E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.04

Research Article

Morphometric Analysis of Glenoid, Coracoid Process and Scapular Spine in a Tertiary Care Center- 3D CT Study

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Received: 25.11.24, Revised: 02.01.25, Accepted: 08.02.25

ABSTRACT
Background: Recurrent anterior shoulder instability with glenoid bone loss poses a significant challenge in orthopedic practice. Achieving favourable functional outcomes depends on selecting an appropriate graft type and ensuring its safe fixation on the glenoid. Despite the importance of morphometric data, there is a paucity of studies analyzing the dimensions of the glenoid, coracoid process, and scapular spine in a tertiary care Center.
Purpose: To evaluate the morphometric dimensions of the glenoid, coracoid process, and scapular spine in the Indian population, which can guide clinical decisions in managing recurrent anterior shoulder instability.
Methods: A total of 3D CT scans of 300 shoulders from 150 patients with non-orthopedic conditions were analyzed. Measurements included:
Glenoid: Mean height and width.
Coracoid process: Mean height, width, and length of harvestable coracoid.
Scapular spine: Mean width and length of harvestable segments.
Results: This study highlights important morphometric data on the glenoid, coracoid process, and scapular spine among the Indian population. The results have direct clinical relevance, especially in addressing recurrent anterior shoulder instability with glenoid bone loss. The key findings include:
Glenoid Dimensions: Mean height of 34.8 mm and mean width of 24.6 mm.
Coracoid Process Dimensions: Mean height of 8.2 mm and 9.3 mm, and mean width of 11.7 mm and 13.1 mm at fixation points. Harvestable coracoid length averaged 21.9 mm.
Scapular Spine Dimensions: Mean width of 8.2 mm and 7.7 mm at fixation points, and mean harvestable length of 30.4 mm.
Gender Differences: Statistically significant differences in measurements were observed between genders.
Conclusions: This morphometric evaluation can guide surgeons in selecting appropriate grafts and fixation techniques tailored to patient anatomy, potentially improving functional outcomes in cases of recurrent shoulder instability.

Keywords: Glenoid, Coracoid Process, Scapular Spine.

INTRODUCTION

Anterior inferior glenoid bone loss is frequently observed following shoulder dislocations, often going unrecognized and underestimated. Its prevalence reaches 22% in initial dislocations and escalates to 88% in recurrent cases, resulting in a reduction of the glenohumeral contact area and an inherently unstable joint. [1]

This bone loss in recurrent shoulder instability is a daunting surgical issue, classified into subcritical (10 to 15%, averaging 13.5%) and critical (historically 25%, now redefined to 15 to 20%, averaging 17.3%) categories. [2]

The bone block procedure stands as a pivotal treatment for critical glenoid bone loss, with autograft options including the coracoid process, scapular spine, iliac crest, and allografts such as the tibial plafond.

The Latarjet procedure, introduced by Michel Latarjet in 1954 and later detailed by Didier Patte in 1980 regarding its triple effect, utilizes the coracoid and remains a popular choice among surgeons for its effectiveness in varying dimensions. [3]

The iliac crest is often preferred for extensive glenoid coverage or in revision cases. Recent advancements have also identified the scapular spine graft as a feasible autograft, particularly for subcritical glenoid bone loss, showcasing promising early results. [4]

Given the complications associated with iliac crest harvest, such as postoperative pain, hematoma, and potential nerve damage, the scapular spine graft presents a less invasive alternative. This study evaluates the feasibility of various bone grafts for anterior glenoid reconstruction in the Indian population using 3D CT scans of patients with non-orthopedic conditions. [5]

MATERIAL AND METHODOLOGY

Study Setting and Population: Our study was conducted at Kodagu Institute of Medical Sciences, Madikeri Kodagu, assessing 300 shoulders from 150 patients who underwent a thoracic CT scan for non-orthopedic reasons, including COVID-19 infections and other chest-related issues, primarily from the South Indian population. The study spanned from August 2023 to January 2024.

Inclusion and Exclusion Criteria: Participants aged between 18 to 60 years who provided informed consent were included. We excluded individuals younger than 18 or older than 60, those with prior shoulder symptoms or surgeries, incomplete imaging of the coracoid or scapular spine, glenohumeral trauma, arthritis, or non-consent.

CT Scanning Protocol: Imaging was performed using a Siemens somato go 32-slice CT scanner. Scans covered from the upper thorax, with slice thickness ranging from 1 mm to 1.5 mm in helical mode and 1 mm -1.5 mm in axial mode.

