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Effectiveness of Combination Flexi-Bar Shoulder Exercise to The Kinesiotaping Application on Increasing Upper Extremity Proprioceptive Ability and Shooting Accuracy in Archery Athletes at Gandawa Archery Club

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ABSTRACT

Kinesiotaping is passive stabilisator, so it is necessary to have a combination of one intervention such as adding Flexi-bar Shoulder Exercise (FSE) as an active proprioceptor stimulator to optimize joint stability and optimalize shooting accuracy for archery. The research method used was a quasi experiment pre and post-test group control with 22 archery athlete, divided into a control group that only received kinesiotaping, and a intervention group that received kinesiotaping and FSE 3 times a week for 4 weeks. Subjects were assessed for proprioceptive ability using the joint position sense test (JPS) of abduction and flexion and shooting accuracy. Based on the difference test pre and post the control group, there were significant differences in flexion JPS (p=0.00), abduction JPS (p=0.00), and shooting accuracy (p=0.03), for the treatment group, there were significant differences in flexion JPS (p=0.00), abduction JPS (p=0.00), and shooting accuracy (p=0.03). Based on the comparison test between the control and treatment groups, there were no significant differences proprioceptive abilities in flexion (p=0.151) and abduction (p=0.00) as well as in shooting accuracy (p=0.163). Combination of FSE with kinesiotaping, can improve proprioceptive abilities and shooting accuracy but did not provide a different effect than the Kinesiotaping group.

Keywords:

Archery, Proprioceptive, Kinesiotaping, Flexi-Bar Shoulder Exercise, Shooting Accuracy

1. INTRODUCTION (10 PT)

The best achievement of the Indonesian Archery Association at the olympics is 72-year ago with the Three Srikandi (Srikandi) medal in 1988. Likewise, the achievements of Balinese archers, who have never won gold at the National Games (PONs), are crucial for improving Indonesian archery performance. Implementing early training programs and strengthening regional clubs are -crucial for athletes, coaches, referees, and teams. Archery is a target sport in which the goal is to score the highest possible points. Arrows vary in weight according to their divisions, which are related to upper-limb muscle strength and stability. Mastering the archery technique is crucial for achieving optimal performance. Although some athletes can execute their techniques well, they may struggle with accuracy. Analyzing the shooting technique and accuracy is crucial for improving the performance.

There are eight techniques in archery: stance, nocking, set-up, drawing, tightening, aiming, release, and after-hold (follow-through).[1,2] The bow-arm refers to the shoulder joint that holds the bow, whereas the draw-arm is responsible for pulling the arrow.[2] During the drawing phase, the bow-arm must endure the pulling force of the arrow to maintain stability for accurate aiming. Proper muscle contraction and kinesthetic awareness during the drawing, tightening, and aiming stages are crucial for achieving precision. In the release stage, the bow-arm muscles must counterbalance the arrow's shooting force, ensuring accuracy during the after-hold when the muscles relax back to a neutral position. If the bow arm lacks stability, accuracy is compromised.[1] Intrinsic factors such as visual coordination, proprioception, strength endurance, and emotional regulation significantly influence effective archery performance. [3] Sensory abilities, particularly visual and proprioceptive skills, are fundamental to motor

development and skill acquisition. Proprioception, an unconscious sensory feedback from muscles and joints, helps to control muscle tension and movement.[4,5] Optimal upper limb proprioceptive ability is vital for archers to enhance shot precision and endure the pull of the arrow.

The pyramidal theory of learning, developed by Williams and Shellenberger, explains how sensory systems contribute to sensory-motor, perceptual-motor, and cognitive development, ultimately affecting motor abilities. These seven sensory abilities include proprioception, which is vital for motor development and skill acquisition.[5,6] Proprioception is an unconscious sensory flow from the muscles, tendons, joints, and skin that helps control muscle tension, balance, and coordinated movements.[4,5] For archers, upper limb proprioception is crucial for shot accuracy. They require endurance in the bow arm to handle the bow's pull while maintaining stability. A poor proprioceptive ability can lead to reduced motor control and shooting accuracy.

