



A new method for measurement of the size of subacromial spurs of the shoulder by cassette tilt view

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Abstract

Objective Subacromial impingement syndrome is one of the most common causes of pain in the shoulder. To this date, there is no specific radiographic view that can be used to evaluate the size of a subacromial spur. This study aims to examine a cassette tilt view can be used to evaluate the size of a subacromial spur.

Methods A cross-sectional study was conducted between the time period of January 1, 2016, and December 31, 2016. Forty-three consecutive patients that had planned treatment of arthroscopic subacromial decompression (SAD) participated in this study. Rockwood view and cassette tilt view (caudal tilt 30° with beam and cassette) X-rays were done in all these patients. The measurements of the spur sizes were calculated from both views and were compared to the spur sizes measured intraoperatively.

Result The size of the spurs from intraoperative measurement was not significantly different from the spur size measured using the cassette tilt view with a mean difference of 0.54 (95% confidence interval (CI): -0.58, 1.65), but the intraoperative measurement was significantly different from the Rockwood view spur measurement, with a mean difference of 2.84 (95% CI: 1.56, 4.11). Average proportions of the size of the spur from the cassette tilt and Rockwood view compared to that from intraoperative measurements were 1.09 and 1.55, respectively.

Conclusion The cassette tilt view is a simple method of measurement of the size of subacromial spurs, with good inter- and intra-observer reliabilities and good validity. This can be useful clinically when setting the patient position and portals to evaluate the size of the spur when planning SAD.

Level of evidence This is level III.

Keywords Subacromial spur · Impingement syndrome · SAD · Rockwood view · Cassette tilt view

Introduction

Subacromial impingement syndrome (SIS) is a frequently encountered condition in primary healthcare. The incidence of shoulder complaints due to shoulder impingement

syndrome is 44–65% [3, 9]. SIS is a clinical diagnosis from history taking and physical examination with modified Neer test [3] and is then confirmed by radiography [7]. Currently, there are various shoulder radiography techniques to visualize the shoulder, such as the supraspinatus outlet view which

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enables physicians to see acromial morphologic traits, acromial slope and inferior osteophytes at the acromioclavicular joint. However, these techniques have limited reproducibility [2, 4] and no significant correlation was present between the various radiological measurements representing the subacromial distance and the SIS [4]. Some physicians may prefer a 30° caudal tilt view or Rockwood view to assess the morphology of the acromion [6]. There have been studies supporting the concept that caudal tilt view is superior at examination and evaluation of subacromial spurs when compared to anteroposterior view [6]. However, tilting X-ray beam to 30° hinders the beam from being perpendicular with the cassette, distorting the size and proportion of the radiography. Moreover, this technique was preferred for diagnosis only when there was no capability to measure the size of subacromial spurs for planning of treatment. Therefore, it can be considered that Rockwood view can be utilized for evaluating subacromial spurs qualitatively but not quantitatively. In addition, this view is unable to show the distinct radiography of the glenohumeral joint because the beam is not parallel with the scapular plane. Therefore, we have introduced the cassette tilt view, which is a radiography technique that can be used to measure the size of subacromial spurs (SS) with clear visualization of the glenohumeral joint by adjusting the cassette to be perpendicular with the X-ray beam at 30° vertically with the patient leaning 40° in order to make the beam perpendicular to the glenohumeral joint. This study was conducted to compare the size of SS when measured with the 30 caudal tilt view (Rockwood tilt view) and the cassette tilt view with reference to intraoperative measurement of the spur.

Materials and methods

The study design was prospective cross-sectional study, which was conducted at the Department of Orthopaedic Surgery in Thammasat University, Bangkok, Thailand during January 1, 2016, to December 31, 2016. A total of 43 patients whom consented to participate in this study were measured in Rockwood view, cassette tilt view and arthroscopic view. Baseline characteristics of age, male sex, and the affected side being the right side were 61 years, 35% and 48%. Informed consent was obtained from all study participants. Approval for the study was given by the Human Research Ethics Committee of Thammasat University protocol ID148/2559. The inclusion criteria for this study was patients aged 18 years and over with fully developed bones who underwent arthroscopic subacromial decompression for impingement syndrome for first time; patients with failed conservative treatment at least 6 months before surgery; and patients who were willing to participate and provided consent. The participants were excluded if they had any of the

following: prohibited from surgery or prohibited from plain radiography, or patients who had previous shoulder surgery on that side.

