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Characteristics of Shooting Time of The World's Top Level Male Archery Athletes

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Abstract: The purpose of this study was to clarify the characteristic features of the shooting time of the world's top-level male archery athletes. The matches used for this study were those from the 1/64th Elimination Round to the Finals in the Men's Individual of the 44th World Outdoor Target Archery Championships. As representative of the world's top athletes, the medalists from these competitions were studied; the mean time and the coefficient of variation of the mean for each phase of shooting were calculated, and compared to those of all the athletes who competed in matches from the 1/64th Elimination Round to the Finals. The results of the study showed for the different phases of shooting, the preparatory phase had the longest mean time regardless of the resulting scores ($p<0.05$); the mean's coefficient of variation was also large for this phase ($p<0.05$). The mean time taken by the medalists for the preparatory phase was shorter than the mean time taken by the competing athletes for the same phase ($p<0.01$). These results suggest that the characteristic feature of shooting time of the world's top-level male archery athletes was a shorter duration of the preparatory phase.

Key words: archery, competitive ability, phase structure of movement

Introduction

In the sport of archery, athletes compete for points by shooting a set number of arrows within a set time. The recurve category, which is an Olympic discipline, is practiced outdoors in any weather except thunder. Athletes thus must take the wind, rain, or other weather conditions into consideration while shooting all their arrows within the prescribed time period. The single-elimination tournament was introduced at the 25th Olympic Games, held in Barcelona in 1992, and has been used in all subsequent Olympic Games. In addition to the psychological element this brings to the struggle between competitors, shooting must take place within the time limit of 40 seconds for each arrow. Under recent revisions to the rules, the time limit for one arrow has been further reduced to 30 seconds as the athletes shot alternately in the rounds in the Olympic Games. This led to a change in the style of shooting: whereas previously athletes could take their time over each arrow, they now take aim instantaneously and shoot over a short period of time. It therefore appears likely that reducing the time required by an athlete to shoot, would have considerable bearing on improving competitive ability.

The technical skill of archery is generally understood to be comprised of eight components: (1) stance, (2) set, (3) nocking, (4) set up, (5) drawing, (6) full draw, (7) release, and (8) follow through. If these are classified according to Meinel's phase structure of movement (Meinel, 1960), (1) stance to (3) nocking is the preparatory phase; (4) set up to (7) release is the main phase; and (8) follow through is the concluding phase. Previous research regarding archery has particularly focused on (6) full draw and (7) release, by studying electromyograms. (Martin, Siler, & Hoffman, 1990; Clarys *et al.*, 1990; Ertan, Kentel, Tümer, & Korkusuz, 2003; Soylu, Ertan, & Korkusuz, 2006; Ertan, Soylu, & Korkusuz, 2005), heart rate (Keast & Elliott, 1990; Salazar *et al.*, 1990), or brain waves (Salazar *et al.*, 1990; Landers *et al.*, 1991). Aiming time and its relationship to resulting scores was examined by Keast and Elliott (1990). They reported that although aiming time was longer for low scoring shots than high scoring shots for some athletes, there was no marked difference. It should be noted that shooting is comprised of eight successive components as mentioned above and the characteristic features of phases other than aiming time are yet to be examined.

In high level competitions such as Olympic Games and international competitions, the contenders are close in ability. In fact, the number of cases where the same athlete winning medals at Olympic Games and international competitions has decreased since the introduction of the single-elimination tournament (International Archery Federation, 2008). Thus, in a single-elimination tournament where any of the top-level archers is capable of winning a medal, the winner is determined by key factors in which the winner excels others. Therefore, it appears that if these factors are clarified, the conditioning goals and indicators for competitions could be set, thus contributing to the improvement of competitive ability.

This study therefore aimed to clarify the characteristic features of shooting time of the world's top-level athletes by examining Men's Individual Recurve medalists at the 44th World Outdoor Target Archery Championships.

Method

Matches studied

The archery matches analyzed for this study were those from the 1/64th Elimination Round to the Finals of the Recurve Men's Individual of the 44th World Outdoor Target Archery Championships, held at Leipzig, Germany from July 7 to 15, 2007.

Athletes studied

The athletes analyzed for this study were 24 men who competed in matches from the 1/64th Elimination Round to the Finals of the Men's Individual respectively. The mean position of the men who competed was 28.1 (±28.3), and their mean score was 107.3 (±2.9). Three medalists (Gold, Silver and Bronze) and their opponents were selected for this study; the other subjects were selected at random. This research was conducted with the approval of the Japan Institute of Sports Sciences Ethics Committee.