Effective sensory systems facilitate body awareness, postural control, reflex maturation, and motor planning, all of which enhance cognitive skill. Archery athletes have been shown to have better joint position sense in the shoulder, as evidenced by active repositioning with closed eyes in shoulder flexion and abduction as well as EMG results (sEMG and iEMG) in the bow arm. This study focuses on shoulder proprioception in the bow arm, measured using joint position sense flexion and abduction of the shoulder. Archers must maintain isometric contractions in the bow arm to ensure shot accuracy.[7] Research indicates that open kinetic chain training is more effective than traditional closed kinetic chain methods in improving proprioception.[8] Conventional training often relies on exercises that activate the proximal area rather than the distal extremity. Flexi-Bar is a new tool that combines vibration stimuli with open kinetic chain training.

The Flexi-Bar is a 152 cm elastic rod with weights at both ends. When shaken, it generates a 5 Hz vibration that activates the limb and core muscles.[8,9] Research shows that Flexi-Bar training enhances muscle strength, coordination, and balance by stimulating proprioception; however, its application in archery athletes remains unexplored. Although it is effective and easy to use, the Flexi-Bar has not been widely adopted in Indonesia. Training for three minutes in four sets with five minutes of rest has been proven to restore joint range of motion without pain or dysfunction.[8] Additionally, a 20-minutes regimen with rest effectively stimulated specific muscle groups.[9] The Flexi-bar also improves shoulder joint stability by activating sensory nerve fibers, which enhances neuromuscular control and reduces abnormal muscle tension.[9] The vibrations increase blood circulation, optimize nutrient delivery, and enhance energy expenditure, making it a potential solution for weight management.[10,11] In taekwondo athletes, Flexi-B-ar exercises improve dynamic balance and postural function by challenging the body to maintain equilibrium.[12]

Kinesiotaping is a common physiotherapy intervention used for the stabilization of movement.[13] It can act as a preventive, curative, and rehabilitative tool.[14] For example, athletes may use kinesiotaping to enhance their joint stability and performance. However, its effectiveness is limited because it is temporary, offers only brief body awareness training, irritates the skin, and is considered a short-term solution.[14] The suboptimal performance of Indonesian archery athletes, particularly in Bali Province, highlights several issues. These include the ineffectiveness of kinesiotaping as a standalone solution, lack of familiarity with the flexi-bar exercise, and limited research on flexi-bar training for archers.

To address these gaps, the author proposes a study that combines flexi-bar exercises with kinesiotaping to enhance long-term proprioceptive learning. This approach aims to improve athlete performance more effectively than kinesiotaping alone. This research will focus on the effectiveness of this combination in optimizing upper-extremity proprioceptive ability and shooting accuracy among archery athletes at the Gandawa Archery Club.

2. METHOD

This study was designed as quasi-experimental research with a pre-test and post-test control group design with 22 samples. The population will perfom pre-tests for joint position sense and shooting accuracy. Participants who met the inclusion criteria were selected as the study sample. Before randomization, eligible participants were provided with a detailed explanation of the study procedures and benefits, and provided written informed consent. Randomization was then conducted to allocate participants into two groups: the Control Group (CG) and the Intervention Group (IG). The CG received kinesiotaping only, while the IG received kinesiotaping combined with Flexi-bar Shoulder Exercise, performed three times per week for four weeks. The post-tests were conducted after the intervention period.

Subjects who met the inclusion criteria were aged 14–18 years, with normal BMI, a minimum of one year of archery training experience, willingness to participate through informed consent, joint position sense score >89 mm, and shooting accuracy score ≤25. The exclusion criteria included any history of upper extremity disorders or concurrent participation in other training programs. Drop-out criteria were defined as attending less than 85% of the training sessions or withdrawing from the club during the intervention period.

Proprioceptive assessment was conducted for shoulder flexiand abduction using a passive positioning protocol followed by active repositioning. The distance (in mm) between the passive target point and the active reproduction point was measured to quantify the proprioceptive accuracy. Shooting accuracy was assessed using a standard barebow and arrows fired at an 18-meter distance from an Archery Shooting Score (ASS) target board.The subjects

performed three shots per trial, and scoring followed standard archery competition guidelines with a maximum cumulative score of 30 point.

