



Accurate Shooting with well-functioning Body:

Guide for Horseback Archers



Anna Minkinen

Author (authors)	Degree	Time
Anna Minkkinen January 2020	Bachelor of Health Care, Physiotherapy	
Thesis title		
Accurate shooting with well-functioning body: Guide for horseback archers		
Commissioned by:		
The Mounted Archers of Southern Finland		
Supervisor		
Anu Valtonen, Ulla Härkönen		
Abstract		
<p>Horseback archery is a growing sport where you shoot with a traditional bow on a cantering horse. However, knowledge of good shooting technique is not currently standardised, instead largely consisting of oral information collected by teachers, and thus often not able to reach the many amateurs who practice alone.</p>		
<p>According to a survey that was done as a basis for this thesis, about one-third of the respondents suffered from horseback archery related aches and nearly half suffered from muscle soreness. Particularly for a beginner, the focus is often on accuracy alone without also considering feedback from body sensations, which exposes them to adopting the wrong technique for soft tissue wellness. Problems often come to light later, when development does not continue or the body begins to show symptoms.</p>		
<p>The purpose of this thesis is to compile a compact guide of the functioning of the upper body in archery, to go through the basics of archery technique for a sound body, and to introduce the most common mistakes leading to pain or injury. The output of this thesis is a guide book in English that can be shared internationally for all horseback archers.</p>		
<p>The sources used in the thesis are the currently available horseback archery books, modern research on archery, interviews with horseback archery trainers and books written on the basis of historical manuscripts on traditional archery and horseback archery.</p>		
<p>Based on the sources, the most important unifying factor was emphasising bone strength rather than muscle strength in archery. When the force exerted by the bow in the full draw is positioned parallel to the straight bones so that the joints are not unnecessarily bent, the stress on the soft tissues can be reduced. In archery, the same movement is repeated hundreds of times, so it is important both for accuracy and for the avoidance of injury that movements and postures are optimal. Adequate attention should also be paid to general training principles such as warming up, cooling down and auxiliary sports.</p>		
Keywords		
Horseback archery, technique, bone strength, overuse injury		

Table of Contents

- 1 Introduction
 - 2 Body functioning during horseback archery
 - 2.1 Performing a good shot in horseback archery
 - 2.1.1 Starting position and nocking
 - 2.1.2 The drawing phase
 - 2.1.3 Anchoring, holding and aiming
 - 2.1.4 Release and follow-through
 - 2.2 Transmission of bow forces to the body
 - 2.3 Muscle functioning
 - 2.4 Importance of breathing
 - 3 Typical mistakes and injuries in horseback archery
 - 3.1 Typical pains associated with archery
 - 3.2 Typical incorrect positions in horseback archery
 - 4 The principles of training horseback archery
 - 4.1 Warming up
 - 4.2 Cooling Down
 - 4.3 Cross-training, strength and conditioning
 - 4.4 Learning horseback archery
- Resources
- Attachment 1: Questionnaire for horseback archers



1 Introduction

Horseback archery is a rapidly growing sport that combines horse riding skills and archery. In the sport one or more targets are shot as quickly and accurately as possible while cantering along the track. The purpose of this thesis is to provide an overview of existing written and oral knowledge of good horseback archery technique for optimal body loading, and to explain how to engage in the sport so that results are improved and body performance is maintained through lifetime of exercising. The thesis is limited to focus specifically on archery and the upper body muscle functioning, although equestrian skills and practice are equally important in the sport.

Horseback archery is an ancient skill, but, rather than fading away, as a modern sport it is only increasing in practitioners around the world. Training methodologies are still developing, as knowledge of effective forms of practice and good shooting technique is not currently standardised, instead largely consisting of oral information collected by different teachers. One can learn to shoot at the target with almost any technique, and the more intuitive the technique is, the better the accuracy, at first. However, problems occur in the mid-level archers when development stalls and in addition the body may begin to show symptoms. (Kassai 2002: 52) Emphasis on good technique right from the start of the hobby is essential, as beginners tend to focus on accuracy rather than feedback of the feel of shooting. Old habits are difficult to get rid of. Bad habits and especially old injuries caused by bad technique can prevent good technique from being learned even when the archer is aware of his problems. (Tian & Ma 2014: 33-39) For beginner archers, the important common basic pillars of archery can be overshadowed by differences in archery styles. In the survey that was done as a basis for this thesis, up to a third of the respondents reported horseback archery related pain and nearly half of the respondents experienced sore muscles. Learning painless or otherwise good technique was perceived challenging, especially because many archers practice alone without a teacher.