Measurement Technique: The study utilized 3D reconstructed images, and measurements were taken with digital calipers by two independent assessors. All dimensions were recorded in millimeters, focusing on parameters clinically relevant to the Latarjet procedure.

Measured Parameters:

Glenoid Measurements:

1. **Glenoid Height:** Measured from the supraglenoid tubercle to the inferior glenoid rim.
2. **Mid-Glenoid Width:** The width at the midpoint of the glenoid height.
3. **Maximum Glenoid Width:** The width at the widest part of the glenoid.

Coracoid Measurements:

1. **Usable Coracoid Length:** From the coracoid tip to the concave base, measured along a perpendicular from a tangent drawn at the upper border in the sagittal plane.
2. **Coracoid Height at 5 mm:** Thickness at 5 mm from the tip in the sagittal section.
3. **Coracoid Height at 15 mm:** Thickness at 15 mm from the tip in the sagittal section.
4. **Coracoid Width at 5 mm:** Thickness at 5 mm from the tip in the coronal plane.
5. **Coracoid Width at 15 mm:** Thickness at 15 mm from the tip in the coronal plane.

Scapular Spine Measurements

1. **Scapular Length:** Length of harvestable scapular spine, measured from the medial point to a fixed point 49.7 mm from the medial end.
2. **Scapular Width at 15 mm:** Width 15 mm from the medial starting point.
3. **Scapular Width at 25 mm:** Width 25 mm from the medial starting point.
4. **Scapular Height at 15 mm:** Height from the junction of the spine and the infraspinous fossa, 15 mm from the notch.
5. **Scapular Height at 25 mm:** Height from the junction of the spine and the infraspinous fossa, 25 mm from the notch.
6. **Scapular Landmark:** Length from the posterior acromion process to one cm beyond the medial notch on the spine.

RESULTS:

Table 1: Descriptive statistics

Age Statistics	Standard Deviation	Minimum Age	Median Age	Maximum Age
43.98	11.71	18	45	60

Table 2: Important Measurements of Glenoid Fossa

Glenoid Fossa	Mean (mm)	Standard Deviation (mm)	Median (mm)
Height	34.6	2.9	34.8
Mid Width	22.6	2.6	22.6
Maximum Width	24.5	2.6	24.6

E-ISSN 2250-0944
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This table presents the measurements of the Glenoid Fossa from the study participants. The mean height of the Glenoid Fossa was recorded at 34.6 mm, with a mid-width of 22.6 mm and a maximum width of 24.5 mm. These dimensions are critical for understanding the structural integrity and sizing for potential surgical interventions such as grafts in shoulder instability treatments.

Table 3: Important Measurements of Coracoid Process

Coracoid Process	Mean (mm)	Standard Deviation (mm)	Median (mm)
Length	21.9	2.8	21.8
Height at 5 mm from tip	8.2	1.4	8.0
Height at 15 mm from tip	9.3	1.6	9.1
Width at 5 mm from tip	11.7	1.4	11.6
Width at 15 mm from tip	13.1	1.7	13.1

Table 3 focuses on the Coracoid Process, an important anatomical structure in shoulder stabilization surgeries like the Latarjet procedure. Measurements include the length, height, and width at various points from the tip, providing essential data for surgical planning and graft selection.

Table 4: Important Measurements of Scapula

Scapula	Mean (mm)	Standard Deviation (mm)	Median (mm)
Length	30.4	7.6	30.1
Width at 15 mm from notch	8.2	2.2	8.0
Width at 25 mm from notch	7.7	1.9	7.4
Height at 15 mm from notch	24.1	4.4	24.3
Height at 25 mm from notch	20.6	4.4	20.6
Landmark (from posterior acromion to medial point)	38.9	4.9	39.1

Table 4 outlines the dimensions of the Scapula, particularly focusing on the scapular spine which is another potential graft site for shoulder surgeries. Measurements include the length and width at specific distances from the notch, and the height at different points, aiding in precise anatomical understanding for graft harvesting and application.

DISCUSSION

The analysis of demographic distribution and morphometric measurements in this study provides comprehensive insights, enriched by comparisons with existing literature in the field of orthopedics and anatomy. Notably, a significant portion of the participants, 55.7%, belonged to the 26-50 year age bracket. This focus on a working-age population mirrors the demographic targeting seen in many orthopedic research studies, which typically examine this age group due to their increased susceptibility to musculoskeletal issues, as noted by JC Garcia Jr. (2016)[6]. This prevalence is often linked to the heightened physical demands and occupational hazards associated with this age group, making them a critical demographic for studies on bone health and joint stability.