Radiographic and arthroscopic measurement

The radiography in this study was performed by a radiology technician. Contrast media scale was used for calibration which was placed on the film cassette with a support to bring it as close to the bone as possible. Radiographs of the Rockwood (30° caudal tilt) views were obtained by placement of the film cassette behind the shoulder of the patient, who was standing 35 cm between the cassette and the source. The X-ray film was projected from the anterior direction at a 30° tilt superiorly to inferiorly. Radiographs of the cassette tilt view were obtained with the patient in standing position (Fig. 1). Patients were instructed to turn approximately 40°, in which the film cassette was placed on the back of the scapula parallel to the scapular blade, which allowed the true AP view of the glenoid to be obtained (Fig. 1), and then, the X-ray beam was projected the same way of Rockwood view (Fig. 1). One orthopedic resident and one orthopedic surgeon who had completed a fellowship in sports surgery evaluated the radiographs. The measurement of the SS size in the cassette tilt view and the Rockwood view is defined as a length measured by using distance between two specific lines; the first line from the inferior border of the acromion to the inferior border of the clavicle. The second line was the line parallel to the first line at the end of SS (Figs. 2 and 3). For arthroscopic measurement, the SS size was measured using an arthroscopic ruler during the arthroscopic subacromial decompression procedure with posterior and lateral portals (Fig. 4). We measured the SS size intraoperatively from the lower border of the clavicle to the tip of the coracoid using the lateral portal with the camera post pointed to 2 o'clock and 11 o'clock on the right and the left shoulders, respectively. Post-operative X-rays were done to assess whether adequate resection was performed.

Statistical analysis

We estimated the sample size for one-sample comparison of two means to the hypothesized value. The mean size difference and standard deviation (SD) between the cassette tilt view and arthroscopic measurements were 1 and 1.99 mm (pilot study). The assumptions are defined as the following: Type I error, power of test, ratio of the treatment groups and detect mean difference were set at 0.05, 0.80, 1:1, and 1 mm, respectively. The estimated required sample size was 43 patients. Data were described using frequency for categorical data, and mean (SD) or median (range) where appropriate for continuous data. The mean difference of SS size was compared between Rockwood view or cassette view and