Horseback archery is a precision and skill sport, so it allows its practitioners to practice and compete for decades. However, the one-sidedness and the monotonous strain on the body can cause premature career breaks if care for the body and quality of training are neglected. Competition careers are often started at a relatively early stage, when the technique is often not fully developed. That can result in strain on the body as the amount of training increases. Investing in a good technique throughout your hobby career allows both body health and optimal accuracy.

Written sources were emphasized in compiling the thesis, but due to the limited amount of written information available on modern horseback archery, interviews with horseback archery teachers and experts have also been used. The interviews were informal and the information the teachers shared during their classes has been included. Two books were written directly about the modern horseback archery: *Horseback Archery*, published by Kassai Lajos in 2002, and *Horseback Archery: Ancient art to modern sport*, produced by the British Horseback Archery Association, edited by Claire and Dan Sawyer, in 2016. Other written sources have sought to expand the knowledge from various perspectives in the widest possible range. The research articles used in the thesis have been searched in the PubMed database with a keyword *archery*.

An initial survey for horseback archers was conducted in the spring 2018 to determine the need for a thesis. It received 152 responses from 21 different countries. The survey was conducted through Google Forms and distributed to national and international social media channels by sports enthusiasts and it was allowed to be answered anonymously. The report of the survey results is attached to the thesis. The most important findings for the thesis were that up to a third of the respondents reported having experienced horseback archery related pain and almost half of the respondents experienced muscular soreness. Learning painless or otherwise good technique was perceived as challenging. The need for material that would help both archery teachers and hobbyists to outline the most essential aspects of horseback archery techniques was very clear.

The author of the thesis is Anna Minkkinen, who, in addition to studying Physiotherapy, competes in horseback archery on an international level and trains horseback archers as her main job in her business Elrohir Oy. Anna has been a certified trainer of the Finnish Mounted Archery Association since 2017, has attended the Finnish Olympic Committee's accuracy sport instructor training VOK1 in 2018 and has participated in international ERASMUS Arch-Ed project for horseback archery teachers in 2019.

Producing the guidebook in English would not have been possible without the help of Andrew Ó Donnghaile, Claire Sawyer and Dan Sawyer, who checked the translation of the thesis. The visual work of the guidebook was done by Anni Jauhiainen, who helped a lot in the final phase of making the thesis.



Picture: Anni Jauhiainen, 2020

2 Body functioning during horseback archery

2.1. Performing a good shot in horseback archery

The aim in all archery is to perform good shots so that the arrows hit a small area with as little mental and physical effort as possible. In a well-executed shot, the arrow will fly using the maximum energy provided by the bow and flies always in the same way. (Axford 1995: 76) Safety, consistency, and accuracy are the basic principles of all archery, and in horseback archery also speed plays an important role. One of the safety factors is that the shooting technique does not unnecessarily strain the body and thus doesn't harm the archer. (Sawyer 2016: 196-198).

One of the most important things for the optimal use of the body is the use of bone strength instead of muscle strength. In practice, this is done by placing the joints in a straight line to resist the force exerted by the bow on the body in the full draw position. KiSik Lee refers to this straight line by talking about creating a "barrel of the gun". Bent joints make the technique more difficult to repeat and thus less accurate, but above all stresses the soft tissue structures of the joints (Sawyer 2016: 198-199; Lee 2013: 46; Ghoorchian 2016; Némethy 2018). Good technique refers to the optimal way to perform a given movement, and good technique implies both a faster and more economical execution (Mero et al. 2004). Although there are different schools within horseback archery that teach slightly different techniques and styles, an overview of good and technical horseback archery technique can be provided.

Figure 1 shows the steps of the shooting cycle with the most common horseback archery styles. The following section will walk you through the shooting cycle one step at a time. The example that is used here is the basic stance of horseback archery, where the archer stands with the bow hand side facing the target and shoots a side shot. Typically most repetitions are done in this position. The position on horseback is slightly different, and in addition horseback archers can shoot arrows forwards and backwards with nearly 180 degrees rotation, but the same basic principles apply in these situations.

2.1.1 Starting position and nocking

The action starts from an initial position, in which the horseback archer nocks the arrow and prepares to draw the bow. A good starting position is very important as errors in the starting position often turn into errors in the drawing and holding positions (Ghoorchian 2016). The starting position may vary depending on the style, but in common for all the styles, the arrow and the archer's hands are placed between the archer's eyes and the target, the arrowhead slightly upwards away from the horse's eyes. (Sawyer 2016: 204-205) Typical starting positions are shown in Figure 1.

