AN ANALYSIS OF THE HOLDING AREA IN OLYMPIC ARCHERY

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In Olympic archery the aiming process is considered less important than in pistol or rifle shooting. For this reason the coaches restrict the training mostly to the moment of release which is considered to have a high impact on the shooting result. However it can be assumed that a precise and stable logging of the target may lead to an improved shooting score. We developed a system to measure this motion that is also easy to handle in training by athletes and coaches. For scientific research we were able to measure the on-target-trajectories by fitting the system on the archers own bow. Over 1000 shots of the complete German Junior-team and the complete German National-team have been analysed. The members of the National-Team showed significant smaller holding areas and a significant higher shooting score. Individual analysis revealed no dependency of the result on the stability of targeting in the Junior National-team but 7 archers out of 9 showed that dependency in the National-team. A stable aiming process seems to be an important parameter in Olympic archery on international level.

KEY WORDS: archery, holding-area, aiming-stability, on-target-trajectories.

INTRODUCTION: The process of shooting with a recurve bow (see Figure 1) can be described as follows. The archer draws the bowstring, pulls the arrow to a certain length, fixes in this position and aims. When he is "on target", he starts to pull the arrow through the clicker (The clicker is a 5cm long and 0.5cm wide piece of spring steel that is fixed to the riser) and releases the shot. From a biomechanical point of view, the archer has to cope with the breakdown of the static balance of forces between the external tension and his muscular forces at the moment of shooting. Since the arrow still sticks to the bowstring after the archer has released his hand from the string, each motion of the bow is transferred to the arrow. The goal of the archer is to keep the bow motionless up to the moment of the contact-loss of the arrow with the string. This moment obviously has a high impact on the shooting score and due to this fact this moment is considered very important in research (Edelmann-Nusser, J. & Gruber, M. 2000, Gruber 2001) and also in the practical training process (Bachmann 2001).

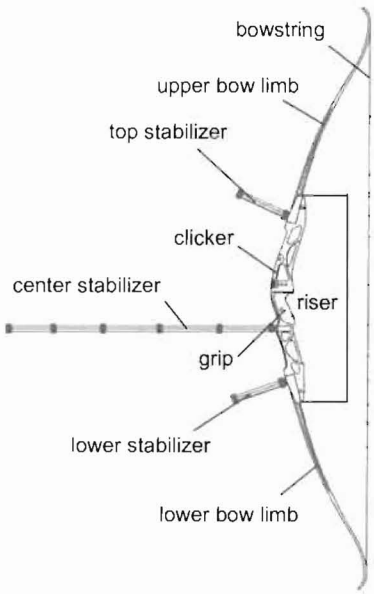

Figure 1. Recurve bow and terminology.

Another process influencing the shooting score is obviously the aiming itself. Up to now this aspect was neglected in scientific research due to the widely missing software and hardware requisites (Edelmann-Nusser, J. & Gruber, M. 2000). The purpose of the study is on the one hand to measure the on-target-trajectories during aiming up to the contact loss of the arrow with the bowstring by a measurement-system that above all is easy to use by coachers and athletes and on the other hand to describe the holding area and therefore the stability of aiming in high level archers.

METHOD: A commercial optoelectronic shooting training and analysis system Noptel ST 2000 Sport (Noptel Inc. Finland), designed for pistol and rifle shooting is used. The Noptel ST

2000 system measures and stores the hit point of the shot and the on-target-trajectory of the alignment of the weapon. The Noptel system (see Figure 2) consists of a small optical unit which is fixed onto the barrel of the shooter' s own gun and linked by a cable to a computer. The optical unit includes an infrared transmitter and receiver. Two or three reflectors (prisms) are fixed around the center of the target so that the optical center of the reflectors corresponds approximately with the center of the target. The trigger release is detected by the vibrations that are induced by the report of the gun.

