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Research Article

Glenoid-version-measurement methods on magnetic resonance imaging: accuracy and reliability analysis

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ABSTRACT

Objective: Glenoid-version-measurement methods were initially defined for computed tomography (CT) but are now used for magnetic resonance imaging (MRI). However, their accuracy and reliability on MRI have not been thoroughly investigated. The aim was to determine the accuracy of these methods on MRI and compare their reliability, hypothesizing that MRI could provide accurate measurements similar to CT using all 3 methods, with the Matsumura method having the highest reliability.

Methods: Glenoid-version measurements of 40 patients (14 female, 26 males; mean age 46.5 ± 17.9 years) with glenohumeral instability were performed using the Friedman, Poon and Ting, and Matsumura methods on MRI. These measurements were compared to those on 3-dimensional corrected slices of CT scans to evaluate accuracy. Reliability was assessed by 2 observers who repeated MRI measurements after 2 months.

Results: All methods demonstrated favorable accuracy. The Friedman and Matsumura methods exhibited good interobserver reliability [intraclass correlation coefficient (ICC)=0.78 (0.58-0.88) and 0.89 (0.79-0.94)], while the Poon and Ting method showed moderate reliability [ICC=0.71 (0.44-0.84)]. Intraobserver reliability was excellent for the Matsumura method [Observer 1 ICC=0.96 (0.93-0.98), Observer 2 ICC=0.86 (0.95-0.99)], good for Friedman [Observer 1 ICC=0.77 (0.57-0.88), Observer 2 ICC=0.82 (0.67-0.91)], and moderate to good for Poon and Ting [Observer 1 ICC=0.68 (0.39-0.83), Observer 2 ICC=0.82 (0.65-0.9)].

Conclusion: All 3 methods can be used confidently for MRI measurements, matching the accuracy of CT scans. The Friedman and Matsumura methods demonstrated higher interobserver and intraobserver reliabilities.

Level of evidence: Level III, diagnostic study.

Introduction

The glenoid version was shown to be involved in various shoulder pathologies such as glenohumeral arthritis (GHA),[1-4] glenohumeral instability (GHI),[5-9] and labral injury (LI).[9-13] The role of accurate determination of the glenoid version is well-known in shoulder arthroplasty for the treatment of GHA.[14-16] However, the importance of the glenoid version in GHI and LI was only recently understood.[7-9,17,18] Accurate measurement of the glenoid version may have a remarkable role in treatment preference and preoperative planning for GHI and LI.[9,17,19,20]

3D computed tomography (CT) is considered the gold standard imaging modality for measuring the glenoid version.[21-24] In parallel, commonly used glenoid-version measurement methods were originally introduced to perform measurements on CT scans.[25] However, magnetic resonance imaging (MRI) has been increasingly used in the evaluation of patients with complaints around the shoulder, especially GHI and rotator cuff tears.[7,10,26,27] Additionally, Aygün et al[27] stated that glenoid-version measurement can be performed with high reliability on MRI, similar to CT.

Among the glenoid version measurement methods, the Friedman[4] method, which is named as the classical method in many studies today, is a scapula body-based method. Unlike the Friedman[4] method, the Poon and Ting,[28] and the Matsumura[29] methods are glenoid vault-based methods. Additionally, in the Matsumura method, 3-dimensionally corrected slices are used as previously described by the authors. This eliminates the confounding effect of differences in scapula position, so it may theoretically offer higher accuracy (Table 1). These 3 methods are the most commonly preferred glenoid version measurement methods on CT scans. However, to the best of the authors' knowledge, the accuracy and reliability of these MRI scan measurement methods have not yet been evaluated or compared. In this study, the accuracy and reliability of glenoid-version measurements performed using these methods on MRI scans were compared. This study is an extension of the 2021 European Society for Surgery of the Shoulder and Elbow (SECEC-ESSE) Meeting oral presentation with corrected patient numbers and expanded analysis.