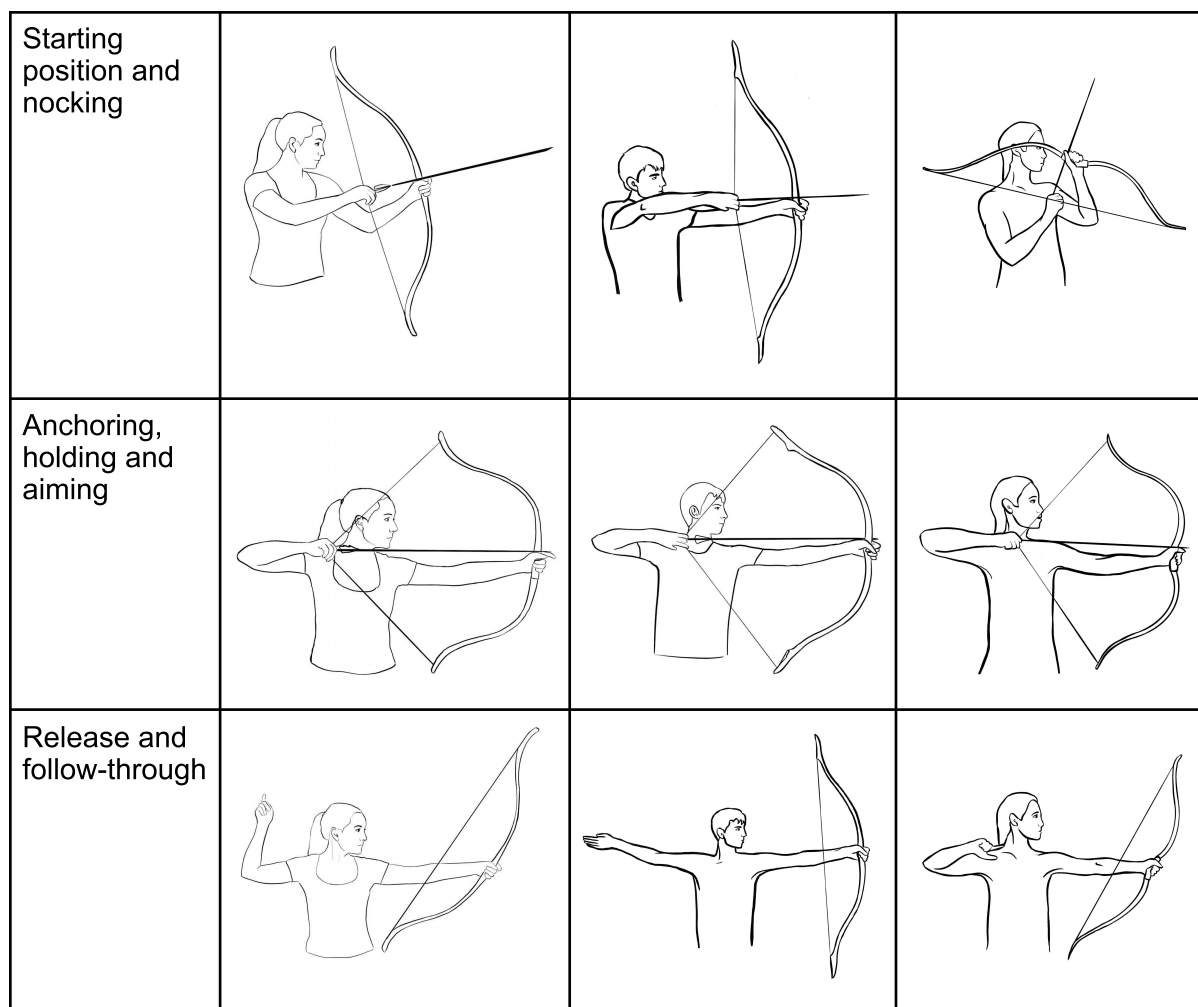


Figure 1. Steps of the shooting cycle with different horseback archery styles. Pictures: Eerika Minkkinen 2019.

Usually in the starting position the archer stands in a shoulder-wide position, the weight evenly on both legs and the spine straight, without tilting the body on either side (Sawyer 2016: 200-201). Typically, a right-handed archer stands with his left side towards the target. Another option is the open stance recommended by KiSik Lee, where a right-handed archer is rotating the left foot about 30-40 degrees and the right foot about 15-30 degrees (Lee 2013: 48). The weight of the body may be more on the forefoot than on the heels, so that the archer can easily rise to his toes, but the whole sole is still touching the ground. The weight of the body is shifted forward only slightly, so that the heels remain firmly on the ground and the leaning does not come from the pelvis (Lee 2013: 48-49, Ruster 2016). The knees are straight but not locked (Lee 2013: 48-49, Ruster 2016).

