Frontiers in Health InformaticsISSN-Online: 2676-7104 www.healthinformaticsjournal.com
2024; Vol 13: Issue 7 Open Access

A Study of Patient Position Indices for Accurate Radiography in Glenohumeral Joint Projection [Grashey method]

Joo Young-Cheol[1] and Hong Dong-Hee[2]*
[1]Department of Radiology, Samsung Medical Center, South Korea
[2]Department of Radiological Science, Shinhan University, South Korea

Cite this paper as:
Joo Young-Cheol and Hong Dong-Hee (2024). A Study of Patient Position Indices for Accurate Radiography in Glenohumeral Joint Projection [Grashey method]. *Frontiers in Health Informatics,* 13(7), 1304-1311.

***Purpose**: The purpose of the present paper is to offer the meniscus shadow distance and image anatomical values of the scapular pole and scapular body according to gender and age, and to provide anatomical indicators for radiological technologists to easily create accurate glenohumeral joint images regardless of the patient's shoulder shape.*

***Materials and methods:** This study retrospectively examined 200 left shoulder joint anteroposterior projection and superoinferior axial projection images of patients who visited a general hospital in Seoul from December 1 to December 31, 2023, with shoulder joint pain. The researcher measured the Halfmoon sign distance, scapular spine angle, scapular plane angle, and scapular body angle, and compared and analyzed the difference in mean values and correlation between each variable.*

***Results**: The average value of the Halfmoon sign distance was 12.08±4.18 ㎜, and males were found to be about 3 ㎜ larger than females, but there was no statistically significant difference according to age. The average scapular spine angle was 15.95±13.20°, and when comparing the average values by gender, females were about 1° larger than males. When compared by age groups, those in their 30s had the smallest at 11.17±4.00°, followed by those in their 20s and younger and those in their 60s; The 70s were measured at similar angles. The average scapular plane angle was 41.04±8.74°, and the difference by gender was not statistically significant, but the difference by age was lowest in those in their 50s and highest in those in their 70s or older. The average scapular body angle was measured at 57.00±11.06°, and the difference between genders was about 3° larger in females than in males, but there was no statistically significant difference. Differences by age showed the largest angle in the 70s or older group and the smallest angle in the 30s group. The correlation results between each measurement showed a weak positive correlation between Halfmoon sign distance, scapular spine angle, scapular plane angle, and scapular body angle. Still, the scapular spine angle showed a strong positive correlation with the scapular plane angle and scapular body angle.*

***Conclusion**: As a result of this study, the average size of the Halfmoon sign distance was 12.08 ± 4.18 mm, the scapular spine angle was 15.95 ± 13.20°, the scapular plane angle was 41.04 ± 8.74°, and the scapular body angle was 57.00 ± 11.06°. During glenohumeral joint projection, it is believed that positioning the scapular spine so that it is level with the image receptor will help produce accurate glenohumeral joint images.*

***Keywords:** glenohumeral joint, glenohumeral joint projection[Grashey method], Halfmoon sign, scapular spine, scapular plane, scapular body*

Ⅰ. INTRODUCTION

The shoulder joint is the joint in the human body with the widest range of motion, formed by the scapula, humerus, and the lateral part of the clavicle. The scapula is located on the posterior side of the thorax, serving as the origin and insertion point for numerous muscles and ligaments involved in shoulder movement. The key joints comprising the shoulder include the **acromioclavicular joint**, formed by the clavicle and the acromion, and the **glenohumeral joint (GH)**, created by the humeral head and the glenoid fossa. Due to its anatomical structure, which resembles a golf ball perched on a tee, the GH joint is known to be the joint with the greatest range of motion in the body and is also considered the most unstable joint [1,2].