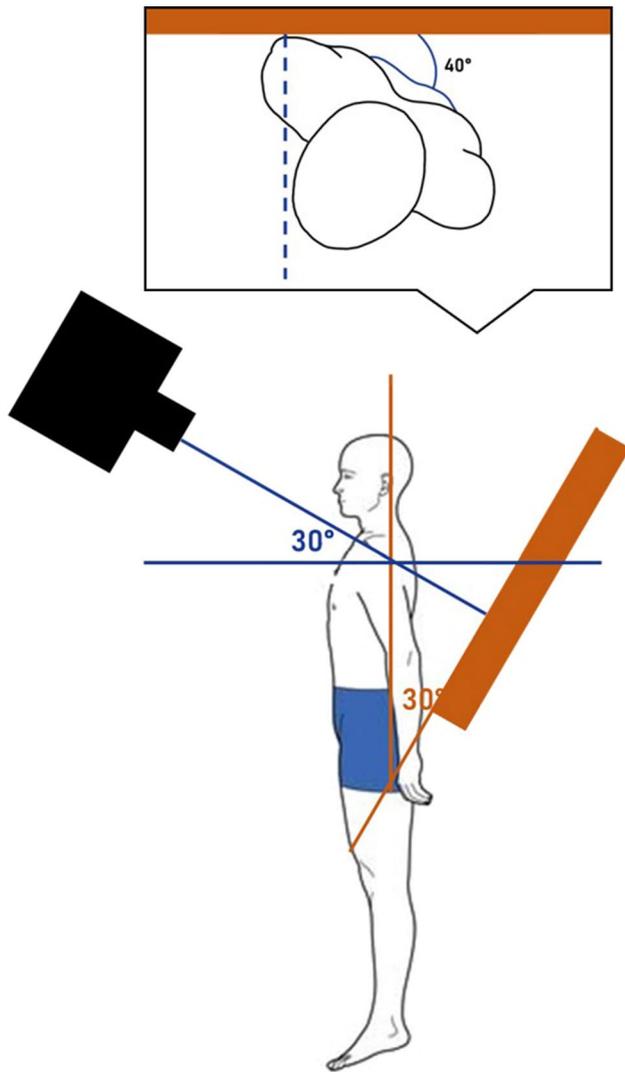


Fig. 1 Cassette tilt view: patient is standing with slight tilt of 40 and beam is projected from front, perpendicular to scapula and parallel to acromion (upper). Cassette is tilted to make it perpendicular to X-ray beam. The film was placed behind the shoulder of the patient, who was standing 35 cm between the cassette and the source. The X-ray beam was projected from the anterior direction at a 30° tilt from superior to inferior (lower)

arthroscopic measurement using *t* test for categorical data and continuous data. Inter- and intra-observer reliabilities were assessed using the limit agreement test. All analyses were performed using STATA version 15.0. A *p* value < 0.05 was considered as statistically significant.

Results

The mean size of SS in cassette tilt, Rockwood and arthroscopic measurements were 5.98 (3.01), 8.30 (3.62) and 5.44 (2.11) mm, respectively. The measurement of SS in



Fig. 2 X-ray obtained by cassette tilt view with demonstration of spur size measurement. The measurement is defined as a length was measured by using distance between two lines; first line from inferior border of Acromion to inferior border of clavicle. And the second line was the parallel to the first line at the end of SS



Fig. 3 X-ray obtained by Rockwood view with demonstration of spur size measurement. The measurement is defined as a length was measured by using distance between two lines; first line from inferior border of Acromion to inferior border of clavicle. And the second line was the parallel to the first line at the end of SS

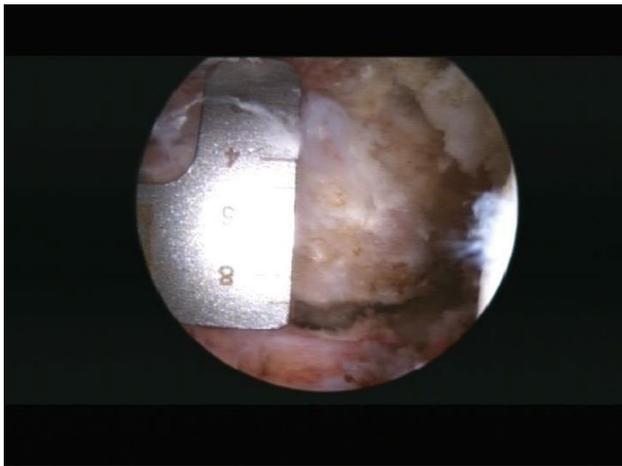


Fig. 4 Arthroscopic view of spur size measurement using arthroscopic ruler

Rockwood view had a statistically significant difference of 2.84 (95% confidence interval (CI): 1.56, 4.11) mm higher when compared to arthroscopic views. Compared to arthroscopic views, there was no statistically significant difference of SS size measured by cassette tilt view with a mean difference of 0.54 (95% CI: -0.58 , 1.65) mm (Table 1). This implies that when compared to arthroscopic view, cassette tilt view had no statistically significant difference in the measures size of SS, while the Rockwood view had statistically significantly higher measurements of approximately 3 mm (Table 1). In cassette tilt and Rockwood view measurements, the mean difference with 95% limits of agreement of intra-observer was 0.24 (-1.61 , 2.09) and -0.20 (-3.11 , 2.71) mm, respectively. The mean difference with