The exercise intervention for the intervention group involved flexi-bar shoulder exercises using Flexi-Bar Speeds (Germany), performed in four movement positions for 20 minutes, followed by 5 minutes of stretching. This training was conducted three times per week for four weeks, and was initiated 20 min after kinesiotaping application. Kinesiotaping was applied using kinesiology tape (Speeds®) following joint stabilization techniques targeting the deltoid region and scapulohumeral structures. Taping included Y-strips and I-strips with a tension of 70–100% and placed with anatomical landmarks as guidance. The application was only performed on the bow arm. Anthropometric measurements included body weight, measured with a standard analog scale, and height, measured using a stature meter. Body mass index (BMI) was calculated using the formula: weight (kg) / [height (m)]², and categorized using the Indonesian Ministry of Health standards (normal range: 18.5–22.9 kg/m²).

3. RESULTS AND DISCUSSION

Result

Table 1. Comparison of Shoulder JPS Before and After Kinesiotaping.

Variable	JPS Flexion (mm) (Mean ± SD)	JPS Abduction (mm) (Mean ± SD)
After Kinesiotaping Application	69,9364±11.512	66,6364±8,947
p Value	0,00*	0,00**

*) *Wilcoxon Signed Rank Test* , **) *Paired Sample T Test*

The results shown in Table 1 demonstrate a statistically significant improvement in shoulder proprioceptive ability following the kinesiotaping application. Both flexion and abduction JPS values improved significantly ($p = 0.00$, $p < 0.05$, respectively), indicating that kinesiotaping effectively enhanced proprioceptive function in these movements.

Table 2. Comparison of Shooting Accuracy Before and After Kinesiotaping.

Variable	Shooting Accuracy (Mean ± SD)
After Kinesiotaping Application	26,36±1,361
p Value	0,03*

*) *Wilcoxon Signed Rank Test*

Based on Table 2, the p-value was 0.03 ($p < 0.05$), indicating a statistically significant difference. Therefore, it can be concluded that kinesiotaping effectively improves shooting accuracy in archery athletes at the Gandawa Archery Club.

Table 3. Comparison of Shoulder JPS Before and After FSE & Kinesiotaping.

Variabel	JPS Fleksi (mm) (Rerata±SD)	JPS Abduksi(mm) (Rerata±SD)
After FSE & Kinesiotaping Application	76,4545±8,767	80,9091±5,593
P Value	0,00**	0,00**

**) Nilai p Uji *Paired Sample T Test*

The results shown in Table 3 demonstrate a statistically significant improvement in shoulder proprioceptive ability following the combination of the FSE and kinesiotaping application. Both flexion and abduction JPS values improved significantly ($p = 0.00$, $p < 0.05$), indicating that the combination of FSE and kinesiotaping effectively enhanced proprioceptive function during these movements.

Table 4. Comparison of Shooting Accuracy Before and After FSE & Kinesiotaping..

Variabel	Akurasi Tembakan (Rerata±SD)
After FSE & Kinesiotaping Application	25,4545±1,572
P Value	0,03*

*) *Wilcoxon Signed Rank Test*

From Table 4, the p-value was 0.03 ($p < 0.05$), indicating a statistically significant difference. Therefore, it can be concluded that the application of a combination of FSE and kinesiotaping effectively improves shooting accuracy in archery athletes at the Gandawa Archery Club.

Table 5. Post-test Comparison of Shoulder Proprioceptive Ability between the Combination Flexi-Bar Shoulder Exercise (FSE) and Kinesiotaping Group and the Kinesiotaping-Only Group

	JPS Flexion Rerata±SD	JPS Abduktion Rerata±SD
Kinesiotaping Group	69,9364±11,51280	66,6364±8,94732
Combination Group	76,4545±8,76771	80,9091±5,59383
Mean Difference	6,51818	14,27273
P Value	0,151*	0,00*

**) Independent T Test*

From Table 5. The comparison of the post-test and shoulder proprioceptive accuracy in flexion also showed no significant difference ($p > 0.05$). However, the post-test results for shoulder proprioception in abduction (as measured by JPS Abduction) revealed a significant difference ($p < 0.05$). Given the non-significant result in JPS flexion, it can be concluded that the combination of Flexi-Bar Shoulder Exercise and Kinesiotaping did not provide a significantly greater improvement in shoulder proprioceptive accuracy than kinesiotaping alone.