Interestingly, the gender distribution in this study showed a higher percentage of females (57.7%) compared to males (42.3%), which is in contrast to findings like those reported by Galvin Joseph W et al. (2019)[7], where a higher prevalence of males was observed in orthopedic samples. This discrepancy could be attributed to regional demographic patterns or possibly the specific non-orthopedic conditions included in the survey, suggesting that females in the region might be more susceptible or more responsive to health surveys, reflecting social or cultural dynamics in healthcare accessibility or health-seeking behaviors. Moroder Philipp et al. (20) [8]

Regarding the state of residence, an overwhelming majority of the participants (88%) were from Tamil Nadu, which correlates with the location of the study's execution at MGM Healthcare in Chennai. This concentration suggests a regional bias, which is common in localized studies, as discussed by Armaghani, Sheyan J et al. (2016)[9]. Such a bias can affect the generalizability of the findings but also provides deep insights into the local population

which is crucial for regional healthcare planning and intervention strategies.

In terms of morphometric measurements, the dimensions of the Glenoid Fossa observed in this study closely align with those reported by Christopher Nacca et al. (2012)[10] for a South Asian cohort. These consistencies across regional studies underscore potential anatomical consistencies that are vital for the surgical planning of procedures that involve the shoulder's glenoid cavity, such as reconstructive surgeries following trauma or degenerative diseases.

Furthermore, the measurements of the Coracoid Process recorded were slightly lower than those typically observed in Caucasian populations as documented by Robert A et al. (2006)[11]. This points to possible ethnic or regional anatomical variations, which are crucial for performing surgeries like the Latarjet procedure, where the coracoid process is used as a graft. Such nuances necessitate adjustments in surgical techniques and tools to accommodate anatomical differences, enhancing surgical outcomes and patient safety.

Additionally, the scapula measurements highlighted in this study are particularly significant for grafting procedures. The variations in scapular spine dimensions compared to findings by Ming Xiang et al. (2021)[12] emphasize the importance of customizing surgical approaches based on detailed morphometric analyses. These anatomical details assist in the precise planning and execution of surgeries, particularly those involving significant bone grafts and reconstructions, ensuring that such procedures are adapted to the unique anatomical framework of the patient population. Nagar, Manoj et al. (2020) [13]

Collectively, these comparisons not only highlight the importance of considering demographic and anatomical nuances when interpreting data but also underscore the need for detailed and region-specific data in planning clinical interventions, particularly in the fields of orthopedic and reconstructive surgery. Such detailed studies contribute to the broader compendium of global medical knowledge, facilitating tailored healthcare solutions that are informed by both local and international research findings. Eric Rohman et al. (2019) [14]

CONCLUSION

In our study, we conducted a detailed morphometric analysis of the glenoid, coracoid process, and scapular spine, which are crucial sites for grafting during reconstructive shoulder surgeries. Our findings specifically cater to the parameters relevant to the Giles Walsh classical Latarjet procedure, which is renowned for providing optimal coverage of the glenoid cavity and facilitating the best possible fixation with the choice of two screws, typically 3.75 or 4 mm in size.

However, our analysis highlighted certain anatomical nuances specific to the Indian population. We observed that both the coracoid height and the scapular spine width tend to be smaller compared to populations studied in other regions. These variations are significant because they influence the surgical approach, particularly in terms of the hardware used for fixation. Given the smaller size of these anatomical features, larger screws traditionally used in such procedures might not be suitable for secure fixation in the Indian demographic.

Consequently, we recommend considering the use of smaller screws, such as 2.7 mm, to ensure a secure and safe fixation. Alternatively, the utilization of fiber tapes could be explored as a means to enhance the stability of the graft while accommodating the smaller anatomical dimensions. This adjustment in surgical practice not only aligns with the morphological characteristics found in our study but also optimizes the outcomes of surgeries such as the Latarjet procedure by ensuring that the hardware used does not compromise the integrity of the smaller bones.

These findings underscore the importance of tailoring surgical techniques and fixation methods to fit the specific anatomical profiles of different populations. For surgeons working in or with the Indian population, awareness of these differences can guide preoperative planning and procedural adjustments, ultimately improving the safety and efficacy of shoulder reconstructive surgeries.

Acknowledgement

We thank the radiological department of kodagu institute of medical sciences for their cooperation.

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