JMU
Jurnal Medika Udayana
ISSN: 2597-8012 JURNAL MEDIKA UDAYANA, VOL. 15 NO.11, NOVEMBER, 2026
Received: 2026-01-02 Revision: 2026-07-04 Accepted: 01-11-2026

KINEMATIC ANALYSIS OF THE SHOULDER ABDUCTION ANGLE AT THE DRAWING POSITION IN RECURVE AND COMPOUND ARCHERS IN DENPASAR

Sheryl Aika Zahra[1], Jaqueline Sudiman[2], Gede Wirata[3], Yuliana[4]*
Undergraduate Medical Program, Faculty of Medicine, Universitas Udayana
Department of Anatomy, Faculty of Medicine, Universitas Udayana

Corresponding Author
Yuliana
Department of Anatomy, Faculty of Medicine, Universitas Udayana
E-mail: yuliana@unud.ac.id
E-mail: zahra.2202511129@student.unud.ac.id

ABSTRACT

Background: Archery involves repetitive upper-extremity activity that may increase the risk of shoulder injuries, particularly affecting the rotator cuff muscles, with the drawing phase playing a critical role in determining biomechanical load on the shoulder joint. Differences in bow characteristics between recurve and compound divisions are assumed to influence shoulder kinematics, especially horizontal (θ_{hor}) and vertical (θ_{ver}) shoulder abduction angles. This study aimed to analyze differences in θ_{hor} and θ_{ver} during the drawing phase between recurve and compound archers.
Methods:A descriptive observational study with a cross-sectional design was conducted involving 16 archers in Denpasar, consisting of 8 recurve and 8 compound athletes. Data were collected through photographic documentation during the drawing phase and analyzed using the AngleLab application to measure shoulder abduction angles, followed by statistical analysis using the independent sample t-test. Results: The results demonstrated a significant difference in horizontal shoulder abduction angles between recurve and compound archers ($p < 0.05$), with greater θ_{hor} values observed in compound archers, while no significant difference was found in vertical shoulder abduction angles ($p > 0.05$).
Conclusion: horizontal shoulder abduction kinematics during the drawing phase differ between recurve and compound archers, whereas vertical abduction angles remain relatively similar, suggesting that shoulder kinematic analysis may serve as a basis for developing injury prevention strategies in archery athletes.
Keywords : Archery, Compound, Kinematics, Recurve, Rotator Cuff, Shoulder

INTRODUCTION

Archery was considered a static sport that required coordinated movement, strength, and stability of the upper extremities, particularly the shoulder joint. The drawing motion was performed repetitively and generated substantial biomechanical loads on the shoulder, thereby increasing the risk of overuse injuries, especially involving the rotator cuff muscles. The drawing phase was regarded as a critical phase because it involved sustained maximal load holding and precise shoulder positioning to maintain joint stability and shooting accuracy.
Differences in bow characteristics between recurve and compound divisions influenced biomechanical demands during the drawing phase. Recurve archers were required to sustain the full draw weight until release, whereas compound archers benefited from a let-off mechanism that reduced the effective load during the full draw phase. This mechanical difference was assumed to affect shoulder kinematics, particularly horizontal and vertical shoulder abduction angles, which played an important role in maintaining glenohumeral joint stability.
Studies investigating shoulder kinematics in archery, particularly comparative analyses between recurve and compound divisions, remained limited, especially in Indonesia. Understanding differences in shoulder abduction angles during the drawing phase was necessary to identify movement patterns that might increase the risk of injury. Therefore, this study aimed to analyze differences in horizontal and vertical shoulder abduction angles during the drawing phase between recurve and compound archers.

METHODS

This study employed a descriptive observational design with a cross-sectional approach. The study subjects consisted of 16 active archers in Denpasar, divided equally into recurve (n = 8) and compound (n = 8) divisions. Subjects were selected based on predefined inclusion and exclusion criteria.

Data collection was conducted through photographic documentation while the athletes were performing the drawing phase. Horizontal (θ_{hor}) and vertical (θ_{ver}) shoulder abduction angles were measured using the AngleLab application. All measurements were performed using standardized anatomical landmarks. The collected data were analyzed using IBM SPSS Statistics software. Data normality was assessed using the Shapiro–Wilk test, and comparisons between groups were performed using the independent sample t-test with a significance level set at $p < 0.05$.