The primary diagnosis of shoulder joint disorders typically begins with a physician's physical examination. However, because physical examinations inherently involve subjective assessments by the physician, radiologic examinations are subsequently conducted to provide a more objective diagnosis. Among the radiologic examinations for the shoulder joint, radiography is the most fundamental diagnostic approach [3]. The standard radiographic procedures for diagnosing shoulder disorders include the **shoulder anteroposterior projection (shoulder AP)** and the **glenoid fossa projection (Grashey method; GHAP)** [4].

In the anatomical position, the scapula is located at the posterolateral side of the thorax, with the glenoid fossa oriented approximately 35° anteriorly in the frontal plane. Consequently, the shoulder AP view often reveals an overlapping shadow of the scapular glenoid and part of the humerus, forming a characteristic half-moon shadow and displaying an oblique view of the glenoid. In contrast, the GHAP provides a direct view of the glenohumeral joint (GH), making it highly useful for observing fractures of the glenoid or other related disorders. Some international studies and textbooks refer to the GHAP as the “true AP” view [3,5].

To obtain the shoulder AP image, X-rays are vertically directed onto the patient with the body in the coronal plane, parallel to the detector. In contrast, the GHAP requires rotating the upper body 40-45° towards the affected side [4,6]. However, as the rotation angle specified in textbooks is only a guideline, radiologic technologists often rely on their intuition to adjust this angle. Additionally, factors such as shoulder morphology, ethnicity, lifestyle, and spinal kyphosis make it challenging to obtain an accurate image. To compensate, some radiologic technologists use subjective experience and the size of the half-moon shadow to estimate the degree of body rotation required.

This study aims to present radiographic anatomical measurements, such as the distance of the half-moon shadow, the scapular spine, and the scapular body, and to analyze the correlation between the half-moon shadow and the anatomical structures of the scapula. By establishing an anatomical reference that allows radiologic technologists to achieve accurate GHAP images regardless of the patient's shoulder morphology, we aim to reduce retake rates, minimize patient radiation exposure, and improve the operational efficiency of radiologic technologists.

Ⅱ. SUBJECTS AND METHODS

1. Subjects of the Study

This study was conducted retrospectively, using radiographic images of patients who presented with shoulder pain at a tertiary hospital in Seoul from December 1 to December 31, 2023. The study population included 98 males and 102 females, with age distribution as follows: 9 patients in their 20s, 14 in their 30s, 23 in their 40s, 56 in their 50s, 68 in their 60s, and 30 aged 70 and above.

In this study, only the **shoulder anteroposterior projection (shoulder AP)** and **shoulder superoinferior axial projection (shoulder axial)** images were selected for analysis from the various shoulder radiographs performed on these patients. Given that the right shoulder is typically more frequently used and subject to greater movement, we focused solely on the left-side images to minimize variability from movement. Furthermore, images of patients who had undergone shoulder surgery, as well as those with degenerative joint disease, humeral fractures, or anterior/posterior dislocations, were excluded from the study.

2. METHODS

1) Image Examination Methods

(1) Shoulder Anteroposterior Projection Method

For the shoulder anteroposterior (AP) view, the image was acquired with the patient standing directly in front of a wall-mounted detector in a neutral position. In this position, the arm was kept in a natural, neutral position without external or internal rotation to ensure optimal visualization of the humeral head and glenoid cavity.

The central X-ray beam was directed perpendicularly toward the glenohumeral (GH) joint, ensuring accurate alignment for clear imaging of the joint structures. The source-to-image receptor distance (SID) was fixed at 100 cm to maintain consistent image magnification and resolution quality.

(2) Methods for Vertical Shoulder Joint Examination

In the shoulder axial imaging technique, the patient is positioned seated at the end of the examination table. The patient's torso is kept upright, and the examined arm is abducted until the elbow joint makes contact with the image receptor. During this process, the patient's torso is tilted toward the elbow joint to maintain alignment. The central X-ray beam is directed perpendicularly toward the glenohumeral (GH) joint, and a source-to-image distance (SID) of 100 cm is used.