Table 6. Post-test comparison of proprioception and shooting accuracy between groups

	Shooting Accuracy Mean±SD
Kinesiotaping Group	26,36±1,361
Combination Group	25,4545±1,572
Mean Difference	0,909
P Value	0,163*

**) Independent T Test*

As shown in Table 6, the post-test scores and mean differences between the pre- and post-test values also showed no statistically significant differences ($p > 0.05$). These findings suggest that the combination of Flexi-Bar shoulder exercise and kinesiotaping did not produce a significantly greater improvement in shooting accuracy than kinesiotaping alone within the 4-week intervention period.

Discussion

The study found that the characteristics of the samples, in terms of sex and archery experience, were normally distributed. All participants (n=22) had over one year of archery experience. However, the gender distribution in both the control and intervention groups was imbalanced, with fewer males than females. This imbalance is considered a limitation, as sex has been shown to influence shoulder proprioception and shooting accuracy.[9] Future research should consider more systematic control of gender as a variable. Normality tests for age and body mass index (BMI) showed non-normal distributions. Nevertheless, all participants were adolescents aged 14–18 years, which is consistent with the inclusion criteria. Thus, age may influence proprioceptive ability and accuracy.[17] As individuals age, proprioceptors require more time to learn and interpret movements.[17] By adolescence, sensory-motor systems have matured. Proprioceptive systems mature by the age of 3 years and continue to improve with age due to the increased sensitivity of muscle spindles.[18] Participants had normal BMI ranges (18.5–22.9), which is relevant for maintaining the center of mass.[19,20] Archers require optimal postural stability, particularly during the release phase.[20] Controlling BMI minimized the potential bias in this study.

The control group showed significant pre-post improvements in shoulder proprioception, as measured by joint position sense (JPS) in flexion and abduction ($p<0.05$). Previous research supports that kinesiotaping improves JPS in the deltoid and supraspinatus muscles and in key shoulder abductors in bow arm function.[13] Kinesiotaping enhances afferent sensory input from the muscles, thereby improving sensory sensitivity.[13] However, Magalhães et al.[21] found no long-term effects (48) of kinesiotaping on proprioception in healthy, active males. Conversely, Justo-Cousiño et al.[22] reported significant improvements in wrist JPS at 30º extension in both placebo and kinesiotaping groups. Mechanistically, kinesiotaping stimulates cutaneous mechanoreceptors and proprioceptors in the surrounding tissues.[23,24] The tape lifts the skinreduces the pressure on the underlying soft tissue.[25] Applied tension provides sensory input, which enhances joint position awareness and kinesthetic perception.[26]

Kinesiotaping significantly improved shooting accuracy ($p<0.05$). Mülazımoğlu demonstrated similar improvements in recurve bow archers over four weeks of kinesiotaping using a Y-shaped application on the deltoid. Rajabzadeh et al.[13] reported significant enhancements in both JPS and shooting accuracy at distances of 18, 30, and 50 m ($P < 0.005$), suggesting kinesiotaping as a performance-enhancing intervention. However, the effects were immediate, with no lasting effects after removal. Future studies should investigate the long-term effects using follow-up designs.

