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Research Study

Are the Current Size Options of Glenoid Baseplates for Reverse Shoulder Arthroplasty Sufficient for our Local Population?
現有反置式人工肩關節置換術中盂底板組件的大小選項是否滿足我們本地人口的需要？

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ABSTRACT

Background/Purpose: Reverse shoulder arthroplasty (RSA) is an effective treatment for patients who suffer from shoulder pain and dysfunction associated with a variety of shoulder pathologies including severe rotator cuff deficiency with or without glenohumeral arthritis. It has been widely used in European countries and the United States and is now gaining popularity in Asia, including Hong Kong. However, there are only limited size options available for glenoid baseplates, with 25 mm being the smallest size in some commonly used systems. The aim of our study is to perform computerized tomography (CT) measurements of the glenoid dimension in the Chinese population and to see if the current glenoid baseplate component size option is sufficient for our local population.
Methods: A total of 70 CT scans of shoulder regions were analysed. Measurements included maximum superoinferior height and the anteroposterior height.
Results: The glenoid dimensions were smaller compared to those from previous studies in Caucasian counterparts. Some 41% of female glenoids had widths measuring < 25 mm (25 mm being the smallest size available in some commonly used RSA systems).
Conclusion: Although there are only limited size options available for the glenoid baseplate in RSA, from our data, it should be able to cover most patients in our local population. However, surgeons should exercise special care when contemplating performing reverse shoulder replacement for small size females in our local population.

中 文 摘 要

簡介：反置式人工肩關節置換術（reverse shoulder arthroplasty, RSA）是一種有效治療由各種肩關節病症所引起的肩膀疼痛和功能障礙，包括嚴重肩袖缺損，或伴隨有盂肱關節炎等。在歐洲國家和美國，它已被廣泛應用，在亞洲包括香港也越來越受歡迎。然而，盂底板組件大小的選擇有限，在常用的系統中最小尺寸為25mm。我們研究的目的，是用電腦掃瞄器來測量在本地中國人中肩關節盂的大小，並查看現有盂底板組件尺寸的選擇是否滿足我們的本地居民的需要。
方法：我們分析了70組肩部區域的電腦掃描。測量包括肩關節盂最大上下高度和前後長度。
結果：我們的結果和其他從高加索人種所作的研究作比較，發現本地中國人的肩關節盂尺寸較小。有41%的女性肩關節盂寬度小於25毫米（25毫米是在一些常用的RSA系統中可用的最小尺寸盂底板組件）。
討論和結論：雖然盂底板組件大小的選擇有限，從我們的數據，現有的盂底板組件應該能夠覆蓋大多數我們本地的患者。然而，基於我們本地女性居民肩關節盂的尺寸較小，外科醫生有進行反置式人工肩關節置換術時，應該特別留意。

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Introduction

Reverse shoulder arthroplasty (RSA; Figures 1 and 2) was originally designed for use in rotator cuff arthropathy and has been used with success in this condition.[1] It was designed to transfer the centre of rotation of the humerus medially and to lengthen the humerus. This would result in increased tension of the deltoid muscle and allow for compression between the humeral component and the glenoid component and thus, stabilize the prosthetic joint and lead to a more efficient deltoid lever arm.[2]

The indications for RSA have now expanded beyond rotator cuff arthropathy and it has been used with success in primary osteoarthritis with rotator cuff compromise (5–10% of patients with primary osteoarthritis of the shoulder have an associated rotator cuff tear[3,4]) or glenoid bone loss,[5] and varying degrees of success in fractures, rheumatoid arthritis, revision arthroplasty, infection, and tumours.

RSA is gaining popularity in Asia, including Hong Kong, for a variety of shoulder pathologies including severe rotator cuff deficiency, especially for those with glenohumeral arthritis and four part proximal humerus fractures in the elderly.

Unfortunately, current reverse shoulder replacements have limited glenoid baseplate (Figure 3) size options. For example, the Aequalis-Reversed II system (Tornier N.V., Amsterdam, Netherlands) only has two sizing options of 25 mm and 29 mm and the Delta Xtend system (DePuy Synthes, West Chester, PA, USA) only has one baseplate option of 27 mm.

Difficulty in the insertion of the glenoid baseplate in smaller sized glenoids in Korean patients has been reported,[6] and this has attributed to the phenomenon where smallest size implant actually covers the entire face of the glenoid with resultant difficulty in achieving stable screw insertion.