The first hypothesis was that glenoid version measurements on MRI could be performed with similar accuracy as measurements performed on CT scans

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Table 1. Characteristics of each method

	Principles	Advantages	Potential limitations
Friedman	• Scapula based • Measurements are carried out on standard 2-dimensional axial slices. • Axial slices immediately inferior to the coracoid process are used.	• The most common method • Easy and fast to measure	• Affected by scapular body morphology • Affected by scapula position on thorax • The medial edge of the scapula, which is necessary for measurement, is not always included in the available images.
Poon and Ting	• Vault based • Measurements are carried out on standard 2-dimensional axial slices. • Axial slices corresponding to the midpoint of the glenoid fossa in the superior-inferior direction in the coronal plane are used.	• Does not affected by scapular body morphology	• Affected by scapula position on thorax
Matsumura	• Vault based • Measurements are carried out on "3-dimensionally corrected" axial slices. • Firstly, the scapular plan, which is defined as the plane that includes the lower end of the scapular body, the center of the glenoid fossa surface, and the end of the medial scapular spine, is obtained with 3-dimensional correction using the 3D MPR technique. The 3-dimensionally corrected axial slice is reconstructed as a plane perpendicular to the scapular plane, containing the center of the glenoid fossa surface and the end of the medial scapular spine (Figure 1). Measurements are carried out on the new 3D corrected axial slices obtained.	• Does not affected by scapular body morphology • Does not affected by scapula position on thorax	• Time-consuming • Requires imaging software that allows the use of the 3-dimensional multiplanar reconstruction technique

MPR, multiplanar reconstruction.

using all 3 methods. The second hypothesis was that the Matsumura[29] method was superior to the other methods and allowed more accurate and reliable glenoid version measurement performed on MRI scans.

Material and methods

Patients

Data of 52 patients diagnosed with glenohumeral instability followed up by a single surgeon who underwent shoulder imaging using both MRI and CT between June 2018 and June 2020 were retrieved from the hospital imaging database. Twelve patients were excluded due to radiographic evidence of glenohumeral osteoarthritis, previous instability surgery, or a history of glenoid or scapular fracture. This study protocol was approved by the Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (Approval No: 2022-11/32, Date: June 24, 2022). Written informed consent was obtained from all participants. A sample size analysis using a point biserial correlation model *t*-test, $\alpha=0.05$, and a power of 0.8 showed the need to include 37 patients. A minimum of 40 patients were selected for the analysis. This study included 14 women and 26 men. The mean age of the patients was 46.5 (range: 16-78) years. The right shoulder was involved in 24 patients, and the left shoulder was involved in 16 patients (Table 2).

Image acquisition

All images were acquired at the same hospital using the same MRI and CT devices with a standard shoulder imaging protocol and saved in the DICOM (Digital Imaging and Communications in Medicine) format. Shoulder CT and MRI images were obtained in all patients, with the elbow in extension and the forearm in the supine position. CT images were obtained using a 16-slice CT scanner (Alexion, Toshiba Medical Systems, Otowara, Japan). The settings were maintained at a 2-mm slice thickness with 5-mm multiplanar 3D reconstruction. Magnetic resonance imaging was obtained using a Siemens Magnetom Aera 1.5T with a 16-channel shoulder coil. The scan settings were maintained at a 4.5-mm slice thickness. Axial PD FAT-SAT (proton density fat-saturated), coronal PD FAT-SAT, sagittal PD FAT-SAT, and coronal T1 TSE (turbo spin-echo) images were used.

Measurements

The measurements were performed by 2 surgeons with experience in shoulder surgery using standard angle measurement tools

HIGHLIGHTS

- Glenoid version is crucial in various shoulder disorders such as glenohumeral arthritis, glenohumeral instability, and labral injury.
- While 3D computed tomography (CT) is considered the gold standard for measuring glenoid version, magnetic resonance imaging (MRI) is increasingly used, showing reliability comparable to CT for this purpose.
- The Friedman, Poon and Ting, and Matsumura methods are commonly used for glenoid version measurement. The Matsumura method is the most accurate and reliable, while the classical Friedman method also shows good accuracy and reliability for MRI scans.