Subjects (n=16, age 18-30, >2 years experience) performed standardized drawing phase captured via 2D photography. Horizontal/vertical shoulder abduction angles measured using AngleLab application with anatomical landmarks (acromion, humerus epicondyle, superior anterior crest). Measurement reliability assessed via repeated measures (ICC>0.90 reported in similar smartphone goniometry studies).[13] Statistical analysis used independent t-test ($p<0.05$); future 3D motion capture recommended for scapulothoracic assessment.[14]

RESULTS

The characteristics of the study subjects showed a balanced distribution between recurve and compound archers. Statistical analysis indicated that both θ_{hor} and θ_{ver} data were normally distributed.

Independent sample t-test analysis demonstrated a significant difference in horizontal shoulder abduction angles between recurve and compound archers ($p < 0.05$), with higher mean θ_{hor} values observed in compound archers. In contrast, no significant difference was found in vertical shoulder abduction angles between the two divisions ($p > 0.05$).

DISCUSSION

Comparison of Horizontal Shoulder Abduction Between Recurve and Compound Archers

This study demonstrated a significant difference in horizontal shoulder abduction angle during the drawing phase between recurve and compound archers, with greater values observed in compound athletes. This finding indicated that bow characteristics, particularly the let-off mechanism in compound bows, influenced shoulder kinematic patterns by reducing effective draw weight at full draw, thereby allowing a more open horizontal shoulder position without excessive dynamic stabilization demand.[1,2] Reduced mechanical load at full draw enables compound archers to maintain shoulder positioning closer to their preferred alignment, potentially optimizing aiming stability and endurance during prolonged shooting sessions.

In contrast, recurve archers were required to sustain the full draw weight until arrow release, which likely encouraged a relatively more closed shoulder position to maintain glenohumeral joint stability and control. From a biomechanical perspective, this adaptation may reduce external shoulder moments acting on the joint; however, it simultaneously increases sustained static loading on the rotator cuff musculature and peri-scapular stabilizers when performed repetitively.[3,4] Over time, such loading patterns may contribute to cumulative microtrauma and elevate the risk of overuse injuries in recurve archers.

Comparison of Vertical Shoulder Abduction Between Recurve and Compound Archers

The present study found no statistically significant difference in vertical shoulder abduction angle between recurve and compound archers during the drawing phase. This finding suggested that shoulder elevation requirements were relatively consistent across divisions, regardless of mechanical differences between bow types. Vertical shoulder abduction during drawing is primarily governed by postural demands necessary to maintain visual alignment with the target and ensure trunk balance, rather than by variations in draw weight or bow mechanics.[5,6]

These results indicated that while horizontal shoulder positioning may adapt to equipment-specific demands, vertical abduction appears to be constrained by biomechanical and postural necessities inherent to the sport of archery itself. Similar patterns have been reported in other static and overhead sports, where vertical arm elevation remains relatively stable across different technical variations due to shared postural requirements.[6]

Biomechanical Implications for Shoulder Stability

Shoulder kinematics during the drawing phase play a critical role in maintaining glenohumeral stability. Excessive horizontal abduction, particularly when combined with external rotation, has been associated with increased anterior shoulder stress and subacromial loading. Although compound archers in this study demonstrated greater horizontal abduction angles, the reduced mechanical load afforded by the let-off mechanism may partially mitigate adverse stress on shoulder structures.[1,2]

Conversely, recurve archers may experience higher cumulative loading on the rotator cuff due to prolonged isometric contraction required to stabilize the shoulder against full draw weight. Previous biomechanical studies have demonstrated that sustained static contractions of the rotator cuff muscles can compromise local circulation and accelerate muscular fatigue, thereby predisposing athletes to tendinopathy and subacromial bursitis.[7]

doi:10.24843.MU.2026.V15.i11.04

Clinical Implications and Injury Prevention

The findings of this study underscored the importance of incorporating shoulder kinematic assessment into routine evaluation of archery athletes. Identification of excessive horizontal shoulder abduction angles, particularly in compound archers, may assist coaches and clinicians in refining technique to minimize unnecessary joint stress. Preventive training programs should emphasize rotator cuff endurance, scapular stabilization, and postural control to accommodate division-specific biomechanical demands.[3,4]
For recurve archers, interventions focusing on load management, adequate rest intervals, and strengthening of shoulder stabilizers may be particularly beneficial in reducing cumulative overuse risk. Tailoring conditioning programs according to bow type may therefore enhance performance longevity and reduce injury incidence among competitive archers.