Proper sizing in RSA is essential as the initial rigid fixation of the glenoid baseplate is dependent on placement of the screws and adequate glenoid bone stock[7] with resultant sufficient bone-implant contact. Improper sizing would result in insufficient bone-implant contact and screw fixation, especially of the anterior and posterior holes of the baseplate, and this may result in glenoid loosening and decreased longevity of the RSA.[8]

The width of the glenoid cavity would be the more significant, limiting dimension when choosing glenoid baseplate sizes, since glenoid height is always the larger of the two measurements.

As most of these reverse shoulder replacement systems were designed with the Caucasian population in mind, coupled with the painful experience of our Korean counterparts, we pose the question: would such limited size options be sufficient to cater for the glenoid sizes of our local Chinese population?

There is a paucity of data available about the size of the glenoid in the Chinese population. There is one prior study quantifying the size of the glenoid in the Chinese population,[9] performed in a healthy, younger population (average age, 39.6 years).

As the age at which patients develop shoulder arthritis and of those that undergo shoulder arthroplasty is typically beyond the 5^{th}–6^{th} decade of life, it would be more appropriate to quantify the size of the glenoid in an older population.

The results of this study may have a bearing on the development of glenoid components for reversed shoulder replacement to cater for the glenoid dimensions of the Chinese population.

Methods

A total of 80 computerized tomography (CT) scans of the glenoid (including routine CT thorax scans and CT shoulder scans) were performed at our centre from January 2014 to April 2014 and were reviewed by two radiologists. Image analysis was performed using the AW Workstation by General Electric (Fairfield, CT, USA).

Patients over the age of 50 years were included in our study and patients under the age of 50 years were excluded from the study. Seventy Chinese patients (46 men; 24 women) with a mean age of 68.4 years were included in the study. Ten patients were excluded as they were younger than 50 years.

These CT images underwent sagittal oblique reformatting along the articular surface of the glenoid and were then analysed once. Maximal superoinferior height, which was defined as the distance

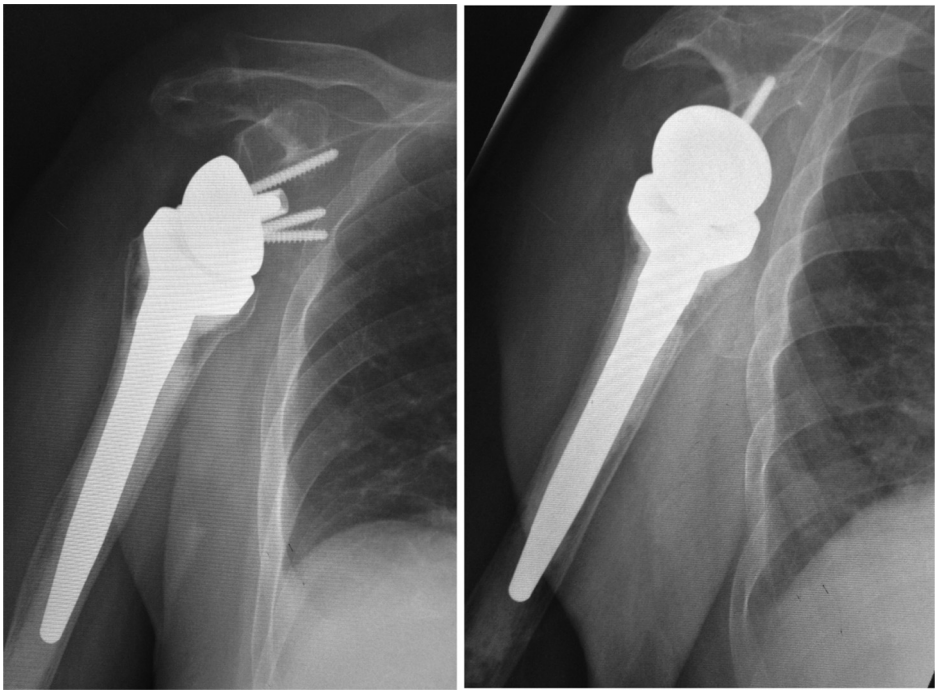

Figure 1. Postoperative radiograph of a patient who underwent reverse shoulder arthroplasty.

Figure 2. Postoperative clinical photograph of a patient who underwent right reverse shoulder arthroplasty showing good abduction range.

between the most superior and inferior points of the glenoid contour, was measured (Figure 4). Measurement of the maximal anteroposterior width of the glenoid, defined as the distance between the most anterior and posterior points of the glenoid contour, was also done. The degree of osteoarthritic change was also assessed.

Statistical analysis was performed using SPSS version 22 (SPSS Inc., Chicago, IL, USA). Student two tailed *t* test was used to analyse the difference between male and female measurements and to assess for any difference between the arthritic and nonarthritic glenoids. Statistical significance was defined as $p < 0.05$.