The pelvis is rotated under the torso and the thorax is brought down with slight abdominal muscle activation (Lee 2013: 48-49, Ruster 2016). The activation of the abdominal muscles ensures that the lower back does not become hollow (Lee 2013: 48-49, Eriksson 2018). Although the arms and the bow are raised in front of the chest, the shoulders should remain in a neutral position and at the same height with each other (Ruster 2016). The face and the eyes are turned towards the target, but the head should be relaxed in the centerline without reaching towards or away from the target while the superficial flexors of the neck remain relaxed. The head should remain in the same, neutral position throughout the archery process (Nichols 2013: 96). Especially if the archer is using a fixed anchor point on his face,

he is tempted to bring his head closer to the bowstring when coming to full draw and move his head at the moment of release to see the hit. (Sawyer 2016: 209) This movement can cause not only inaccurate hits, but also neck pain and headaches.

2.1.2 The drawing phase

In the drawing phase the archer draws the bow by pushing the bow hand towards the target and at the same time pulling the string backwards, reaching full draw length and moving to the holding phase (Sawyer 2016: 212). The most common ways of drawing a bow are to either lift the bow slightly upwards and to draw the bow with the help of gravity as the upper limbs lower into their places or by pushing the bow perpendicularly towards the target, using the body rotation to draw the bow. (Axford 1995: 94-97) These different ways of drawing the bow are shown in Figure 2.

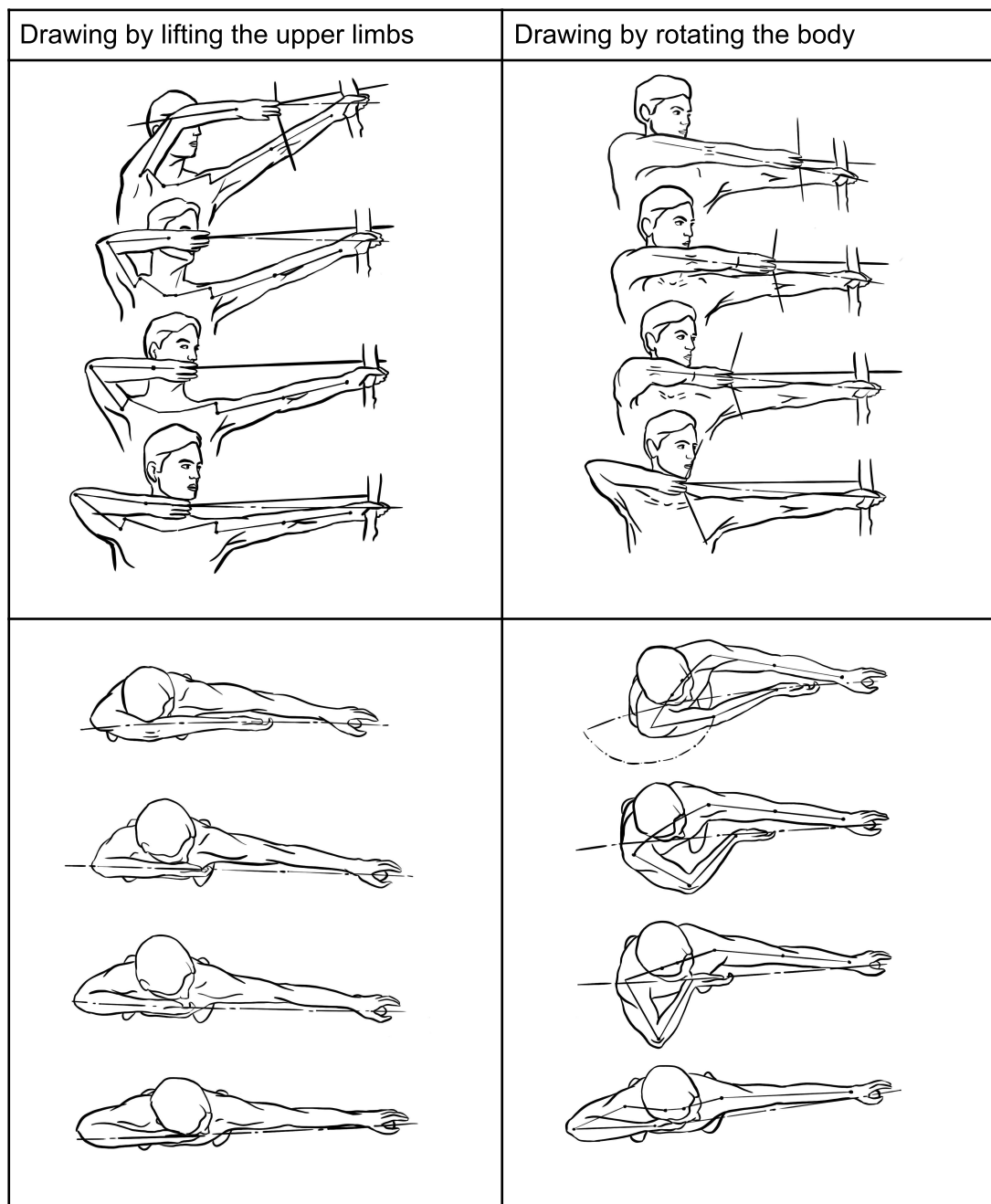


Figure 2. Different ways to draw the bow. Pictures: Eerika Minkkinen, 2019, based on the pictures Axford 1995: 92-99.

