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MRI-Based Evaluation of Landmarks for Anterior Approach to the intra-articular Glenohumeral Joint injection : Identifying the Most Reliable Landmark

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Introduction and Background

Shoulder joint aspiration or injection is a widely performed procedure across various medical specialties, including orthopedics, diagnostic radiology, rheumatology, and general practice. This procedure serves both diagnostic and therapeutic purposes, aiding in the evaluation and treatment of shoulder conditions. There exists a multitude of techniques and approaches for shoulder joint aspiration or injection, often utilizing various tools to improve procedural accuracy.

Research studies investigating different methods and techniques for shoulder joint injection have consistently highlighted the importance of accuracy. Precise injection into the glenohumeral joint has been shown to enhance both diagnostic accuracy and therapeutic efficacy [1-4]. Among the different approaches, anterior shoulder injection has been reported as the most accurate when compared to posterior shoulder injection, particularly without the use of adjunctive equipment [5]. Even among inexperienced operators, anterior injection demonstrated higher accuracy compared to posterior injection

However, in certain situations and clinical settings, operators may employ different techniques and utilize different equipment to enhance procedural accuracy. Techniques such as ultrasound-guided shoulder injection have been introduced to improve accuracy and precision [6]. However, the availability and cost of such equipment pose limitations, impacting their widespread adoption and utilization in clinical practice. Consequently, the accuracy and effectiveness of shoulder joint injection may vary depending on the specific circumstances and resources available at each institution or clinical setting.

This research aims to address these challenges by identifying techniques and methods that can achieve accurate and effective shoulder joint injection using basic equipment readily available in all healthcare facilities. By eliminating the need for specialized equipment, this approach aims to ensure consistent procedural accuracy and efficacy across different clinical settings. Furthermore, this study investigates the influence of patient body mass index (BMI) on the accuracy of shoulder joint injection. Previous research by Tobola et al. highlighted the superior accuracy of anterior shoulder injection compared to posterior injection, particularly without the use of adjunctive equipment[5].Additionally, it was found that even inexperienced operators achieved higher accuracy with anterior injection. However, variations in techniques and equipment across different settings may lead to differences in accuracy and efficacy. Thus, this study seeks to identify the most reliable and accurate landmarks for guiding anterior shoulder injections, considering factors such as BMI and shoulder morphology. By retrospectively analyzing MRI images of patients visiting Thammasat University Hospital between 2020 and 2023, this study aims to elucidate the optimal injection site for the anterior approach to the glenohumeral joint. Through exclusion criteria targeting specific shoulder conditions, the study aims to focus specifically on anatomical variations that may influence the accuracy of injection sites. Ultimately, the findings of this research endeavor are anticipated to contribute valuable insights into improving the precision and effectiveness of shoulder joint injection techniques, thereby enhancing patient care and outcomes.

Material and Method

Study Design: This retrospective review study focused on a population undergoing MRI shoulder examinations at Thammasat University Hospital between 2020 and 2023.

Patients were excluded if they met any of the following criteria :

- History of previous shoulder surgery
- Fracture around the shoulder
- Massive rotator cuff tear
- Septic shoulder joint
- Osteoarthritis
- Labral injury

MRI Measurements: The following measurements were taken from MRI images

1.Measurement of angles for needle insertion:

- The needle insertion point was marked 1 cm lateral to the coracoid process[8], in the same plane as the scapular spine parallel to the distance from the coracoid tip [Figure1].

- Angles for needle insertion into the glenohumeral joint were measured in the horizontal plane, starting from 0 degree [Figure2].

- The length of the needle was determined by measuring the center of the first zone representing the needle length [Figure3].

- Angles for needle insertion into the joint were also measured in the vertical plane,starting from 0 degrees[Figure4].

2.Measurement of angle to the acromion :

- The injection point was linked to the coronal view T1, and the angle from the injection point to the lateral acromion was measured [Figure5].

Results

The study population consisted of 323 individuals, with ages ranging from 19 to 85 years (mean age: 58 years). Among them, 101 (31.27%) were male, and 222 (68.73%) were female. The distribution according to BMI categories was as follows: ≤ 18.5 kg/m^2 (n=14), 18.5 – 24.9 kg/m^2(n=172), 25.0 – 29.9 kg/m^2 (n=99), and ≥ 30.0 kg/m^2 (n=38).