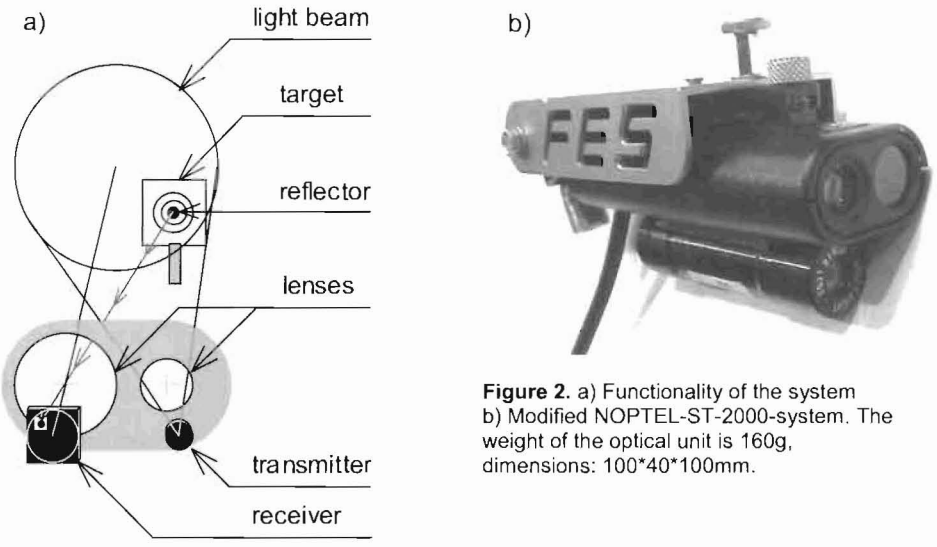

Figure 2. a) Functionality of the system b) Modified NOPTEL-ST-2000-system. The weight of the optical unit is 160g, dimensions: 100*40*100mm.

To use the Noptel-system in Olympic archery the system has to be modified and adapted to the singularities of a bow. The Noptel system is mounted on the riser instead of the lower stabiliser (see Figure 1). Due to the fact that the lower stabilizer does not point at the center of the target a visible laser is mounted on the system (see Figure 2b). After the Noptel system is fitted onto the riser the laser is switched on and the archer has only to shoot three to five times before the prisms can be fixed around the projection point of the laser beam so that the optical center of the reflectors corresponds approximately (< 5cm) with the projection point of the laser beam (see Figure 2a). The remaining positioning error is corrected afterwards by software tools comparing the real hits with the hits computed by the measuring system. For the present study the shooting score was registered and the holding area was indicated separately for the horizontal and vertical axes by means of the deviations (dev_x, dev_y) in the last second before releasing the arrow. The determination was based on the central point of the aiming path during this time interval. The sample of this study consisted of the German Junior-Team (seven woman and nine men) and the German National-Teams of women (four subjects) and men (five subjects). Altogether over 1000 shots were measured in April and November 2001 and statistically analyzed. For cluster analysis stable aiming was assumed when both dev_x and dev_y were less one. In this case the archer was supposed to be always in the ten when aiming. If either dev_x or dev_y were over 1 the aiming was considered unstable. In line with the classification of the holding area the scores were also categorized. In the case of a ten the shot was accepted as a hit. If the result was lower then ten the shot was considered as no hit. On the base of this two times two matrix the subjects were clustered with the method of Ward.

RESULTS AND DISCUSSION: Figure 3 shows the mean score and the associated deviations in horizontal (dev_x) and vertical (dev_y) direction subdivided into gender and squad affiliation. The mean level in score in the National-team archers is higher and at the same time the holding area in horizontal and vertical direction is lower compared to the

Junior-team members. Concerning the gender a quite similar ratio can be observed between male and female archers. The male archers have a higher score level and lower deviations during the aiming process. This fact could easily lead to the conclusion that aiming stability is important for a high shooting score. Calculating intraindividual correlations this presumption can not be validated. There are only ineffectual correlations between the holding area and the score.