Most of the muscle work should be done with the large muscles of the back by rotating the shoulder blade towards the spine, not by the muscles of the arms (Rüster 2016; Sawyer 2016: 212). At the same time, the bow arm pushes the bow against the pressure and towards the target with the help of *serratus anterior* muscle (Rüster 2016). When shooting with a short reflexed bow and a thumb ring the drawing requires also tension on the muscles of both arms, which is usually avoided in archery, but the strong small bow cannot be drawn with only the back muscles. However, when reaching the holding phase, the aim is also to move the unnecessary tension from the arms to the back muscles and form a strong straight line of the bones. (Swoboda 2012: 56-57, 108)

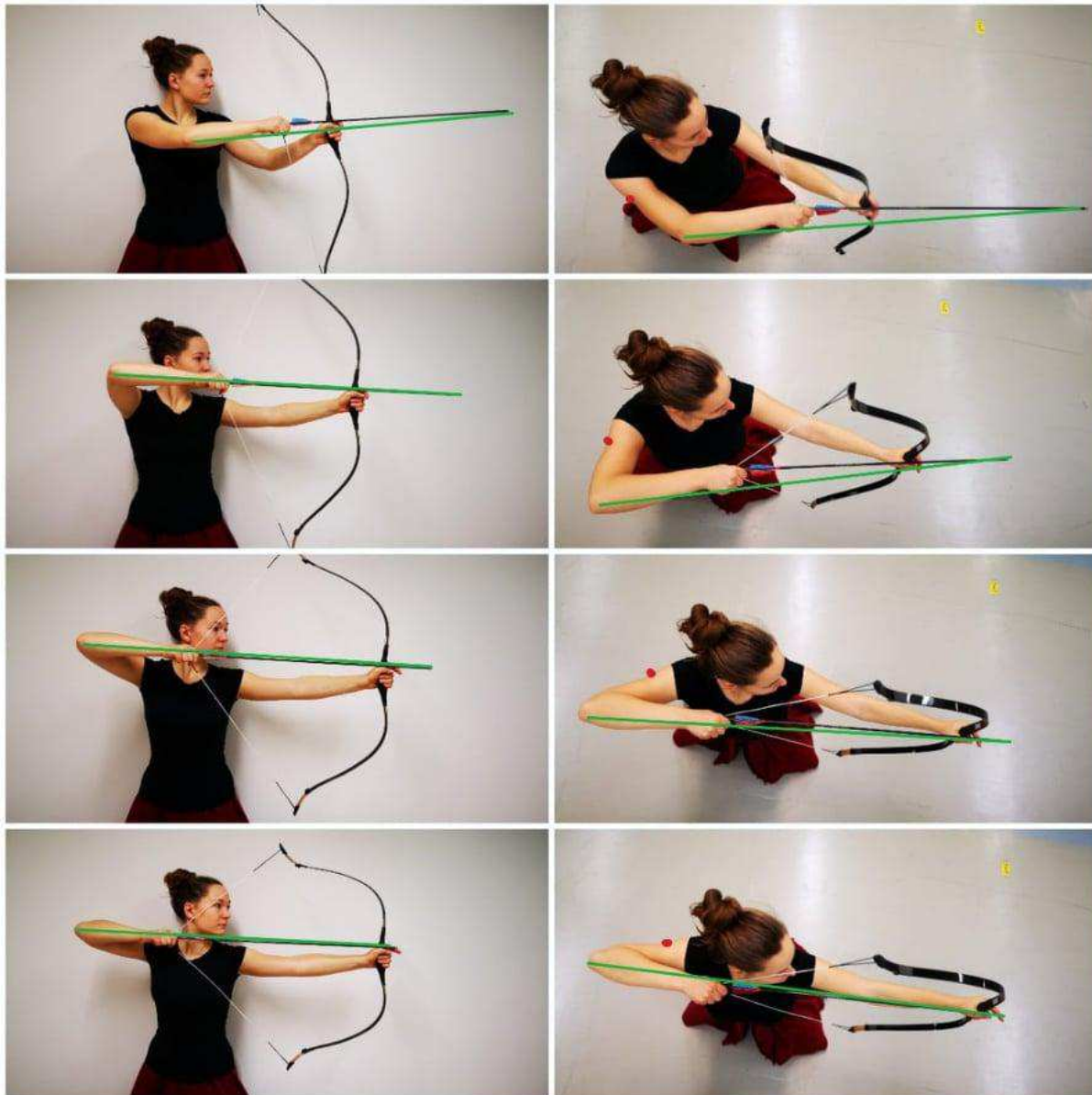


Figure 3. Drawing the bow while keeping the draw force line straight and focusing on the LAN 2 area (the red dot). You can read more about LAN 2 in the Chapter 2.3. Pictures: Anni Jauhiainen 2020.

