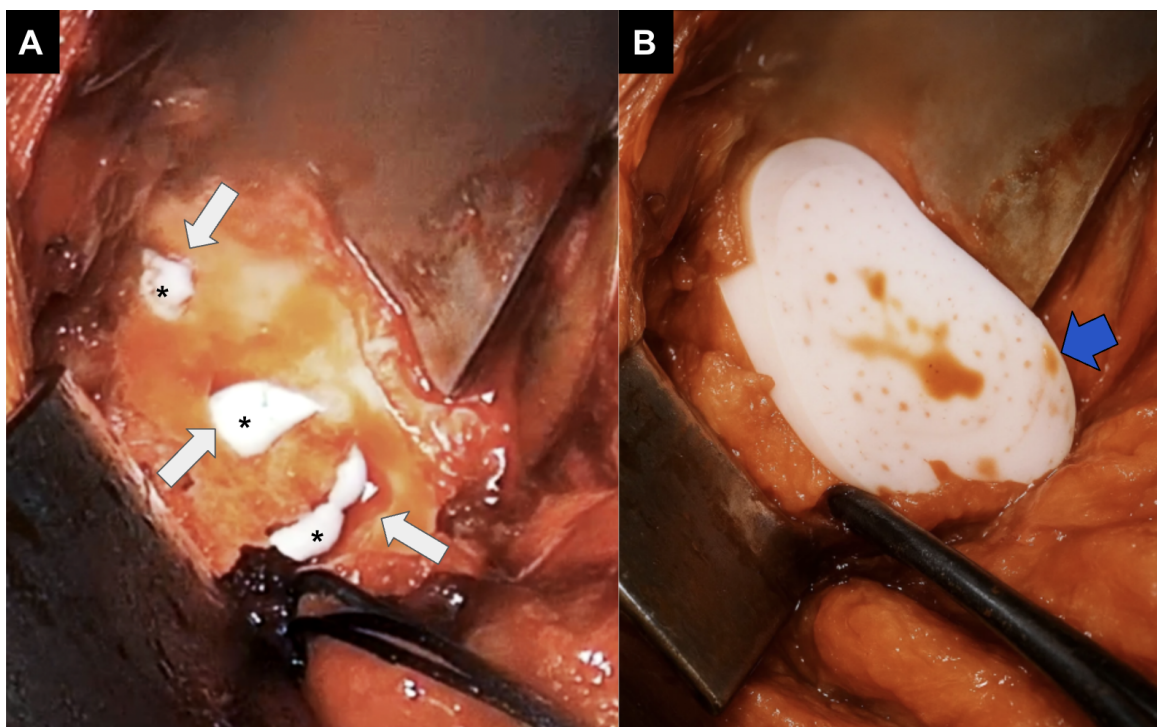


Figure 8. Final cementation and implantation of the all-polyethylene glenoid component in anatomic TSA. A) Application of low-viscosity bone cement (black asterisks) into the peg holes (white arrows) and along the prepared glenoid surface. The cement is selectively placed to augment fixation while minimizing excess volume, particularly in the presence of impacted autograft. B) Definitive seating of all-polyethylene glenoid component (blue arrow).