2) Image Analysis Methods

This study obtained research data by measuring the relationships between anatomical structures on Shoulder AP and Shoulder axial images, with the measurements conducted directly by the researcher using the picture archiving and communication system (PACS). The measurement methods for each image are as follows.

(1) Measurement method for halfmoon sign distance(HSD)

Humeral-Socket Distance (HSD) was measured on Shoulder AP images by drawing perpendicular lines at the overlapping edges of the humeral head and the glenoid cavity. The distance between these two lines was defined as the overlapping range of the crescent-shaped shadow. (**Fig. 1a**).

(2) Measurement method for scapular spine angle(SSA)

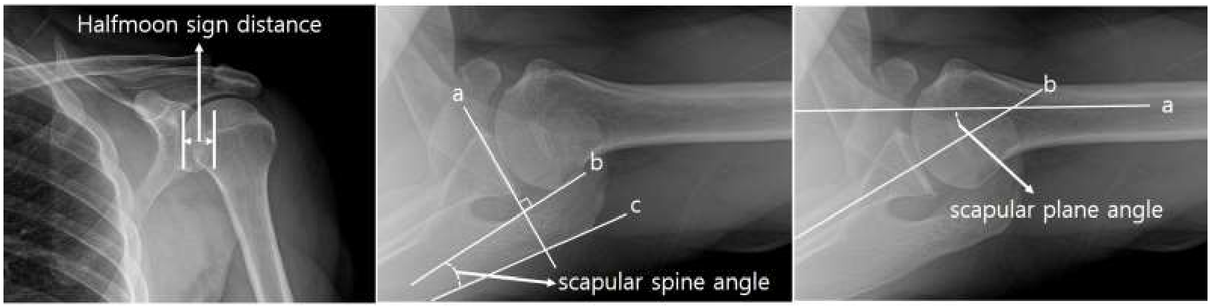
The Scapular-Spine Angle (SSA) was defined on Shoulder axial images as the angle formed between line (a), which is perpendicular to the extended line of the glenoid cavity, and line (b), which represents the posterior aspect of the scapular spine. This angle indicates the degree to which the posterior aspect of the scapular spine must be rotated backward to position the glenoid cavity perpendicular to the image receptor. (**Fig. 1b**).

(3) Measurement method for scapular plane angle(SPA)

The Scapular-Plane Angle (SPA) was defined on Shoulder axial images as the angle between the coronal plane of the body (line a) and the scapular body (line b), representing the degree of anterior deviation of the scapular body. The coronal plane was based on the line horizontally aligned with the midpoint of the glenoid cavity on the image, while the scapular body line was determined by the extended line of the scapular body as shown in the image. (**Fig. 1c**).

(4) Measurement method for scapular angle(SA)

The Scapular Angle represents the sum of the Scapular-Spine Angle (SSA) and the Scapular-Plane Angle (SPA), indicating the overall degree to which the scapula is tilted forward relative to the thorax.



(a) (b) (c)

Fig 1. Measurement method for halfmoon sign distance, scapular spine angle and scapular plane angle

(a) is a method of measuring the distance of the halfmoon sign. It represents the overlap distance between the humerus head and the posterior glenoid rim. (b) is a method of measuring scapular spine angle. This angle is the angle formed between the line perpendicular to the glenoid fossa and the outline of the scapular spine. (c) is the scapular plane angle. This angle represents the angle formed between the coronal plane and the scapula body.

3) DATA ANALYSIS METHODS

The data analysis methods in this study included descriptive statistics and percentiles for each measurement, with normality tested using the Shapiro-Wilk test ($p > 0.05$). To compare the means between groups by gender, an independent t-test was used, while one-way ANOVA was employed for comparing means across age groups, with Duncan's test applied as a post-hoc analysis. Correlations between variables were analyzed using Pearson's correlation analysis. Data analysis was conducted with SPSS (version 22.0, SPSS, Chicago, IL, USA), with the significance level (α) set at 0.05 and p-values below 0.05 considered statistically significant. The specific data analysis methods for each approach are as follows.