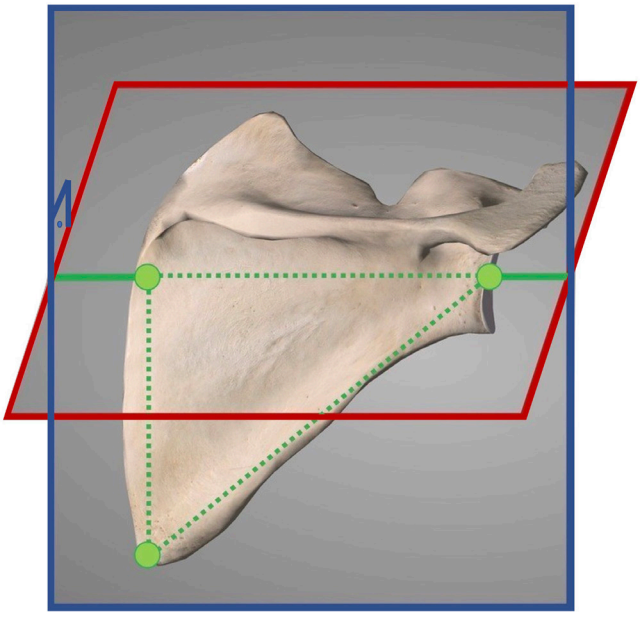


Figure 1. Principles of reconstruction of 3D corrected slices for the Matsumura method. The plane of the scapula: 3 green points placed at the center of the glenoid, the inferomedial pole of the scapula, and the end of the medial scapular spine (the triangle formed by the green dotted lines) are chosen to define the scapular plane (the plane surrounded by a blue frame). The plane including the scapular axis, which is defined as the lines connecting the center of the glenoid surface, the end of the medial scapular spine, and the lower end of the scapular body (the green solid lines), and perpendicular to the scapular plane is reconstructed as the 3D corrected slice (the plane surrounded by a red frame).

Table 2. Patients demographics

Variable	Data
Patients, n	40
Mean age, yrs, SD	46.5 ± 17.93
Sex, n	
Female	14
Male	26
Side, n	
Left	16
Right	24

n, number; yrs, year.

in Horos v4.0.0 RC4 (Horos Project). The accuracy of the measurements performed on the MRI images for each method was tested by comparing them with the 3-dimensionally corrected slices of the CT scans. Images were obtained using the multiplanar reconstruction (MPR) technique (Figure 1). Axial slices determined as described in the original articles of the methods were used for MRI measurements.[4,28,29] For the Friedman[4] method, axial slices immediately inferior to the coracoid process were used, as described by the authors (Figure 2). For the Poon and Ting[28] method, axial slices corresponding to the midpoint of the glenoid fossa in the superior-inferior direction in the coronal plane were used (Figure 3). For the Matsumura[29] method, 3-dimensionally corrected slices were used to eliminate the confounding effect of differences in the position of the scapula, as described previously by the authors (Figure 4). The scapular plane was defined as the plane that included the lower end of the scapular body, center of the glenoid fossa surface, and end of the medial scapular spine. The 3-dimensionally corrected slice was reconstructed as a plane perpendicular to the scapular plane, containing the center of the glenoid fossa surface and the end of the medial scapular spine[29,30] (Figure 1). Each observer performed 2 measurements on the MRI scans at 2-month intervals. The accuracy of the methods was evaluated by comparing the glenoid version measurements performed on MRI scans for each method with the measurements performed on 3-dimensional corrected slices of CT scans. Inter-observer reliability was evaluated by comparing the MRI scans of the 2 observers. Intraobserver reliability was evaluated by comparing the 2-month-interval measurements of each observer. For the test of reliability, the intraobserver agreement and interobserver agreement were quantified using intraclass correlation coefficients (ICCs).[31] An ICC ≥ 0.9 was considered to be excellent agreement, 0.75 ≤ ICC < 0.9 was considered to be good, 0.5 ≤ ICC < 0.75 was considered to be moderate, and ICC < 0.5 was considered to be poor reliability.[32]

Statistical analysis

Statistical analyses were performed using SPSS Version 26.0, (IBM SPSS Corp.; Armonk, NY, USA). The level of significance was set at $P < .05$. A paired *t*-test was used to test the significance of the difference in the glenoid version values between the MRI scans and reference CT scan measurements. The paired t-test showed no significant difference, indicating that the CT and MRI readings were not different. Under these conditions, a Pearson correlation test was performed to assess how well the measurements from the MRIs correlated with the measurements from the CT scans. Intraclass correlation coefficient values were calculated based on a 2-way random-effects model to evaluate the interobserver and intraobserver reliabilities of glenoid-version measurements on MRI scans in a 2-way mixed-effects model.