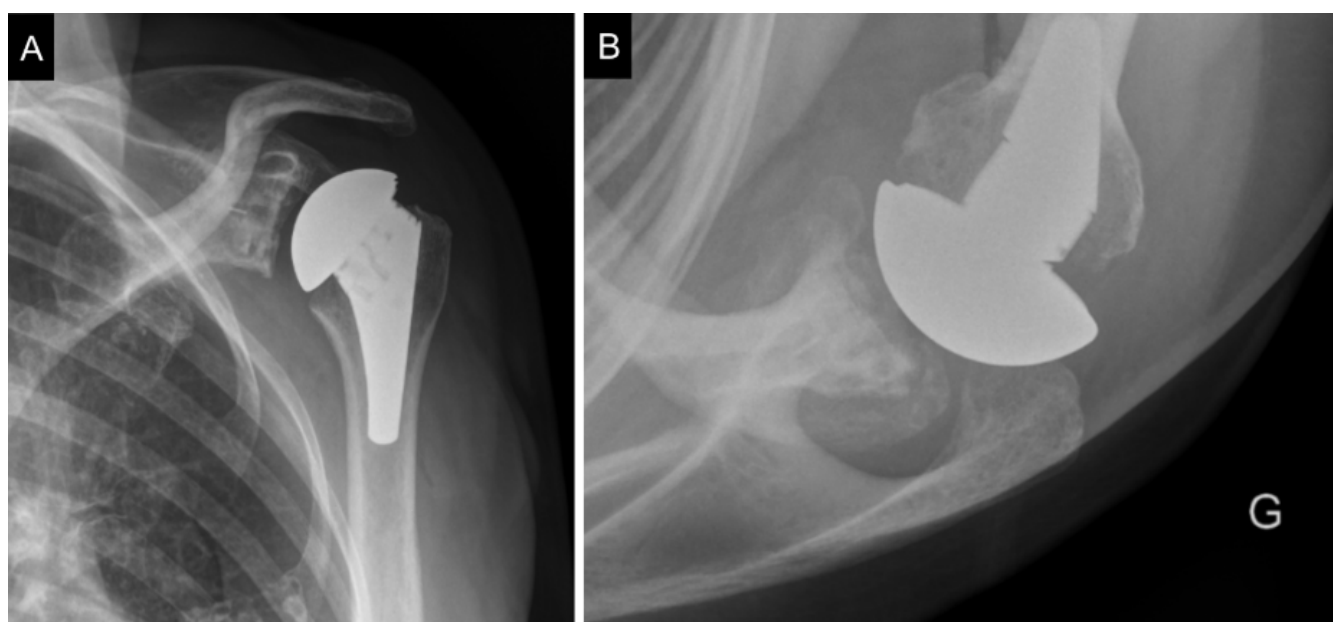


Figure 9. Postoperative radiographic following evaluation of anatomic TSA using autograft compaction technique. A) True anteroposterior radiograph demonstrating well-positioned TSA components. The humeral stem is appropriately aligned within the medullary canal, and the convex-backed polyethylene glenoid component is seated flush against the native glenoid. No evidence of radiolucent lines or component loosening is observed. B) Axillary radiograph confirming concentric reduction of the humeral head relative to the glenoid component. Proper version and orientation of the glenoid implant are maintained, and no signs of posterior subluxation or malposition are evident.

Discussion

The use of humeral head bone for grafting the humerus during total shoulder arthroplasty (TSA) remains a common practice among surgeons. However, given that the humeral

component is rarely the primary source of failure in TSA, redirecting this autograft to support glenoid fixation may represent a more strategic use of this biologically valuable material. This approach aims to address one of the most persistent challenges in TSA: glenoid component loosening.

The cancellous compaction technique represents a sophisticated approach to addressing the challenges of glenoid fixation in TSA. By prioritizing bone preservation and structural stability, this method provides a compelling alternative to traditional cemented fixation techniques [3]. One of its key advantages lies in the use of autograft material harvested from the humeral head, which is typically discarded during the procedure. This approach not only minimizes waste but also harnesses the biological potential of the patient's own cancellous bone, which is inherently suited for integration and load-bearing.

The meticulous process of compaction ensures that the graft material is evenly distributed within the keel slot, creating a robust scaffold for the glenoid component. This technique avoids the extensive use of cement, which has been associated with long-term complications such as radiolucent line formation and subsequent component loosening. By relying on autograft compaction, the technique mitigates these risks while simultaneously preserving the subchondral bone, a critical factor for implant longevity.

Another key advantage of the cancellous autograft technique is its contribution to achieving a dense and uniform bony interface during the cementing phase [3]. The presence of compacted autograft provides an extremely hard substrate that prevents posterior diffusion of the cement and instead promotes its lateral spread around the pegs. This theoretically enhances the fixation of the glenoid component by improving the mechanical interlock of the cement around the pegs, thereby contributing to greater stability and durability of the construct.

Clinically, the outcomes associated with this technique have been promising. Studies report reduced progression of radiolucent lines and improved implant stability over time. Additionally, the method's simplicity and cost-effectiveness make it a practical choice for a wide range of surgical settings [1][3]. However, successful implementation requires meticulous surgical technique, particularly in preparing and compacting the autograft material. Any inconsistencies in these steps could compromise the structural integrity of the reconstruction.