Ⅲ. RESULT

1. Descriptive Statistics and Percentiles of HSD, SSA, SPA, SA

The mean values for each independent variable in this study were as follows: the crescent shadow distance was 12.08±4.18 mm, the Scapular-Spine Angle was 15.95±13.20°, the Scapular-Plane Angle was 41.04±8.74°, and the Scapular Angle was measured at 57.00±11.06° (Table 1).

Table 1. Descriptive statistics and frequency analysis results for each variable

variable	n	mean ±SD	min	max	percentile						
					5	10	25	50	75	90	95
HSD(㎜)	200	12.08 ± 4.18	2.90	25.30	5.02	7.10	9.70	11.70	14.40	17.19	20.68
SSA(°)		15.95 ±13.20	3.00	33.00	6.80	8.32	12.30	15.35	19.70	23.49	26.17
SPA(°)		41.04 ± 8.74	19.90	62.00	23.86	28.51	35.75	41.70	47.30	51.76	54.17
SA(°)		57.00 ±11.06	26.10	87.70	38.13	42.61	50.05	57.05	63.95	72.15	76.63

1. HSD is Halfmoon sign distance. SSA is scapular spine angle. SPA is scapular plane angle, SA is scapular angle.

2. Comparison of the mean values of HSD, SSA, SPA, and SA according to gender

The mean value of the crescent shadow distance was 13.26±4.47 mm for males and 10.93±3.54 mm for females. The mean Scapular-Spine Angle was measured at 15.11±6.34° for males and 16.76±4.79° for females. The mean Scapular-Plane Angle by gender was 40.83±8.18° for males and 41.24±9.28° for females, while the Scapular Angle was 55.95±11.12° for males and 58.00±10.96° for females. The differences in the mean values of the crescent shadow distance and the Scapular-Spine Angle were statistically significant (p<0.05), whereas the Scapular-Plane Angle and Scapular Angle showed no statistically significant differences (p>0.05) (Table 2).

Table 2. Average comparison results of each variable according to sex

variable	sex	n	mean±SD	min	max	t	p
HSD(㎜)	male	98	13.26±4.47	3.90	25.30	4.104	0.001
	female	102	10.93±3.54	2.90	21.30		
SSA(°)	male	98	15.11±6.34	3.00	33.00	-2.068	0.039
	female	102	16.76±4.79	6.20	28.30		
SPA(°)	male	98	40.83±8.18	21.10	56.20	-3.26	0.745
	female	102	41.24±9.28	19.90	62.00		
SA(°)	male	98	55.95±11.12	26.10	54.80	-1.315	0.190
	female	102	58.00±10.96	27.00	87.70		

1. HSD is Halfmoon sign distance. SSA is scapular spine angle. SPA is scapular plane angle, SA is scapular angle.
2. 'p' was calculated independent t-test.

3. Comparison of the mean values of HSD, SSA, SPA, and SA by age group.

The mean value of the crescent shadow distance was 11.70±4.91 mm for those under 20 years old, 10.63±3.70 mm for those in their 30s, 11.14±3.76 mm for those in their 40s, 12.31±3.74 mm for those in their 50s, 12.33±3.98 mm for those in their 60s, and 12.63±5.56 mm for those over 70 years. There was no statistically significant difference among age groups (p>0.05), and post-hoc analysis indicated they belonged to the same group.

The mean Scapular-Spine Angle (SSA) by age group was as follows: 17.80±5.65° for those under 20, 11.17±4.00° for those in their 30s, 14.86±5.78° for those in their 40s, 15.25±5.32° for those in their 50s, 17.12±6.01° for those in their 60s, and 17.12±4.67° for those over 70 years. There was a statistically significant difference among age groups (p<0.01), and post-hoc analysis identified only the 30s age group as an independent group.