Linear drawing, so that the arrowhead is constantly aligned to the center of the target and the draw hand moves linearly away from it to the full draw, stresses the drawing side shoulder more and increases the risk of shoulder injury. In order to avoid repetitive strain

injuries, such as inflammation of the biceps tendon or rupture of the rotator cuff, it is important that the archer's position and the muscles that are used are correct especially during the draw phase. Also the draw should be more circular than linear. (Krueger 2013: 37, Némethy 2018) In linear drawing the maximum movement of the draw arm shoulder occurs when the draw length and hence the tensile stiffness begins to increase, which explains its strain on the shoulder. If body rotation is used for pulling and it happens in the wrong order, the result may be an incorrect position at full draw. This can prevent the formation of a stable bone line, make the draw length shorter, cause overstretching of the arm and unnecessary tension in the neck muscles. (Axford 1995: 94-101) Linear pulling allows one to aim at the same time when drawing the bow, which is why some horseback archers use it, even though it has many disadvantages for the body.

When drawing by lifting the upper limbs, it is good to make sure that the movement is not too dramatic, as larger movements take more time and when shooting from horseback the shooting time is limited. In addition, especially in rushed shots, the movement from up to down may continue during the release, resulting in dropping the bow arm during the shot. A typical way of drawing the bow in horseback archery is the combination of the two methods. In the best situation the target can be followed as soon as possible after the arrow has been nocked, but the body can be used ergonomically and the bow be drawn in a circular motion. (Némethy 2018) Drawing the bow with a circular draw is shown in the Figure 3.

2.1.3 Anchoring, holding and aiming

The fixed anchor point, such as touching the cheekbone or the chin, has been replaced by a floating anchor point in many styles of horseback archery. In this case, the maximal adduction of the shoulder blade (i.e. the rotation of the shoulder blade towards the spine and the transfer of the force of the bow in the direction of the straight bones) serves as anchoring (Némethy 2018, Ghoorchian 2016, Kassai 2002). The time spent in full draw, i.e. the holding phase, is relatively short as there is no time for actual aiming on the galloping horse and the shooting is done instinctively (Kassai 2002: 58). The aiming happens subconsciously, not by the shooter consciously aiming with reference to points on the target. However, the drawing movement should stop or the movement slow down for a moment before the shot. Shooting without stopping resulting in an inconsistent draw length is called "snap shooting" and it causes difficulties in getting stable results (Eriksson 2018).

In the holding phase it should be easy for the archer to maintain the full draw length for some time without urgent need to shoot. At full draw a straight line should be formed from the arrow head through the draw hand wrist and to the draw hand elbow. This line is called the draw force line. It should be straight from both the side view and the top view. Another straight line is "the barrel of the gun", the line of straight bones from the bow hand wrist through the bow hand shoulder to the draw hand shoulder (Lee 2013: 46). The tension in the back muscles is maintained as the draw side shoulder blade rotates towards the spine and the bow hand shoulder blade pushes towards the target. The middle torso is active and the shoulders are supported against the ribs, so that a good basic posture is maintained during the holding phase. (Rüster 2016) All but the necessary muscles should remain relaxed (Kassai 2002: 53-54).

2.1.4 Release and follow-through

In the release the drawing hand continues to move away from the target, allowing the bow string to open the fingers and let the arrow to fly to the target. The release should happen as naturally and relaxed as possible (Kassai 2002: 53). In many cultures the draw hand moves backwards during the release, for example in Persian culture the shorter movement is called "*moonshine*" and the longer movement "*tiger tail*" (Ghoorchian 2016). In Hungarian style the draw hand continues to horizontal opening of the arm and forearm (Némethy 2018, Kassai 2002). These movements are illustrated in Figure 1. With proper tensioning of the back muscles these movements occur naturally, as the muscles continue to work but the counter-force produced by the bow disappears in the moment of the release. Even as a learned habit, moving the draw hand away from the target can be beneficial to make sure that the shot is executed fully before the draw hand moves to the quiver to get next arrow. (Rantanen 2019) On the other hand it is good to be careful not to interfere the flight of the arrow, for example by pulling the string away from the archer's body during the release. The bow arm should be kept steady with the bow pointing towards the target through the shot. With the correct grip of the bow grip, "*khatra*", or tilting the bow towards the target, is achieved. The *khatra* should follow as the natural consequence of the tension in the bow disappearing at the moment of the release. In the release the pressure of the palm on the top of the handle and the small and ring finger grip on the bottom of the handle remain and cause the top of the bow to lean towards the target. When *khatra* is done as a forced movement it often interferes with the arrow flight and causes harmful side effects, such as the bow hand dropping towards the ground during the release. (Sawyer 2016: 222-229, Ghoorchian 2016, Némethy 2018)