Phase construction of shooting

The current study divided the technique of shooting into four phases, using the phase construction of movement put forward by Meinel (1960). Phase 1–2 is from the sound of the bell, which indicates that one may begin shooting, until the set up of the bow; phase 2–3 is from the set up of the bow until anchoring; phase 3–4 is from anchoring until the release of the arrow, denoting the time taken for aiming; and phase 4–5 is from the release of the arrow until the end of the follow through. In terms of the phase construction of movement (Meinel, 1960), phase 1–2 is the preparatory phase of shooting, phases 2–3 and 3–4 are the main phase, and phase 4–5 is the concluding phase. Dividing the shooting into four phases in this way enables the characteristics of the movements in each phase to be checked in detail, and is thus likely to be an effective means for modification of incorrect movements. As this method is expected to yield results in settings for coaching shooting technique, in the present study shooting technique was divided into four phases for analysis.

Match recording

A video camera (Sony HDR-HC3, 30 frames per second) was set up on the middle tier of the spectators' stand in order to record the shooting technique of athletes during the matches, and a full-body video recording following the movements of each athlete was made. The video recordings were played back frame by frame in order to obtain the time taken for each phase of shooting.

Analysis of shooting time

Shooting time was evaluated by obtaining the mean time and calculating the coefficient of variation (CV) of the mean for each phase of shooting. Analysis of shooting time was conducted in all matches the athletes who were studied competed in. Using the mean time for each phase of shooting and the mean's CV, an analysis of variance was conducted on two factors, the competition results (competitors, medalists; 2 groups) andthe phases (1–2, 2–3, 3–4, 4–5; four phases). A multiple comparison analysis was subsequently performed using Ryan's method. The level of significance of these analyses was 5%.

Results

Mean time for each phase of shooting

Figure 1 shows the mean time in seconds taken for each phase of shooting by the competitors (n=24) and medalists (n=3) in the Men's Individual. Analysis of variance indicates that the main effect of phase ($F(3, 75)=23.21$, $p<0.01$) and the interaction of competition results and phase ($F(3, 75)=2.87$, $p<0.01$) were significant. In addition, the competition results showed significant trends ($F(1, 25)=3.60$, $p<0.10$). In phase 1–2, the mean time for medalists was shorter than the mean time for competitors ($F(1, 100)=11.57$, $p<0.01$);

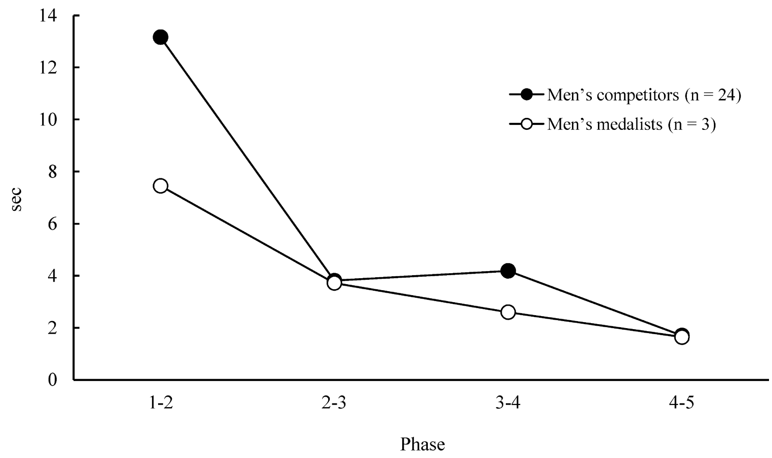

Figure 1. Mean time (sec) for each phase of shooting for competitors ($n=24$) and medalists ($n=3$) in the Men's Individual.

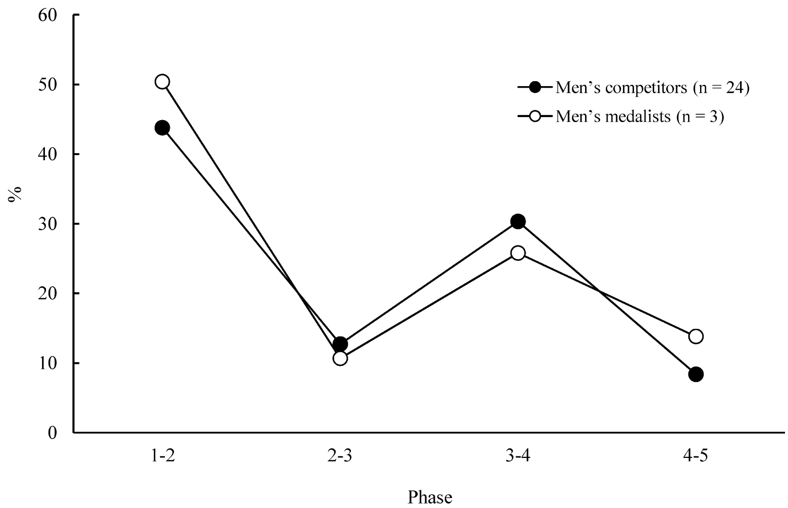

Figure 2. CV (%) of the mean time (sec) for each phase of shooting for competitors ($n=24$) and medalists ($n=3$) in the Men's Individual.