For the Scapular-Plane Angle (SPA), the mean values by age group were 39.40±5.94° for those under 20, 39.70±11.71° for those in their 30s, 39.83±9.55° for those in their 40s, 38.95±8.14° for those in their 50s, 41.79±8.84° for those in their 60s, and 45.29±6.79° for those over 70 years. The differences in mean values among age groups were statistically significant (p<0.05). The 20s and 30s groups were classified as the same group, while the 70s-and-above group was identified as an independent group.

The mean Scapular Angle (SA) by age group was 57.20±6.81° for those under 20, 50.87±13.09° for those in their 30s, 54.70±10.31° for those in their 40s, 54.21±9.43° for those in their 50s, 58.91±12.01° for those in their 60s, and 62.41±9.53° for those over 70 years. The differences in mean values among age groups were statistically significant (p<0.01). Post-hoc analysis revealed that the under-20 age group was similar to all other age groups, while only the 30s and 70s-and-above groups were independent groups.

4. Correlation Analysis Results of HSD, SSA, SPA, and SA.

The analysis of correlations between each dependent variable showed that the correlations between dependent variables by gender were not significant. However, there was a weak negative correlation between age and the crescent shadow distance (r=-.281, p<0.01). The crescent shadow distance showed a weak positive correlation with the Scapular-Spine Angle (r=.204, p<0.01), Scapular-Plane Angle (r=.264, p<0.01), and Scapular Angle (r=.313, p<0.01). Additionally, there was a strong positive correlation between the Scapular-Spine Angle and Scapular Angle (r=.623, p<0.01), and a very strong positive correlation between the Scapular-Plane Angle and Scapular Angle (r=.863, p<0.01).

Table 3. Average comparison results of each variable according to age

variable	age	n	mean±SD	min	max	F	p
HSD(㎜)	under 20	9	11.70±4.91	3.50	20.30	0.766	0.576
	30	14	10.63±3.70	6.40	19.30		
	40	23	11.14±3.76	4.20	19.90		
	50	56	12.31±3.74	4.50	21.30		
	60	68	12.33±3.98	4.80	23.00		
	over 70	30	12.63±5.56	2.90	25.30		
SSA(°)	under 20	9	17.80±5.65^{b}	11.20	27.60	3.598	0.004
	30	14	11.17±4.00^{a}	5.00	19.20		
	40	23	14.86+5.78^{b}	6.20	26.30		
	50	56	15.25±5.32^{b}	6.20	28.30		
	60	68	17.12±6.01^{b}	3.00	33.00		
	over 70	30	17.12±4.67^{b}	7.60	26.20		
SPA(°)	under 20	9	39.40±5.94^{a}	30.360	49.30	2.457	0.035
	30	14	39.70±11.71^{a}	21.10	56.20		
	40	23	39.83±9.55^{ab}	20.30	57.40		
	50	56	38.95±8.14^{a}	19.90	60.20		
	60	68	41.79±8.84^{ab}	22.20	62.00		
	over 70	30	45.29±6.79^{b}	26.90	55.90		
SA(°)	under 20	9	57.20±6.81^{abc}	45.30	66.30	3.874	0.002
	30	14	50.87±13.09^{a}	26.10	75.40		
	40	23	54.70±10.31^{ab}	27.00	74.80		
	50	56	54.21±9.43^{ab}	32.20	77.80		
	60	68	58.91±12.01^{bc}	35.00	87.70		
	over 70	30	62.41±9.53^{c}	34.50	80.40		

1. HSD is Halfmoon sign distance. SSA is scapular spine angle. SPA is scapular plane angle, SA is scapular angle.
2. 'p' was calculated one-way ANOVA and post hoc was Duncan.