The release is immediately followed by a follow-through, where the bow continues to be pointed at the target. When shooting whilst moving, the bow arm must follow the target while passing it. The duration of the follow-through phase depends on how soon the next arrow is to be shot, but still it plays an important role in accurate and optimal shooting performance even in fast shooting. (Sawyer 2016: 224-229) In horseback archery one arrow can be shot in less than 2 seconds, but still each shooting performance includes all of these steps of the shooting cycle. The steps should be learned carefully and they should be well mastered before the novice horseback archers start practicing speed shooting (Kassai 2002).



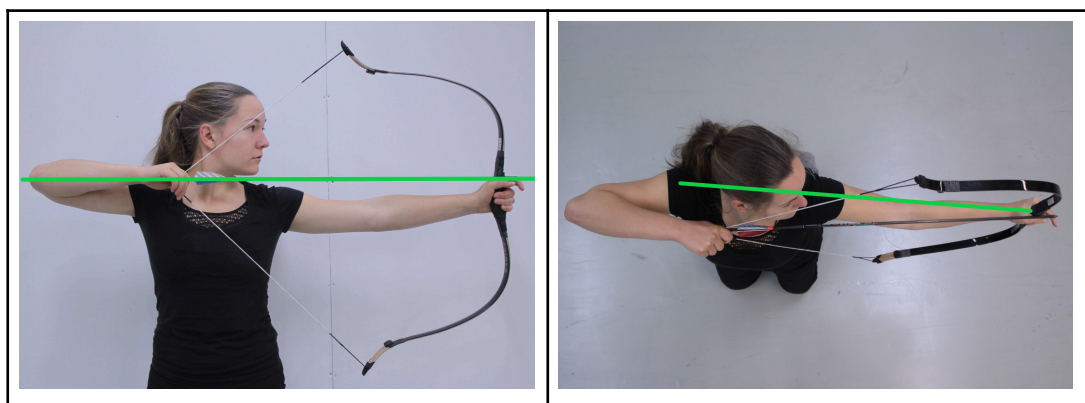
Picture: Timo Rantanen, 2019

2.2. Transmission of bow forces to the body

Archery can be viewed as a mechanical performance determined by the lines and angles between the bow and the body. In archery, the bow exerts forces on the body. One of the forces is the gravity, which affects the arm holding the bow proportionately to the weight of the bow. In horseback archery the bows are often quite light, so holding the bow in your hand does not require much muscle work. We have to pay more attention to the force exerted on the body when the bow is in the full draw, against which the musculature must work to achieve and maintain the desired shooting position. (Axford 1995: 78) However, in a body-saving technique, the strain on the muscles and joints is minimized by applying this force to the straight bones, creating a so-called “barrel of the gun” (Lee 2013: 46, Sawyer 2016, Swoboda 2012: 56-59; Némethy 2018; Ghoorchian 2016; Eriksson 2018; Kassai 2002). In addition to these forces, when shooting on horseback, the forces exerted by the horse on the rider require the horseback archer to use his lower and middle torso to compensate the upward and downward movement of the horse to create a stable platform for shooting.

When the bow is drawn, the palm of the bow hand forms a pivot point where the pressure from the bow handle pressure is greatest. Depending on the style, the location of the pivot point may vary, but it is often located on the skin between the forefinger and thumb or on the muscles of the base of the thumb and palm (Sawyer 2016: 202-203). A straight line runs from the pivot point to the elbow of the bow arm, to the shoulder joint, to the joint between the outer shoulder and the clavicle and to the inner clavicle and the sternum. The form of the shoulders and the anatomy of the archer's body influence whether the head of the humerus tends to rise up from the glenoid or if it remains neatly in place without much muscle work. The lower the bow arm is, the easier it is for the shoulder to rise. Also strongly inclined collar bones affect the structure of the shoulder joint, making the shoulder more prone to rise by the force of the bow. (Axford 1995: 78) The wrist should be in a straight neutral position, and the elbow should be straight but not locked (Sawyer 2016: 206). The forearm is rotated into the inner rotation so that the elbow points outwards. (Lee 2013: 56)

The corresponding straight line should be formed from the tip of the arrow by draw hand wrist to the draw hand elbow, as if the draw arm elbow would be pulled perpendicularly away from the target. The line is called the draw force line DFL. (Sawyer 2016: 210-211) The draw hand shoulder blade should be maximally rotated towards the spine, providing both an anchor point and with the use of the right muscles it ensures forming the straight line (Sawyer 2016: 210-215; Némethy 2018; Ghoorchian 2016). The draw force line should be straight both from the side and straight from above.