furthermore, significant differences between the phases were observed for competitors ($F(3, 75)=20.86$, $p<0.01$) and for medalists ($F(3, 75)=5.22$, $p<0.01$). Multiple comparison analysis shows that for competitors in the Men's Individual, the mean time taken for phase 1–2 was longer than the mean time taken for phase 2–3 ($MSe=6.61$, $p<0.05$), phase 3–4 ($MSe=6.61$, $p<0.05$), and phase 4–5 ($MSe=6.61$, $p<0.05$). Also, for competitors the mean time taken for phase 4–5 was shorter than the mean time taken for phase 2–3 ($MSe=6.61$, $p<0.05$) and phase 3–4 ($MSe=6.61$, $p<0.05$). For medalists, the mean time taken for phase 1–2 was longer than the mean time taken for phase 3–4 ($MSe=6.61$, $p<0.05$) and phase 4–5 ($MSe=6.61$, $p<0.05$).

Mean Time's CV for each phase of shooting

Figure 2 shows the CV (%) of the mean time taken for each phase of shooting by competitors ($n=24$) and medalists ($n=3$) in the Men's Individual. Analysis of variance indicates that the main effect of phase ($F(3, 75)=22.68$, $p<0.01$) was significant. Multiple comparison analysis shows that the CV of the mean time taken for phase 1–2 was greater than the CV of the mean time taken for phase 2–3 ($MSe=135.62$, $p<0.05$), phase 3–4 ($MSe=135.62$, $p<0.05$), and phase 4–5 ($MSe=135.62$, $p<0.05$). The CV of the mean time taken for phase 3–4 was greater than the CV of the mean time taken for phase 2–3 ($MSe=135.62$, $p<0.05$) and phase 4–5 ($MSe=135.62$, $p<0.05$).

Discussion

This study investigated the characteristic features of shooting time of the world's top-level male archery athletes. The results of the study show that among the mean times for each phase of shooting, the preparatory phase (phase 1–2) had the longest mean time and the mean's CV was also greater for the preparatory phase regardless of the score. The preparatory phase of shooting in archery is generally taken to consist of stance, set, and nocking, and it may be conjectured that the preparatory phase of shooting, which involves more procedures than the other phases, caused such study results. However, the mean time for the preparatory phase of shooting showed a difference according to the score, and was shorter for medalists than for competitors in the Men's Individual. Ordóñez and Benson (1997) define a state called "time pressure" when time constraint causes a feeling of stress and creates a need to cope with a limited time. The presence or absence of time pressure is regarded as an important factor that influences the score and time pressure is considered a psychological stressor that impairs skill performance (Murayama, Tanaka, Sugai, & Sekiya, 2007). Furthermore, time pressure is a psychological stressor that is considered an influence on cognitive performance that decreases the quality of decision making behavior in movement activities (Bar-Eli & Tractinsky, 2000). Taking these into account, it may be inferred that the medalists were coping with time pressure that could have had adverse effects, as described above, by reducing the time of the preparatory phase of shooting.

Since the introduction of the single-elimination tournament at the 25th Olympic Games (Barcelona in 1992), shooting must take place within the time limit of 40 seconds for one arrow. Due to the recent revision to the rules, when athletes shot alternately in the rounds in the Olympic Games, the time limit for one arrow was further reduced to 30 seconds. Therefore archers are presently forced to shoot over a shorter period of time than before. The results of this study indicate the possibility that reducing the time for the preparatory phase could directly reduce the overall time for shooting. Meinel (1960) states that the preparatory phase is a prerequisite for the efficient and economical execution of the main phase, and furthermore that it has a decisive role to play in the success of the performance. In shooting, it could be denoted that a shorter time for the preparatory phase plays such a role and is a characteristic feature of the shooting time of the world's top-level male archery athletes.

Conclusion

The current study aimed to clarify the characteristic features the shooting time of the world's top-level male archery athletes. The results of the mean time taken for each phase of shooting show that the preparatory phase was longest and had the greatest CV of the mean regardless of the scores. Nevertheless, the mean time taken for the preparatory phase of shooting varied with scores, and the medalists had shorter mean times than the other competing athletes. These results indicate that the characteristic feature of the shooting time of the world's top-level male archery athletes was the shorter time of the preparatory phase of shooting.

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