The intervention group showed significant pre-and post-improvements in JPS flexion and abduction

($p<0.05$). Flexi-bar exercises actively stimulate stabilizing muscles, whereas kinesiotaping provides passive joint stability.[27] The combination enhanced proprioception and joint stability. Vibrational stimulation from the flexi-bars activates joint mechanoreceptors and motor neurons involved in proprioception.[9,28] Regular training improves neuromuscular control.[8] Flexi-bars effectively enhanced scapular stability over six weeks.[9] As an open kinetic chain tool, flexi-bars isolate specific joint movements and target prime movers.[29,30] In contrast, closed-chain exercises activate synergism.[31,32] Flexi-bars are recommended for targeted proprioceptive training.[31,32] Flexi-bar training at shoulder angles of 90º, 130º, and 180º, conducted three times weekly for four weeks, improved joint stability.[8] Different angles yield distinct benefits, highlighting the importance of optimal joint positioning.

The combined intervention significantly improved the shooting accuracy ($p<0.05$). Although accuracy was not directly measured, flexi-bar training improved shoulder external rotator strength and throwing performance.[33] Better shoulder coordination and stability likely supports the accuracy of throwing-based sports.[34] Increased muscle strength from flexi-bar training and enhanced joint stability from kinesiotaping contribute to maintaining posture during archery, particularly for the bow arm.[28,33] Flexi-bar stimulates proprioceptive receptors such as muscle spindles and Golgi tendon organs, while kinesiotaping activates cutaneous mechanoreceptors. This combination creates a more responsive neuromuscular environment for complex motor tasks.[9]

No significant difference in shoulder proprioception improvement was found between the combined and kinesiotaping-only groups. One explanation for this is the sufficient stimulation provided by the kinesiotaping. However, tape duration varied among participants depending on individual tolerance, although a minimum application during training (~1 h) was maintained. Systematic reviews report low-to very low-quality evidence of the effectiveness of kinesiotaping on shoulder JPS.[24] Similarly, Turgut et al.[35] found minimal proprioceptive improvements across 20 studies, with the exception of individuals with ankle instability. Another factor is that ceiling effect archers may already have well-developed proprioception, making further improvements difficult.[36] Despite the statistical insignificance, the intervention may still offer clinical or subjective benefits. Further studies with larger sample sizes and extended training durations are warranted. No significant differences were observed between the two groups in terms of shooting accuracy. Archery accuracy involves multiple factors beyond proprioception, including technique[37], confidence[38], concentration, emotional regulation[39], physical condition, and environmental elements, such as wind[40]. Although the flexi-bar exercise improves shoulder stability through vibration training, it may not produce immediate, statistically significant improvements in complex motor tasks. Individual neuromuscular responses may also vary, especially in experienced athletes who approach the performance ceiling.[36]

This study had several limitations that should be considered. They did not measure arm length, muscle strength, or leg length, all of which are important factors influencing shooting accuracy[19], especially considering the role of the vertebral, upper/lower extremity, and core muscles in archery performance. Furthermore, the duration of kinesiotaping application was not standardized across participants, which could have affected the consistency of its proprioceptive and stabilizing effects. Additionally, the study did not control for other variables that influence shooting accuracy, such as technique[37], confidence[38], concentration, emotional states[39], overall physical condition, and external environmental factors, such as wind direction.[40]

4. CONCLUSION

This study demonstrated that kinesiotaping, both alone and in combination with flexi-bar shoulder exercises, can enhance proprioceptive abilities and shooting accuracy in archery athletes at the Gandawa Archery Club. These findings confirm that kinesiotaping effectively improves joint position sense and accuracy by stimulating sensory input and stabilizing the shoulder area. Moreover, the addition of flexi-bar shoulder exercises to kinesiotaping improves shoulder abduction proprioception, which plays a crucial role in the biomechanics of archery. However, the combination of flexi-bar shoulder training and kinesiotaping did not provide a different effect from the Kinesiotaping Group in improving Shoulder Proprioceptive Ability and Shooting Accuracy in archery athletes in the Gandawa Archery Club. To improve future research, it is recommended to control psychological factors, such as athlete confidence and emotional state, that may affect accuracy. Using a single type of flexi-bar exercise could provide s more focused analysis of the muscle activation. In addition, anthropometric variables such as arm length, muscle strength, and leg length should be measured and controlled to reduce the bias in proprioceptive assessments. Increasing the sample size is necessary to enhance the validity and reliability of the findings in future studies.

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