Figure 3. Diagram showing insertion of a glenoid baseplate.

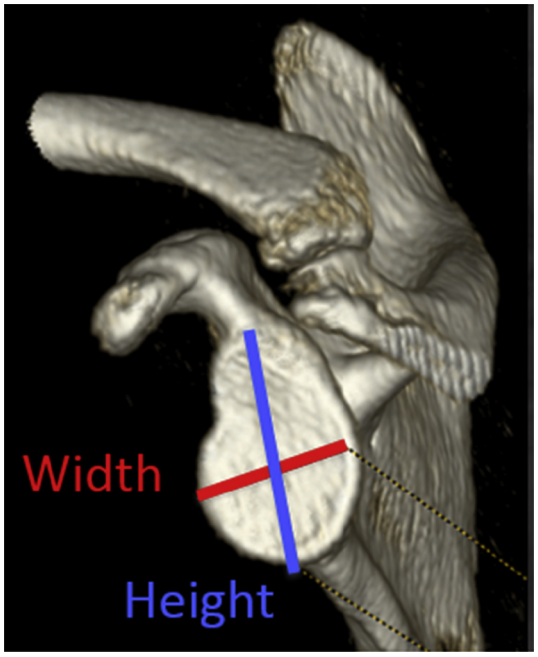

Figure 4. The dimensions of measurement.

Results

Sixty-three of the 70 glenoids measured in our study showed evidence of arthritis. Seven glenoids did not show evidence of arthritis.

The mean height of male and female combined arthritic glenoids was 37.4 mm [standard deviation (SD) 4.1] and the mean width was 28.6 mm (SD 3.6). Glenoid measurements were larger in men (mean height, 30.2 mm; mean width, 39.1 mm) than in women (mean height, 25.8 mm; mean width, 34.4 mm; Table 1 and Figure 5).

Mean height and width of the arthritic glenoids was greater than the values in normal glenoids. However, this observed difference in the height ($p = 0.45$) and the width ($p = 0.637$) between the arthritic and nonarthritic groups was not found to be statistically significant.

Glenoid dimensions were also observed to increase with the degree of osteoarthritis (Table 2 and Figure 6). However, these differences were not found to be statistically significant.

Discussion

To our knowledge, this study is the first to include the investigation of the dimensions of the arthritic glenoid in the Chinese population.

A prior study by Wang et al[9] in 2009 on healthy Chinese patients with nonarthritic glenoids showed that the general size of Chinese glenoids were generally on the smaller end of the spectrum compared to Caucasian and Black counterparts. The mean width and height measurements were larger for our patients with arthritic glenoids compared to the dimensions for these healthy Chinese patients with nonarthritic glenoids, and this may reflect the general trend of enlargement in arthritic glenoids likely due to incorporation of peripheral osteophytes.

Table 1
Glenoid dimensions amongst patients of different sexes with or without evidence of arthritis

Type of glenoid (no. of patients)	Average width (mm)	Range (mm)	SD	Average height (mm) (standard deviation)	Range (mm)	SD
Male, normal (6)	30.5	26.6–33.5	2.6	37.2	33–40.5	3
Male, arthritic (40)	30.2	23.1–25.2	2.8	39.1	32.2–48	3.5
Female, normal (1)	22.3			29.7		
Female, arthritic (23)	25.8	21.9– 32.1	3	34.4	29.0–44.2	3.4
Combined, normal (7)	29.3	22.3– 33.5	3.9	36.1	29.7–40.5	4
Combined, arthritic (63)	28.6	21.9–35.2	3.6	37.4	29–48	4.1

SD = standard deviation.
This difference in height and width of the glenoid between males and females was also statistically significant with a p value < 0.001.