The results of angle measurements indicating accuracy for needle insertion into the glenohumeral joint were as follows:

1.In the BMI ≤ 18.5 kg/m^2 group

- Horizontal plane: Injection zone ranged from 31.5 to 90.5 degrees, with a center at 61 degrees.
- Vertical plane: Injection zone ranged from 66.5 to 129.5 degrees, with a center at 98 degrees.
- Average needle length: 21.09 mm
- Angle between external landmark and acromion: 54.5 degrees

2. In the BMI 18.5 – 24.9 kg/m^2 group

- Horizontal plane: Injection zone ranged from 40 to 92 degrees, with a center at 68 degrees
- Vertical plane: Injection zone ranged from 69 to 126 degrees, with a center at 97.5 degrees
- Average needle length: 25.12 mm
- Angle between external landmark and acromion: 51 degrees

3. In the BMI 25.0 – 29.9 kg/m^2 group

- Horizontal plane: Injection zone ranged from 49 to 91 degrees, with a center at 70 degrees
- Vertical plane: Injection zone ranged from 71 to 121 degrees, with a center at 96 degrees
- Average needle length: 30.1 mm
- Angle between external landmark and acromion: 52 degrees

4. In the BMI ≥ 30.0 kg/m^2 group

- Horizontal plane: Injection zone ranged from 56.5 to 92.5 degrees, with a center at 74.5 degrees
- Vertical plane: Injection zone ranged from 72 to 121.5 degrees, with a center at 96.75 degrees
- Average needle length: 33.49 mm
- Angle between external landmark and acromion: 49 degrees

Conclusions

The findings of this study provide valuable insights into identifying suitable angles for blind injection of medication into the anterior aspect of the glenohumeral joint without the aid of special equipment. Interestingly, consistent results were observed across all BMI groups in the studied population.

The majority of the population fell into the BMI categories of 18.5-24.9 kg/m^2 and 25.0-29.9 kg/m^2, comprising 172 and 99 individuals, respectively, totaling 271 out of 343 (79%) participants. In these groups, the optimal angle for injection in the horizontal plane was approximately 69 degrees from the lateral side, while in the vertical plane, it was approximately 96.75 degrees from the top. Additionally, the angle between the external marking landmark and the most lateral aspect of the acromion process was approximately 51.5 degrees from the top, we therefore use an estimate from the injection point, at approximately 51.5 degrees from the lateral most part of the acromion, which corresponds to the 2 o'clock position on a clock face.

The average needle length required for injections in these BMI groups was approximately 27.52 mm, suggesting the use of a needle length of 1.5 inches. However, it is noteworthy that for individuals with BMI $\leq$ 18.5 kg/m^2 or BMI $\geq$ 30.0 kg/m^2, slight variations in angle measurements and needle length may be warranted based on the presented data. However, if you want to use a needle length that can be injected into everyone in the BMI weight group, you can use a 1.5 inch needle length

Figure & Table 1.

Table I. Summary of results

BMI (kg/m^2)	N (323)	Horizontal (degree)	Vertical (degree)	Length (mm)	Acromion angle (degree)
≤18.5	14 (4.33%)	31.5-90.5 (61)	66.5-129.5 (98)	21.0914286	54.5
18.5-24.9	172 (53.25%)	40-92 (68)	69-126 (97.5)	25.5176744	51
25.0-29.9	99 (30.65%)	49-91 (70)	71-121 (96)	30.099899	52
≥30	38 (11.77%)	56.5-92.5 (74.5)	72-121.5 (96.75)	33.4871053	49

Figure & Table 2.

Table II. Summary of Intraclass correlation coefficient (ICC)

	Intra-rater Reliability		Inter-rater Reliability	
	ICC (95%CI)	p-value	ICC (95%CI)	p-value
Horizontal	0.922 (0.834-0.964)	<0.001	0.973 (0.949-0.987)	<0.001
Start	0.889 (0.769-0.949)	<0.001	0.972 (0.946-0.986)	<0.001
Stop	0.963 (0.890-0.988)	<0.001	0.974 (0.935-0.991)	<0.001
ZoneCenter	0.964 (0.891-0.988)	<0.001	0.975 (0.938-0.991)	<0.001
Center				
Injection	0.923 (0.777-0.975)	<0.001	0.974 (0.935-0.991)	<0.001
Length	0.949 (0.889-0.977)	<0.001	0.989 (0.979-0.995)	<0.001
Vertical	0.915 (0.815-0.962)	<0.001	0.975 (0.952-0.988)	<0.001
V2	0.751 (0.509-0.879)	<0.001	0.915 (0.835-0.960)	<0.001
Stop2	0.949 (0.837-0.985)	<0.001	0.988 (0.967-0.996)	<0.001
ZoneCenter2	0.971 (0.905-0.992)	<0.001	0.989 (0.972-0.997)	<0.001
Center				
Injection2	0.881 (0.637-0.964)	<0.001	0.970 (0.917-0.991)	<0.001
Acromioangle	0.924 (0.840-0.965)	<0.001	0.972 (0.947-0.987)	<0.001

Values less than 0.5 are indicative of poor reliability

values between 0.5 and 0.75 indicate moderate reliability,

values between 0.75 and 0.9 indicate good reliability,

and values greater than 0.90 indicate excellent reliability [9].