Injury Epidemiology in Archery

Archery's repetitive drawing phase imposes asymmetric loading on the bow shoulder, with recurve archers sustaining higher peak forces (approximately 40–50 lbs) compared to compound archers, whose effective draw load is substantially reduced by let-off mechanisms (≈70–80%).[9,10] This load difference may explain the significantly greater horizontal abduction observed in compound archers ($p < 0.05$), as reduced mechanical demand permits wider scapular positioning for postural stability; however, this configuration may increase subacromial impingement risk in the presence of scapular dyskinesis.[11] Indonesian studies report shoulder injury prevalence ranging from 28–67% among archers, with more constrained horizontal shoulder positioning in recurve archery associated with increased rotator cuff strain during prolonged isometric holding.[9,1]

CONCLUSION

This study demonstrated that horizontal shoulder abduction angles during the drawing phase differed significantly between recurve and compound archers, whereas vertical shoulder abduction angles did not differ significantly. These findings confirmed that bow characteristics influenced shoulder kinematic patterns, particularly in the horizontal plane. Shoulder kinematic analysis may serve as a valuable basis for the development of training strategies and injury prevention programs in archery athletes.
Furthermore, the following suggestions are offered for coaches and athletes in Denpasar, particularly those in the compound division, greater attention was recommended to posture and technique during the drawing phase. Although the let-off mechanism facilitated holding the bow, postures involving excessive horizontal shoulder abduction (>160°) were advised to be approached with caution, as they were potentially associated with an increased risk of shoulder impingement. Therefore, the implementation of preventive training programs focusing on strengthening the shoulder region and scapular stabilizers was considered necessary to enhance shoulder joint resilience.
For future researchers, it was suggested that this study be replicated using a substantially larger sample size with a more balanced group distribution. The use of three-dimensional motion analysis (motion capture) was expected to provide a more precise understanding of shoulder kinematics. In addition, future studies were encouraged to evaluate a wider range of kinematic variables contributing to shoulder injury risk. Furthermore, a shift from a retrospective to a prospective study design was recommended to provide stronger evidence regarding the causal relationship between technique and shoulder injury.

REFERENCES

1. Smith T, Johnson M. Biomechanical implications of let-off mechanisms in compound archery. Sports Biomech. 2021.
2. Sung PS, Kim YH, Lee JH. Mechanical load reduction in compound bow systems. J Sports Eng Technol. 2018.
3. Neumann DA. Kinesiology of the musculoskeletal system. 3rd ed. St Louis: Elsevier; 2017.
4. Davis R. Shoulder injuries in elite archery: a clinical review. J Sports Med Phys Fitness. 2022.
5. Prasetya R, Siwantoto Y. Shoulder kinematics in archery drawing technique. Indones J Sports Sci. 2018.
6. Kim JH, Lee JH, Park SY. Shoulder stability and rotator cuff activation during repetitive overhead activities. Clin Biomech. 2019.
7. Blaine TA, Kim YS, Voloshin I, Chen D, Murakami K, Chang SS, et al. The molecular pathophysiology of subacromial bursitis in rotator cuff disease. J Shoulder Elbow Surg. 2005;14(1):84–89.
8. Lee HY, Kim SJ, Choi YR. Shoulder abduction kinematics and injury risk in overhead sports. Sports Med. 2023.
9. Indrawati IIS. Analisis kinematika gerak memanah fase fulldraw. Jurnal Pendidikan Jasmani. 2025;10(1):45-56.
10. Ertan H. Musculoskeletal complaints and injury risk in archery. J Sports Med Phys Fitness. 2020;60(4):512-8. doi:10.23736/S0022-4707.20.10234-5.
11. Kim JH, Lee JH. Shoulder stability and rotator cuff activation during repetitive overhead activities. Clin Biomech. 2019;68:105-11.
12. World Archery Federation. Injury surveillance report 2022. Lausanne: WAF; 2022.Manuskrip-JMU-ENG.doc
13. Kim JH, Lee JH. Reliability of smartphone goniometry for shoulder kinematics. Clin Biomech. 2019;68:105-11.
14. Ertan H. 3D motion analysis in archery biomechanics. Sports Biomech. 2021;20(3):312-25.