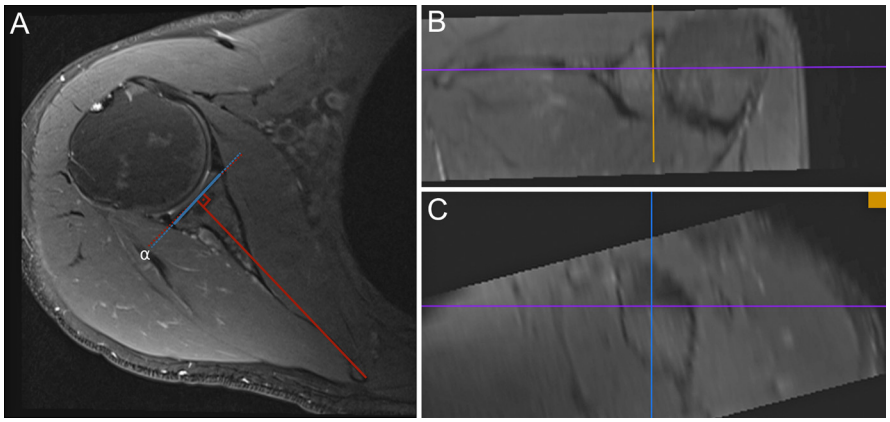


Figure 2. (A) In the Friedman method, the line joining the middle of the glenoid joint face and the anterior edge of the most medial of the scapular body is used in the axial slice immediately inferior to the coracoid process without any correction. The glenoid version is defined as the angle between this line and the line parallel to the glenoid fossa joint surface. (B) and (C) Note where the axial slices used correspond to the coronal and sagittal planes.

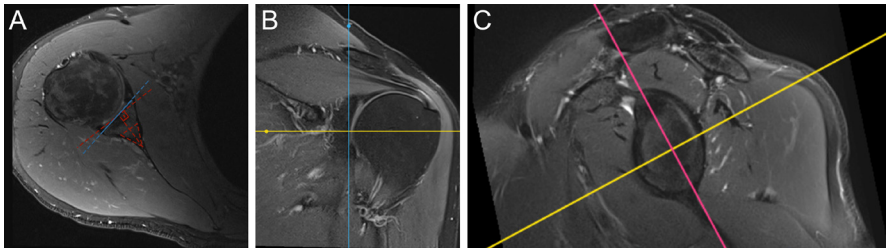


Figure 3. (A) In the Poon and Ting method, the authors defined the plane perpendicular to the angle bisector of the apex of the isosceles within the medial end of the glenoid endosteal vault as the neutral version. In this method, the angle between the line parallel to the glenoid fossa joint surface (the glenoid endosteal face) and the plane of the neutral version is defined as the glenoid version. In the Poon and Ting method, measurements are carried out on 2D-corrected axial slices. (B) and (C) Note where the axial slices used correspond to the coronal and sagittal planes.

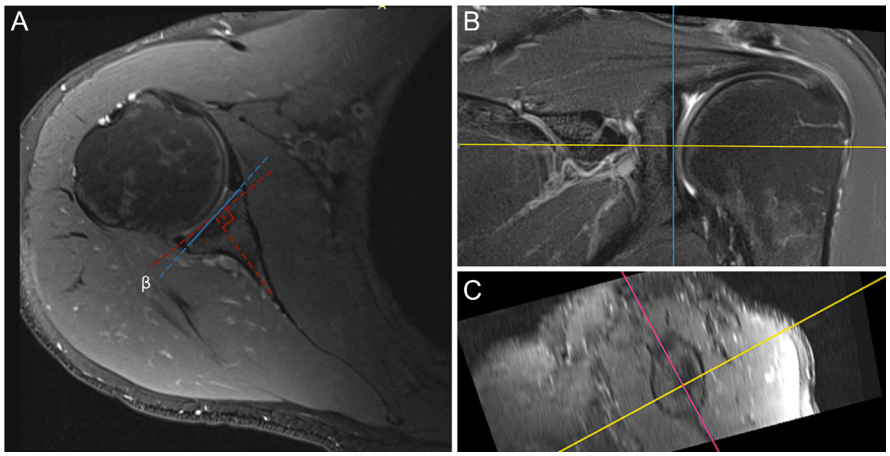


Figure 4. (A) In the Matsumura method, the line that joins the middle of the glenoid fossa surface and the apex of the isosceles is used. The glenoid version is the angle between the perpendicular line drawn to this line and the line parallel to the glenoid fossa joint surface. In the Matsumura method, measurements are carried out on 3D-corrected axial slices. (B) and (C) Note where the axial slices used correspond to the coronal and sagittal planes.