95% limits of agreement of interobserver of cassette tilt view and Rockwood view measurement was -0.18 (-2.26 , 2.63) and -0.10 (-2.77 , 2.58) degrees, respectively (Table 1). Table 1 shows a comparison of the size of SS measured by Rockwood view and cassette tilt view, our novel measurement technique. Here, the intra- and interobserver mean difference is 0.24 mm and -0.18 with a 95% confidence interval -1.61 to 2.09 mm and -2.26 to 2.63 mm. Thus, the cassette tilt view tends to give a lower reading, being between -1.61 to 2.09 mm and -2.26 to 2.63 mm. Despite this, the limits of agreement (-3.11 to 2.71 and -2.77 to 2.58) are small enough for us to be confident that the cassette tilt view can be used in place of the Rockwood view for SS size measurement.

Discussion

This research was conducted to design a radiographic imaging technique that could measure the size of the spur that would provide an accurate measurement when compared to the actual size of the spur. Kitchel et al. [5] and Ono et al. [8] reported the use of the Rockwood tilt view to evaluate the prominence of the anterior acromion. The 30° in the caudal direction aligns the X-ray beam parallel to the inferior surface of the acromion, allowing the inferiorly projecting spurs to be more easily visualized. Cone et al. [1] also supported this theory by stating that the delineation of SS can be improved by tilting the beam 30° caudally [6]. This view would help in preoperative planning for patient with shoulder impingement syndrome. However, the Rockwood view with a beam of 30° was unable to measure the size of the spur because the cassette was not perpendicular to the X-ray

Table 1 Comparison of mean spur size of patients between Rockwood view, cassette view with arthroscopic view and intra- with interobserver reliabilities test

Measurement view	N	Mean	SD	95% CI		
Cassette tilt view	43	5.98	3.01	5.05, 6.91		
Rockwood view	43	8.30	3.62	7.16, 9.39		
Arthroscopic view	43	5.44	2.11	4.80, 6.09		
Mean difference cassette tilt versus scope 0.54 (-0.58 , 1.65) (p value 0.341)						
Mean difference Rookwood versus scope 2.84 (1.56, 4.11) (p value <0.001)*						
Intra- and interobserver reliabilities (mean difference with 95% limits of agreement)						
Intra	Time 1	Range	Time 2	Range	Difference	95% Limit of agreement
Cassette tilt view	5.98	1.29–13.99	5.74	1.23–14.68	0.24	-1.61 , 2.09
Rockwood view	8.28	0.97–16.43	8.48	1.02–17.7	-0.20	-3.11 , 2.71
Inter	Observer 1	Range	Observer 2	Range	Difference	95% Limit of agreement
Cassette tilt view	5.98	1.29–13.99	5.80	1.06–12.2	0.18	-2.26 , 2.63
Rockwood view	8.28	0.97–16.43	8.38	1.11–16.01	-0.10	-2.77 , 2.58

*Significant difference $p < 0.05$

beam. Consequently, the obtained radiograph was larger than actual size. Cassette tilt view helped to adjust the cassette to be perpendicular to the X-ray beam. It was expected that with this technique, radiograph obtained would not be oblong and it would be possible to obtain the actual size of the spur. The results revealed that the size of SS measured during surgery had no statistically significant difference when compared to the size measured by cassette tilt view. On the other hand, there was a statistically significant higher measurement of about 3 mm when compared to the spur size measured by Rockwood view. The average proportion of cassette tilt view measurement was about 9% higher when compared to arthroscopic measurement, while Rockwood view measurement was about 55% higher when compared to arthroscopic measurement. Our findings indicated that the size of subacromial spurs measured by cassette tilt view was 9% larger than the size measured arthroscopically and was seen as less scattered dots when plotted on the chart. The size of the subacromial spurs measured by Rockwood view was also 55% larger than the size measured during surgery and was seen as more scattered dots when plotted on chart. This study showed that cassette tilt view is a valid method of measurements that provides results similar to the actual measurements. In terms of reliability, there is higher precision of both intra- and interobserver reliability test for the cassette tilt view when compared to the Rockwood view measurement.