Table 4. Correlation analysis results of HSD, SSA, SPA, and SA

variable	sex	age	HSD(㎜)	SSA(°)	SPA(°)	SA(°)
sex	1					
age	.127	1				
HSD(㎜)	-.281**	.113	1			
SSA(°)	.146*	.177*	.204**	1		
SPA(°)	.023	.184**	.264**	.142*	1	
SA(°)	.093	.236**	.313**	.623**	.863**	1

1. HSD is Halfmoon sign distance. SSA is scapular spine angle. SPA is scapular plane angle, SA is scapular angle.
2. 'p' was calculated Pearson's correlation analysis.

VI. 고 찰

When anterior dislocation occurs, a Hill-Sachs lesion develops on the posterolateral aspect of the humeral head, often accompanied by a Bankart lesion, which is a fracture occurring on the anterior border of the inferior glenoid. A Bankart lesion involves tearing of the cartilage portion of the anteroinferior labrum and sometimes causes fractures in the labral region. When a scapular fracture results from external trauma, it is essential to observe glenoid rim and glenoid fractures due to joint involvement, accounting for about 10% of scapular fractures [3].

The Grashey method, developed by Grashey in 1923, allows accurate imaging of the glenohumeral (GH) joint without overlap of the humeral head and coracoid process. This method is particularly useful for observing anterior, inferior, and anterior dislocations, calcifications, and posterior dislocations when suspected [3,7]. In standard Shoulder AP images, the humeral head and glenoid may appear overlapped, making posterior dislocation easy to overlook. In such cases, GHAP is highly helpful; in normal situations, the GH space is clearly delineated, while in posterior dislocation, the joint space appears overlapped by the humeral head and glenoid. A compression fracture on the anteromedial side of the humeral head, known as the Trough sign, is indicative of posterior dislocation when exceeding 6 mm [8]. Another study suggested that GHAP is more effective than Shoulder AP in visualizing the humeral head and greater tuberosity (GT), making it easier to observe calcifications and osteophytes in the GT and providing evidence for medium-sized rotator cuff tears [9,12]. Additionally, it has been proposed to measure the Critical Shoulder Angle (CSA), defined as the angle from the lateral end of the acromion to the inferior end of the glenoid, as well as the distance from the humeral head's center of rotation to the acromion, acromiohumeral distance, and scapular neck length, especially before shoulder replacement surgery [10].

Given its importance, efforts have been made to acquire GHAP images in a supine position. Previous research suggests that adjusting the X-ray angle by 30–35° towards the midsagittal plane of the body can produce images similar to those in the standing GHAP position [4]. Jae-seop Lee and colleagues proposed that rotating the body by 40° provides the best visualization of the GH joint [11].

However, most prior studies have focused on the optimal X-ray incidence angle and upper body rotation for accurate GHAP imaging, while there has been limited exploration of imaging characteristics or examination methods based on anatomical structure for various shoulder types. Thus, this study aimed to provide objective data on image characteristics and propose methods for accurate GHAP imaging across different shoulder structures. The discussion of these findings is as follows:

In Shoulder AP, the mean HSD was 12.08±4.18 mm, with males having an approximately 3 mm larger HSD than females. No statistically significant differences were observed across age groups. The mean SSA was 15.95±13.20°, with females having a mean about 1° larger than males. Among age groups, the 30s showed the smallest angle at 11.17±4.00°, while those under 20, in their 60s, and over 70 showed similar angles.

For SPA, literature mentions that the scapular plane is directed approximately 30–40° anteriorly to the coronal plane [2], and this study found a similar mean value of 41.04±8.74°. SPA showed no significant gender differences, but age-based differences were significant, with the 50s group showing the lowest angle and those over 70 showing the highest angle.

The mean SA was measured at 57.00±11.06°, with females having an average of about 3° higher than males, though not statistically significant. By age, those over 70 had the largest angle, while the 30s showed the smallest angle.