Results

The mean glenoid versions of observer-1 were 0.49° (range, −16.06°-25.1°), −16.91° (range, −35.01°-2.4°), and −5.59° (range, −26.13°-15.73°) for the Friedman,[4] Poon and Ting[28] and Matsumura[29] methods, respectively (Table 3). The mean glenoid version of observer-2 was −1.77° (range, −23.55°-24.84°), −16.1° (range, −41.02°-5.54°), and -9.72° (range, −32.38°-12.6°) for the Friedman,[4] Poon and Ting[28] and Matsumura[29] methods, respectively (Table 3).

In the accuracy analysis, the mean differences of the glenoid versions on MRI scans were −1° (range, −2.98°-0.99°, P = 0.32), −0.59° (range, −2.98°-1.8°, P = .62), 0.57° (range, −1.58°-2.63°, P = .62) for the Friedman, Poon and Ting, and Matsumura methods concerning those on CT scans, respectively (Tables 4 and 5). According to the results of the Pearson correlation test, the Matsumura method has a correlation coefficient of 0.91 (P < .01), the Friedman method has correlation coefficients of 0.71 (P < .01) and Poon and Ting methods have correlation coefficients of 0.65 (P < .01). All 3 methods seemed to have favorable accuracy for measurements performed on MRI scans.

In the interobserver reliability analysis, the Friedman[4] method showed good interobserver reliability [ICC=0.78 (0.58-0.88)]. The Poon and Ting[28] method had moderate interobserver reliability [ICC=0.71 (0.44-0.84)], and the Matsumura[29] method had good interobserver reliability [ICC=0.89 (0.79-0.94)].

In the intraobserver reliability analysis, the Matsumura[29] method showed excellent-good intraobserver reliability [Observer 1 ICC=0.96 (0.93-0.98), Observer 2 ICC=0.86 (0.95-0.99)]. The Friedman[4] method had good-good [Observer 1 ICC=0.77 (0.57-0.88), Observer 2 ICC=0.82 (0.67-0.91)], and the Poon and Ting[28] method had moderate-good intraobserver reliability [Observer 1 ICC=0.68 (0.39-0.83), Observer 2 ICC=0.82 (0.65-0.9)] (Table 6).

Table 3. Mean glenoid versions* obtained with the Friedman, Poon and Ting, and Matsumura methods on MRI scans

	Friedman	Poon and Ting	Matsumura
Observer 1			
Mean (°)	0.49	−16.91	−5.59
Min-Max (°)	−16.06-25.1	−35.01-2.4	−26.13-15.73
SD (°)	6.34	5.95	6.22
Observer 2			
Mean (°)	−1.77	−16.1	−9.72
Min-Max (°)	−23.55-24.84	−41.02-5.54	−32.38-12.6
SD (°)	6.76	6.87	6.22

Max, maximum; Min, minimum; MRI, magnetic resonance imaging.
*Negative values indicate glenoid retroversion; positive values indicate glenoid anteversion.

Discussion

This study was presented as an oral presentation at the 2021 European Society for Shoulder and Elbow Surgery (SECEC-ESSE) Meeting and includes corrected patient numbers and an extended analysis. The accuracy analysis of this study revealed that all 3 glenoid measurement methods could be used with a favorable degree of accuracy on MRI scans when the measurements from 3-dimensionally corrected CT images were used as a reference (Tables 4 and 5). After no significance was seen as a result of a paired t-test, Pearson correlation test was applied to evaluate how much measurements obtained from MRIs were associated with measurements obtained from CT scans. According to the Pearson correlation test, the highest accuracy rate was observed in measurements performed using all 3 methods. The Matsumura method demonstrated a correlation coefficient of 0.91 (P < .01), the Friedman method has correlation coefficients of 0.71 (P < .01) and Poon and Ting methods have correlation coefficients of 0.65 (P < .01). The accuracy of measurements with the Friedman[4] method was similar to those previously reported.[27,33,34] On the other hand, no study was detected in a literature search to compare the accuracy findings for the Poon and Ting[28] and Matsumura[29] methods. In the study by Lowe et al[33] glenoid version measurement was carried out only using the Friedman method, and the measurements performed on MRI images were similar to those performed on CT images in Type A1, A2, and B1 glenoids. However, in Type B2 and C glenoids, the measurements performed on MRI images were found to be inferior to the measurements performed on CT images. Since the Matsumura method, which stands out with the highest accuracy and good-excellent reliability in the study, is a measurement based on the glenoid

Table 5. Evaluation of the accuracy of the measurements performed on magnetic resonance imaging using the Pearson correlation test

	r	*P*
Friedman	0.71	<.01
Poon and Ting	0.65	<.01
Matsumura	0.91	<.01

r, Pearson correlation coefficient.