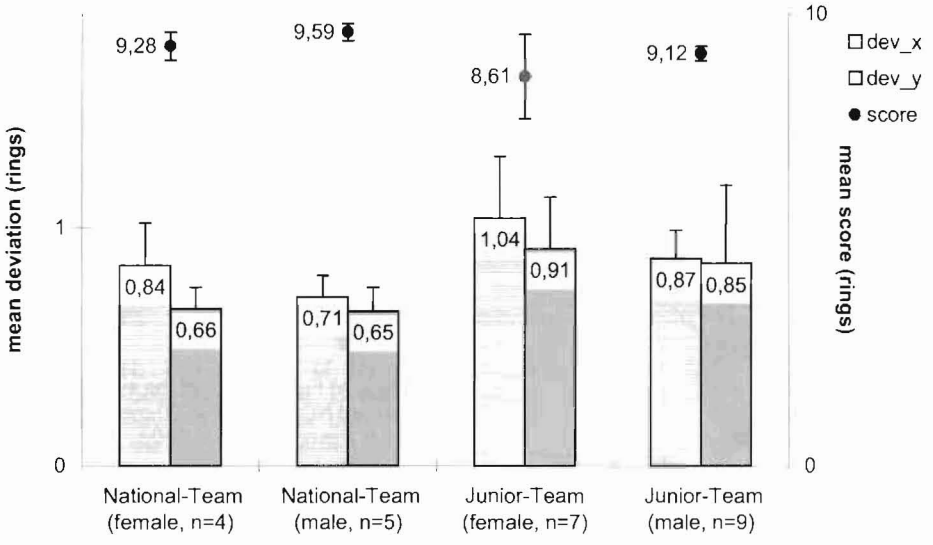

Figure 3. Mean score and mean aiming deviations of all examined archers subdivided in squad affiliation and gender.

According to the fact that in high level Olympic archery only the ten is considered to be a real hit (the World Record is about 597 rings out of 600) categorization of the shots in hit (=ten) and no-hit (less ten) seems reasonable. On the other hand the aiming stability, which is parameterized by the holding area can also be categorized as stable (last second in the ten) and unstable (last second not always in the ten). If we do so, a cluster analysis of the resulting two times two matrix shows us four typical groups of archers (see Figure 4). Group one is characterized by a very stable aiming process, it is the only group with a stable hit to unstable hit ratio bigger than one. The Group is made up of the five best German archers, four males and one female. Group two maybe is the most interesting one. It is characterized by a high mean score but most hits are realized with an unstable aiming. In line with group one there is a hit to no-hit ratio bigger than one but the ratio is equal comparing stable-hit to stable – no hit and unstable - hit to unstable – no hit ratio. So there seems to be almost no effect whether the holding area is only within the ten or outside the ten in group two. Group two is made up of four National-Team archers and six Junior-Team archers. All archers of group one and two archers out of group two showed a significant dependency of score and holding area. The groups three and four a mainly characterized by a hit to no hit ratio less than one. The difference is the stable – hit to stable – no hit and unstable –hit to unstable no hit ratio. It seems that concerning the influence of stable aiming group three is comparable to group one but on a much lower score level. Related are the conditions concerning group two and group four, in both groups stable aiming seems to have no influence on the mean score but again on different score levels.

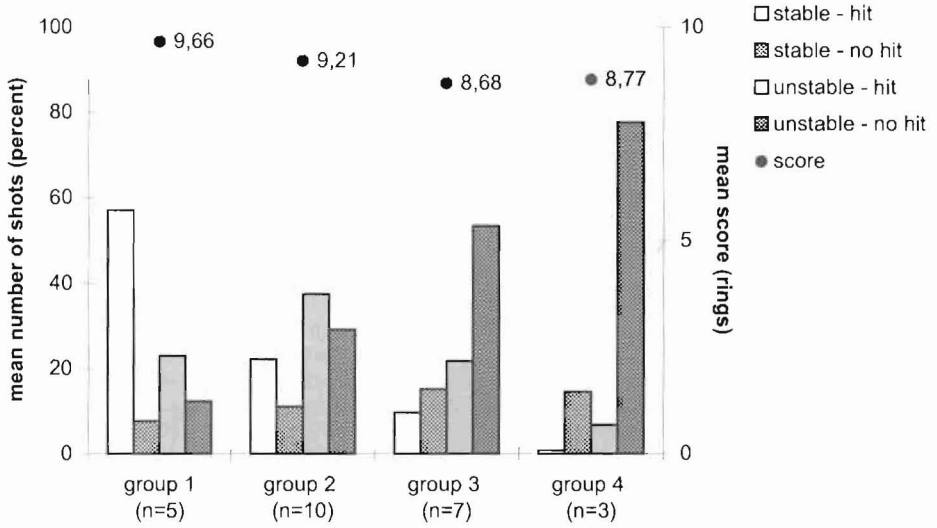

Figure 4. Mean score (rings) and mean number of shots (percentage) of the four cluster variables.

CONCLUSION: In addition to the moment of release and a precise aiming a stable aiming process seems to be an important parameter in Olympic archery at least on international level. Therefore it can be concluded that basic abilities and the training of basic skills which are important for stable aiming should be awarded much more attention on international and national Junior level and maybe even on regional level. More scientific research is required in order to identify these basic abilities and skills and the connectivity of aiming and release in Olympic archery. The modified Noptel-system is perfectly suited to achieve this goal. Above all it is easy to use and can help the archer and the coach in the training process to control the training results and therefore increase stability in aiming.

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