The first main strength of this study is that we have described a cassette tilt view that could measure the size of SS through plain radiography with good validity and reliability. Secondly, this technique can be performed in any hospital with an X-ray machine without requiring CT scan that would be more difficult to obtain and with higher cost. Moreover, to measure the size by quantitative evaluation, it would be able to examine and see the shapes of spur that were considered as qualitative evaluation as well. This study had some limitations of the generalization of this measurement technique in all racial groups. A further variety of group study samples are needed in a various range of normal and pathologic conditions as well. We did not compare this measurement technique with CT scan or MRI that is usually used in clinical practice. Further cost analysis is needed to compare which technique is the most efficient.

Conclusion

The cassette tilt view is a simple method, with good inter- and intra-observer reliabilities and good validity to measure the size of subacromial spurs. This can be useful to setting the position of the patient and their portals to evaluate the size of spurs for the planning of SAD.

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Author contributions BC was responsible for the conception and design, collection and assembly of data, analysis and interpretation of the data, drafting of the manuscript, final approval of the article. CK was responsible for the conception and design, collection and assembly of data, critical revision of the manuscript for important intellectual content, final approval of the article. PB was responsible for manuscript writing, critical revision of the manuscript for important intellectual content, final approval of the article. KB was responsible for manuscript writing, critical revision of the manuscript for important intellectual contents, final approval of the article. AA was responsible for collection and assembly of data. JK was responsible for the conception and design, collection and assembly of data, supervision of analysis and interpretation of the data, writing the manuscript, critical revision of the manuscript for important intellectual contents, final approval of the article, statistical expertise.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Ethics approval Human Research Ethics Committee of Thammasat University and the protocol (ID148/2559).

Data sharing statement All data supporting this study will be provided in manuscript of the study's final results.

References

1. Cone RO 3rd, Resnick D, Danzig L (1984) Shoulder impingement syndrome: radiographic evaluation. *Radiology* 150(1):29–33. <https://doi.org/10.1148/radiology.150.1.6689783>
2. Duralde XA, Gauntt SJ (1999) Troubleshooting the supraspinatus outlet view. *J Shoulder Elbow Surg* 8(4):314–319
3. Guosheng Y, Chongxi R, Guoqing C, Junling X, Hailong J (2017) The diagnostic value of a modified Neer test in identifying subacromial impingement syndrome. *Eur J Orthop Surg Traumatol Orthop Traumatol* 27(8):1063–1067. <https://doi.org/10.1007/s00590-017-1979-8>
4. Kanatli U, Gemalmaz HC, Ozturk BY, Voyvoda NK, Tokgoz N, Bolukbasi S (2013) The role of radiological subacromial distance measurements in the subacromial impingement syndrome. *Eur J Orthop Surg Traumatol Orthopedie traumatologie* 23(3):317–322. <https://doi.org/10.1007/s00590-012-0960-9>
5. Kitchel SHBK, Rockwood CA (1984) The shoulder impingement syndrome *Orthop Trans* 8:510
6. Kongmalai P, Apivatgaroon A, Chernchujit B (2017) Morphological classification of acromial spur: correlation between Rockwood tilt view and arthroscopic finding. *Sicot-j* 3:4. <https://doi.org/10.1051/sicotj/2016039>
7. Newhouse KE, el-Khoury GY, Nepola JV, Montgomery WJ (1988) The shoulder impingement view: a fluoroscopic technique for the detection of subacromial spurs. *AJR Am J Roentgenol* 151(3):539–541. <https://doi.org/10.2214/ajr.151.3.539>

8. Ono K, Yamamuro T, Rockwood CA Jr (1992) Use of a thirty-degree caudal tilt radiograph in the shoulder impingement syndrome. *J Shoulder Elbow Surg* 1(5):246–252. [https://doi.org/10.1016/s1058-2746\(09\)80066-9](https://doi.org/10.1016/s1058-2746(09)80066-9)
9. van der Windt DA, Koes BW, de Jong BA, Bouter LM (1995) Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis* 54(12):959–964