Glenoid component loosening remains one of the most significant challenges in TSA, directly influencing implant longevity and long-term clinical outcomes. A multicenter analysis by Walch et al. conducted a radiographic assessment in 518 TSAs and reported a 32% rate of definitive

glenoid loosening after more than five years of follow-up. They identified three primary patterns of glenoid migration: superior tilt, subsidence, and posterior tilt, which were associated with technical factors such as excessive reaming and loss of subchondral bone support [1]. Their findings highlight the biomechanical significance of preserving subchondral bone in resisting compressive and eccentric forces that contribute to implant loosening. In contrast, a prospective study by Gazielly et al. documented favorable clinical outcomes using cancellous bone graft from the humeral head for glenoid preparation, with a markedly lower incidence of definitive radiographic loosening (15.5%) and a low revision rate of only 2.5% after an average follow-up of 8.5 years [3]. This approach, which emphasizes minimal reaming, preservation of subchondral bone, and limited use of cement, was associated with a limited progression of radiolucent lines and sustained functional improvement in most patients. The compaction technique appears to offer a more physiologic implant-bone interface, potentially enhancing long-term fixation. These studies underscore the critical role of subchondral bone preservation in maintaining glenoid component stability. They emphasize that even within the context of cemented implants, the technical details of glenoid preparation may significantly influence the long-term success of TSA.

Conclusion

The cancellous compaction technique offers a reproducible, low-cost, and biologically favorable approach to glenoid fixation in TSA. By preserving subchondral bone, using autologous grafts from the humeral head, and limiting cement use, this method enhances implant stability and aligns with modern bone-preserving strategies. It addresses glenoid loosening effectively, improving both short- and long-term outcomes.

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Source of funding

None.

Conflict of interest

Alexandre Lädermann is a paid consultant for Arthrex, Stryker, and Medacta. He received royalties from Stryker and

Medacta. He is the (co-)founder of FORE, Med4Cast, and BeeMed. He owns stock options in Follow Health. He is on the board of the French Arthroscopic Society. Alberto Guevara-Álvarez is a paid consultant for Arthrex. All other authors (G.V.V and G.L.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Philippe Collin receives royalties from and is a consultant and paid speaker for Stryker and Enovis. He is the co-founder of Med4Cast and Follow. He is on the board of SECEC and IBSES.

Acknowledgments

We are grateful to Dr. Dominique Gazielly for having introduced us to this refined and elegant surgical technique. We also would like to thank the Leading Advancements in Therapeutic and Outcome-based Research (LaTour) study group for their help.

Movie Legend

Movie 1. Surgical technique: Compaction of Autograft from Humeral Head for Glenoid Preparation in TSA

Video 1 provides an overview of the described surgical technique. The procedure begins with a standard deltopectoral approach. Identify the cephalic vein and mobilize laterally. The deltopectoral interval is identified and bluntly dissected. Identified the long head of the biceps and suture in the groove to the upper border of the pectoralis major. Subscapularis tendon is referred with a suture and then cutted in the medial side to expose the articular surface. The humeral head is exposed, resected and carefully set aside for subsequent autograft harvesting. Now preparation for the insertion of the humeral stem is carried out. A resection protector device is placed into the proximal humerus. Complete exposure of the glenoid articular surface is essential for precise implant placement. Remove labrum tissue and osteophytes. Assemble the glenoid guide handle that best matches the glenoid surface area. Place the pin through the glenoid vault until it reaches the medial cortical bone. Slide the cannulated reamer over the guide pin and carefully ream the glenoid surface. With the guide pin in place, a 6 mm cannulated drill is used to prepare the central peg hole. Place the reamer connect adapter guide into position by engaging the peg into the previously drilled central peg hole and drill the superior and inferior holes. A pegged glenoid punch is used to prepare the peg holes in place of the glenoid broach. Advance the punch until the shoulder of the punch is flush with the bone surface. The prepared cancellous autograft of the humeral head is then densely compacted into the slot, filling any voids to enhance

load distribution and support, doing this procedure three to four times. Insert the glenoid trial with the glenoid trial forceps. Verify the trial is fully seated to ensure proper fit. Using a syringe, inject low-viscosity cement into the keel slot and the superior peg hole. Impact the cement two to three times to ensure proper interdigitation, avoiding impaction on the final cement placement. The glenoid vault implant can be inserted manually or with the forceps. Once the fluted central peg is seated, push and impact the implant firmly into the cemented glenoid vault. Maintain pressure until the cement has fully cured. Then the humeral stem and head trials are placed, use the trial driver and attach to the trial head to adjust offset. Reduce and verify glenohumeral stability. Remove the trials. A transosseous suture is passed through the lateral cortex for later use in the repair of the subscapularis tendon. Insert the final stem into the humeral canal, place the angled morse taper stem impactor over the morse taper and complete impaction. Place by hand the implant humeral head onto the humeral stem and perform reduction. Subscapularis tendon is repaired with side-to-side technique sutures using non-absorbable material.

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