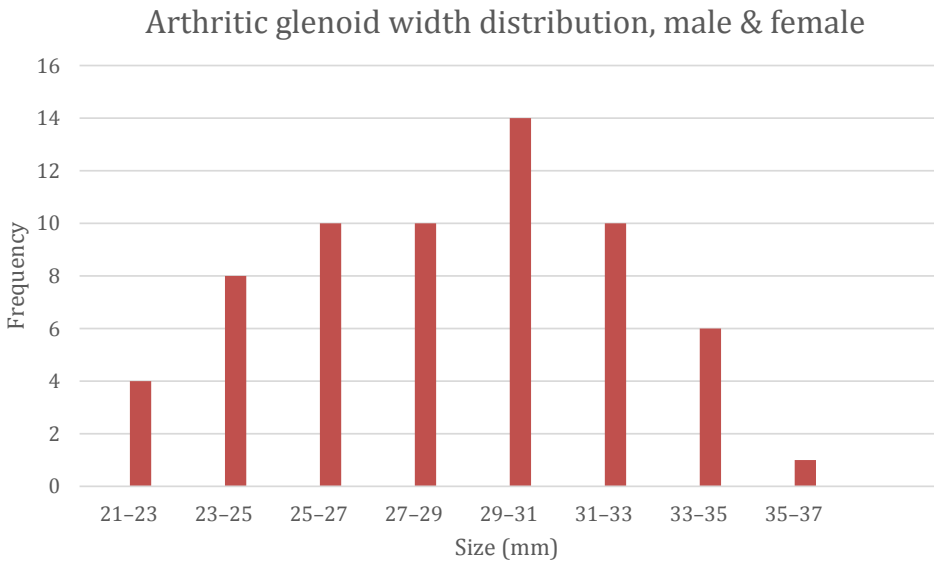

Figure 5. Graph showing the distribution of the glenoid sizes amongst the patients in our study.

Table 2
Glenoid dimensions for patients of different sexes with varying degrees of severity of osteoarthritis

Sex, degree of osteoarthritis	Average width (mm)	Range (mm)	SD	Average height (mm)	Range (mm)	SD
Male, mild	29.7	23.1–34.6	2.8	37.3	32.2–44.5	2.9
Male, moderate	30.6	26.2–35.2	2.9	40.9	35–48	3
Male, severe	32.2	28.6–34.2	3.1	42.2	39.5–46.1	3.4
Female, mild	24.4	21.9–27.3	1.7	33.1	29.0–36.0	2.5
Female, moderate	27.5	22.3–31.2	3.2	35.7	31.4–39.4	2.4
Female, severe	30.4	28.6–32.1	2.5	39	33.8–44.2	7.4
Combined, mild	27.6	21.9–34.6	3.6	35.7	29.9–44.5	3.4
Combined, moderate	29.6	22.3–35.2	3.3	39.9	31.4–48	3.7
Combined, severe	31.5	28.6–34.2	2.7	40.9	33.8–46.1	4.8

SD = standard deviation.

Although we observed a difference in the means for height and width between our patients with evidence of glenohumeral arthritis, this difference was not found to be statistically significant.

The results also indicated that there was an increase in size of glenoid dimensions with increasing severity of osteoarthritis, which again reflects the increasing amount of incorporation of peripheral osteophytes into the glenoid cavity. However, whether these peripheral osteophytes actually serve as a suitable support surface for implants is unclear, and there is a lack of information available in the literature regarding this issue.

Prior studies into glenoid dimensions showed that there were significant differences in the size of glenoids in males and females.[10] Our results also echoed these findings with statistically significant differences in the size between male and female arthritic glenoids noted.

The height and width of the arthritic glenoids measured in our study were smaller than those measured of a primarily Caucasian based population of arthritic glenoids by Walch et al[11] (Tables 3 and 4).

As the width of the glenoid cavity is always less than its height, it is the limiting dimension when choosing the glenoid baseplate size.

It should be highlighted that in our female patients 41.7% (10/24 females) had a glenoid width which measured < 25 mm with the size of the smallest glenoid measured being 22 mm. With limitations in the glenoid baseplate options for some commonly used RSA systems, for example, 25 mm being the smallest size available for

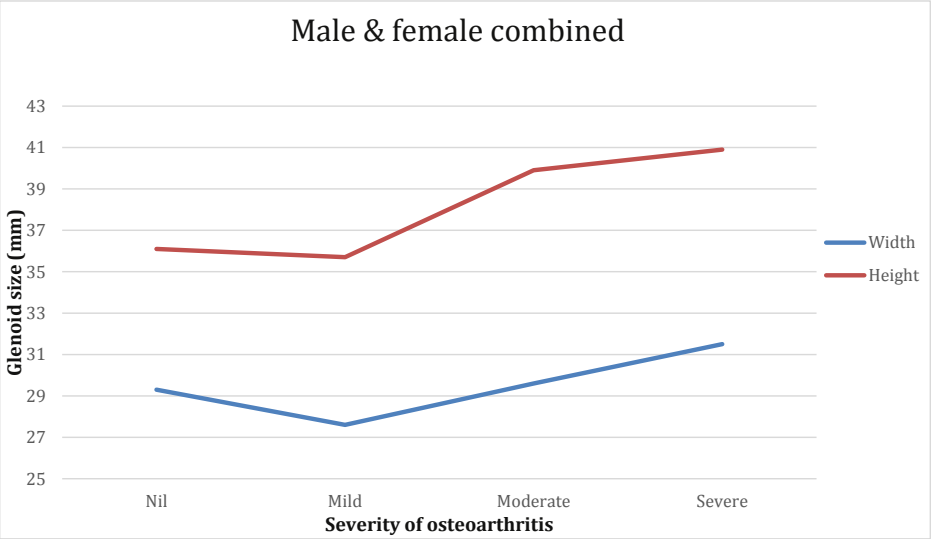

Figure 6. Graph illustrating the relationship between glenoid size (height and width) and severity of osteoarthritis.