Table 4. Evaluation of the difference of each glenoid version** measurement method with reference to a 3-dimensionally corrected computed tomography scan

	Difference*			
Variable	**Mean (°)**	**SD (°)**	**95% CI (°)**	***P***
Friedman	−1	6.12	−2.98-0.99	.32
Poon and Ting	−0.59	7.47	−2.98-1.8	.62
Matsumura	0.53	6.57	−1.58-2.63	.62

*Refers to the difference between MRI scan measurements and 3-dimensionally corrected CT scan measurements obtained separately by each method.
**Negative values indicate glenoid retroversion; positive values indicate glenoid anteversion.

vault, whether the Matsumura method provides similar accuracy and reliability in MRI measurements to CT measurements in Type B2 and C glenoids may be a subject of research for further studies.

The interobserver reliability determined for the Friedman[4] method in this series was good (Table 6), which was lower than the findings of Aygün et al,[27] similar to the findings of Parada et al[34] and Ditzler et al,[35] and higher than the findings of Lowe et al[33] (Table 7). The intraobserver reliability of the Friedman[4] method in this study was good (Table 6). These values were lower than those reported by Parada et al[34] and considerably higher than those reported by Lowe et al[33] (Table 7).

The interobserver reliability was moderate, and the intraobserver reliability was moderate-good (Table 6), which were determined for the Poon and Ting[28] method in this series. Although glenoid version measurements have been carried out on MRI scans using the Poon and Ting[28] method, no reliability analysis has been reported in the literature.[7,9,18]

For the Matsumura[29] method, the interobserver reliability was good, and the intraobserver reliability was excellent-good (Table 6), similar to the findings of Maister et al,[26] which was the only study in which the reliability of the Matsumura[29] method was evaluated (Table 7).

In this study, the interobserver and intraobserver reliabilities for measurements performed on MR scans were compared with the reliability in the original series, in which all 3 methods were originally described in the measurements performed on CT scans. Remarkably, all 3 methods had lower interobserver and intraobserver reliabilities in this study (Tables 6 and 8).

Table 6. Intraobserver and interobserver reliability: Intraclass correlation coefficients* for the glenoid version measurements

	Friedman	**Poon and Ting**	**Matsumura**
Interobserver reliability			
ICCs	0.78 (good)	0.71 (moderate)	0.89 (good)
Range	0.58-0.88	(0.44-0.84)	(0.79-0.94)
Intraobserver reliabilities			
Observer 1			
ICCs	0.77 (good)	0.68 (moderate)	0.96 (excellent)
Range	0.57-0.88	0.39-0.83	0.93-0.98
Observer 2			
ICCs	0.82 (good)	0.82 (good)	0.86 (good)
Range	0.67-0.91	0.65-0.9	0.95-0.99

ICC, intraclass correlation coefficients.
*An ICC ≥ 0.9 was considered to be excellent, 0.75 ≤ ICC < 0.9 was considered to be good, 0.5 ≤ ICC < 0.75 was considered to be moderate, and an ICC < 0.5 was considered to be poor reliability.

According to the findings of this study, the Matsumura[29] method had the highest accuracy and reliability. Measurements using the Friedman[4] and Poonand Ting[28] methods were performed on 2-dimensional axial slices. However, the measurements using the Matsumura[29] method were performed on 3-dimensional corrected slices, parallel to each author's description. Bryce et al,[36] and Bokor et al[37] that glenoid version measurements were performed on 2-dimensional axial CT scans and were prone to inaccuracies. The accuracy and reliability of each method for measurements performed on 3-dimensional corrected slices should be studied further. In contrast, to determine the axial slice to be measured, only the glenoid fossa midpoint was used in the superior-inferior direction on the coronal plane in the Poon and Ting[28] method. In the Matsumura[29] method, the anteroposterior direction was used in the sagittal plane to determine the midpoint of the glenoid fossa. Thus, measurements were performed on better-standardized images. This may explain why these findings show that the Matsumura[29] method is more accurate and reliable than the other methods.