Correlation analysis among the measurements revealed a weak positive correlation between HSD and SSA, SPA, and SA, while SSA showed a strong positive correlation with SPA and SA. These results suggest that considering SSA and SPA rather than HSD may facilitate accurate GHAP imaging. Therefore, aligning the easily palpable scapular spine parallel to the image receptor during GHAP examination may aid in obtaining accurate GHAP images.

As the measurements in this study were obtained from Shoulder Axial images, there may be slight discrepancies from gross anatomical features. Prospective studies based on these results may offer further clinical insights.

Ⅴ. CONCLUSION

This study aimed to present imaging anatomical measurements of the crescent shadow distance, scapular spine, and scapular body, and to examine the correlations between the anatomical structures of the crescent shadow and scapula to facilitate accurate GHAP imaging. The results are as follows:

The mean value of the crescent shadow distance was 12.08±4.18 mm, while the Scapular-Spine Angle, Scapular-Plane Angle, and Scapular Angle were measured at 15.95±13.20°, 41.04±8.74°, and 57.00±11.06°, respectively.

Correlation analysis indicated that, compared to the crescent shadow distance, the Scapular-Spine Angle showed a strong positive correlation with both the Scapular-Plane Angle and Scapular Angle. This suggests that positioning the scapular spine parallel to the image receptor during GHAP may aid in obtaining accurate GHAP images.

REFERENCE

1. Admam Greenspan, Orthopedic imaging A practical Approach 4thedition, 2004 LIPPINCOTT WILIAMS &WILKINS, 93~131
2. Donald A. Neumann, Kinesiology of the Musculoskeletal system Foundations for Rehabilitation 3rd edition, 135~139
3. Ajay Goud, Dmitri Segal, Pejman Hedayati, John J. Pan, Barbara N. Weissman, Radiographic evaluation of the shoulder, European Journal of Radiology, 68, 2-15, 2008
4. Seo Jae-Hyun, Choi Nam-Gil, Consideration of Shoulder Joint's Image with the Changed Tube Angle of the Shoulder Oblique Projection in Supine Position, Journal of Radiological Science and Technology, 31(2), ,109-114, 2008
5. Timothy G, Sanders, Sean L. Jersey, Conventional Radiography of the Shoulder, Seminars in roentgenology. WB Saunders, 40(3), 207-222, 2005.
6. The Korean Society of Medical Imaging Technology, TEXTBOOK of Radiographic Positioning AND Clinical Diagnosis 6th edition(vol Ⅰ), 2020. CHUNG-KU Publisher, 173
7. Charles A, RockWood, Jr, Frederick A. Matsen, Ⅲ, Michael A. Wirth, Steven B. Lipptitt, The Shoulder 4th edition, 2009, SAUNDERS ELSEVIER, 177~179
8. Stephan J. Cisternino, Lee F. Rogers, Bradley C. Stufflebam, Gerald D. Kruglik, The Trough Line: A Raiographic Sign of Posterior Shoulder Dislocation, Am J Roentgenol 130, 951-954, 1978
9. Kyoung Hwan Koh, Kye Young Han, Young Cheol Yoon, Seung Won Lee, Jae Chul Yoo, True anteroposterior(Grashey)view as a screening radiography for further imaging study in rotator cuff tear, J shoulder Elbow Sur, 22. 91-97, 2013
10. Oh Joo-Han, Jeong Hyeon-Jang, Won Yoo-sun, Implant selection for successful revere total shoulder arthroplasty, Clin Shoulder Elbow 26(1), 93-106, 2023
11. Lee Jae-seob, Kim Young-jae, The Study of Grashey Method Viewing the Glenohumeral(shoulder) Joint, J. Korean Soc. Radiol., 9(6), 331-335, 2015
12. Charles A, RockWood, Jr, Frederick A. Matsen, Ⅲ, Michael A. Wirth, Steven B. Lipptitt, The Shoulder 4th edition, 2009, SAUNDERS ELSEVIER, 661~664