Table 3
Comparison of the mean glenoid width for our study and the study conducted by Walch et al[11]

	Male & female combined width	Female glenoid width	Male glenoid width
Chinese (Our study)	28.6	25.8	30.2
Caucasian (Walch et al[11])	29.1	27.2	32.5

Table 4
Comparison of the mean glenoid height for our study and the study conducted by Walch et al[11]

	Male & female combined average height	Female average glenoid height	Male average glenoid height
Chinese (Our study)	37.4	34.4	39.1
Caucasian (Walch et al[11])	40.25	37.77	44.82

the Aequalis-Reversed II system (Tornier N.V.) and 27 mm for the Delta Xtend system (DePuy Synthes) in which only one size of glenoid baseplate is available, sizing issues may be of concern for a substantial proportion of females in our Chinese population, and intraoperative difficulties in insertion of the glenoid baseplate, such as that encountered by our Korean colleagues, may be anticipated.

By contrast, only two of the 40 male patients (5%) with evidence of glenoid arthritis measured $\leq$ 25 mm in width.

This may serve as a point of reference in the development of glenoid implants which are more catered for the sizing needs of the Chinese population.

This should also alert the surgeon to exercise special caution when contemplating performing reverse shoulder replacement for small size females in our population when this sizing issue may be encountered.

Conclusion

This study found that for reverse shoulder replacement, a significant proportion of the Chinese female population have a glenoid size that may not be able to be covered by the sizes currently available for some commonly used reverse shoulder replacement systems.

Our results provide a guide for future design of the glenoid component which is more suitable for the Chinese population and should alert the surgeon to exercise special care when contemplating performing reverse shoulder replacement for small size females and males.

Conflicts of interest

The authors hereby declare that they have no conflicts of interest.

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References

1. Wall B, Nové-Josserand L, O'Connor DP, et al. Reverse total shoulder arthroplasty: a review of results according to etiology. *J Bone Joint Surg Am* 2007;**89**:1476–85.
2. Nyffeler RW, Werner CML, Gerber C. Biomechanical relevance of glenoid component positioning in the reverse Delta III total shoulder prosthesis. *J Shoulder Elbow Surg* 2005;**14**:524–8.
3. Edwards TB, Boulahia A, Kempf JF, et al. The influence of rotator cuff disease on the results of shoulder arthroplasty for primary osteoarthritis: results of a multicenter study. *J Bone Joint Surg Am* 2002;**84-A**:2240–8.
4. Norris TR, Iannotti JP. Functional outcome after shoulder arthroplasty for primary osteoarthritis: a multicenter study. *J Shoulder Elbow Surg* 2002;**11**:130–5.
5. Wall B, Nové-Josserand L, O'Connor DP, et al. Reverse total shoulder arthroplasty: a review of results according to etiology. *J Bone Joint Surg Am* 2007;**89**:1476–85.
6. Ji JH, Jeong JY, Song HS, et al. Early clinical results of reverse total shoulder arthroplasty in the Korean population. *J Shoulder Elbow Surg* 2013;**22**:1102–7.
7. Harman M, Frankle M, Vasey M, et al. Initial glenoid component fixation in "reverse" total shoulder arthroplasty: a biomechanical evaluation. *J Shoulder Elbow Surg* 2005;**14**(1 Suppl S):162S–7S.
8. Chae SW, Kim SY, Lee H, et al. Effect of baseplate size on primary glenoid stability and impingement-free range of motion in reverse shoulder arthroplasty. *BMC Musculoskelet Disord* 2014;**15**:417.
9. Wang H, Tang K, Gong J, et al. Measurement and analysis of glenoid bony anatomy. *Zhongguo Xiu Fu Chong Jian Wai* 2009;**23**:822–6.
10. Merrill A, Guzman K, Miller SL. Gender differences in glenoid anatomy: an anatomic study. *Surg Radiol Anat* 2009;**31**:183–9.
11. Walch G, Mesiha M, Boileau P, et al. Three-dimensional assessment of the dimensions of the osteoarthritic glenoid. *Bone Joint J* 2013;**95-B**:1377–82.