Although the scapular version is measured rather than the glenoid version in the Friedman[4] method, it is possible to measure the true glenoid version based on the glenoid vault in both the Poon and Ting[28] and Matsumura[29] methods. The fact that measurement is not affected by the morphology of the scapular body and the ability to use these methods even in cases where CT or MRI scans do not include the entire scapula (especially the medial scapula) stands out

Table 7. Interobserver and intraobserver reliabilities of the Friedman and the Matsumura methods for measuring glenoid versions on MRI scans

					Intraobserver reliabilities		
Study	**Study population**	**n**	**Statistical test**	**Interobserver reliability**	**Observer 1**	**Observer 2**	**Observer 3**
Friedman method							
Parada et al[34]	GHI	32	ICC	0.76	0.94	0.94	–
Lowe et al[33]	GHA	30	ICC	0.62	0.63	0.73	–
Aygün et al[27]	GHI	55	ICC	0.98	–	–	–
Ditzler et al[35]	OBPP	30	Pearson Correlation	0.75	0.36	0.04	0.03
Matsumura method							
Maister et al[26]	GHI	20	ICC	0.86	0.88	0.81	0.67

GHA, glenohumeral arthritis; GHI, glenohumeral instability; ICC, intraclass correlation coefficients; MRI, magnetic resonance imaging; n, number of shoulders; OBPP, obstetric brachial plexus palsy.

Table 8. Interobserver and intraobserver reliabilities of the Friedman, Poon and Ting, and Matsumura methods for measuring glenoid versions on computed tomography scans

					Intraobserver reliabilities		
Method	**Study population**	**n**	**Statistical test**	**Interobserver reliability**	**Observer 1**	**Observer 2**	**Observer 3**
Friedman*	GHA	63	ICC	0.96	0.97	NA	NA
Poon and Ting	GHA	63	ICC	0.95	0.96	NA	NA
Matsumura	GHA	150	ICC	0.91	0.9	0.91	0.9

ICC, intraclass correlation coefficients; n, number of shoulders; NA, not available.
*The ICC values were retrieved from the study by Poon and Ting[28] because they were not reported in the original study by Friedman et al.[4]

as the other strengths of these 2 novel methods. Although some studies have reported that missing the entire scapula in the measurement of glenoid versions on shoulder CT scans and MRI scans is a common issue, no MRI scan images were detected and only 1 CT scan image was missing the medial scapula in only 1 patient.[26,29,34] Additionally, using the midpoint of the glenoid fossa as a reference while calculating the glenoid version in the Matsumura[29] method may be more helpful for proper implant positioning in arthroplasty surgery compared to the Poon and Ting[28] method. However, Cunningham et al[25] stated that the measurements performed using the Matsumura[29] method from the mid-glenoid fossa and inferior glenoid fossa levels were as reliable as the Friedman[4] method, but less reliable at the superior glenoid fossa level. For this reason, it should be considered that measurements in the Matsumura[29] method should be performed at the mid-glenoid fossa level, as stated in the original technique for the 3-dimensionally corrected slices.

The limitations of this study may include the number of observers being limited to 2, and the fact that the observers were shoulder and elbow surgeons rather than musculoskeletal radiologists. Although this seems to be a limitation, it may also be a strength of the study in terms of the validity of outcomes in orthopedic practice. These measurements are often performed by orthopedic surgeons in daily clinical practice. The main strength of this study was that the axial slices to be measured were determined as specified in the original definitions of each measurement method, and individual measurements were performed on these unique slices. Another strength of the study is that the power analysis was performed before the study, and the reference values against which MRI scan measurements were compared to test the accuracy of each method were measured using 3D-corrected CT scan images. Additionally, the study population was homogenous, consisting only of only patients with glenohumeral instability and not those with GHA. In future studies, it would be appropriate to study patients with GHA separately.

In conclusion, glenoid-version measurements on MRI scans with favorable accuracy can be obtained with all 3 methods. However, the Matsumura[29] method had the highest accuracy, good interobserver reliability, and excellent intraobserver reliability among the 3 methods. In addition, the Friedman[4] method, which is considered the "classical method" for glenoid-version measurements, can be used for measurements on MRI scans with confident accuracy, good interobserver reliability, and good intraobserver reliability.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: This study was approved by the Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (no: 2022-11/32 Date: June 24, 2022).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – G.K., A.C.A.; Design – G.K., O.T.; Supervision – A.C.A; Resources – G.K., O.T.; Materials – G.K., A.C.A.; Data Collection and/or Processing – G.K., O.T.; Analysis and/or Interpretation – G.K., O.T.; Literature Search – G.K., O.T.; Writing – G.K.; Critical Review – O.T., A.C.A.

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