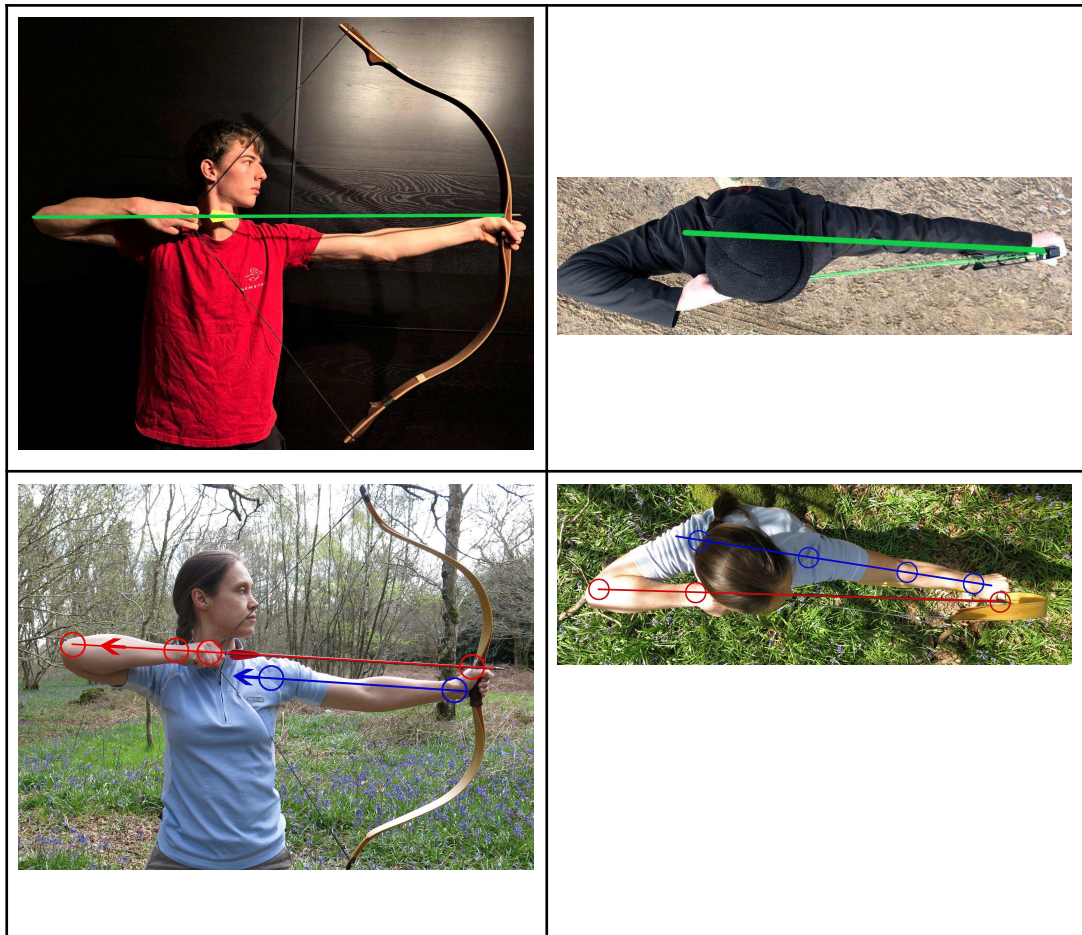


Figure 3. Draw force line DFL on the left and the line of straight bones, “the barrel of the gun”, on the right. Pictures: Timo Rantanen, Christoph Némethy & Dan Sawyer.

When the joints are aligned and “the barrel of the gun” is created, the stress caused by the bow tension is not applied to the joints and soft tissues. The repeatability of the movement is improved and the load on the body is reduced. (Némethy 2018, Sawyer 2016: 210-211) As early as in the 17th century, the famous Ming Dynasty General Qi Jiguang has emphasized the importance of the full draw, the correct bone alignment and use of the bone strength instead of the muscle strength in horseback archery (Tian & Ma 2014: 123). The popular Persian saying “*Sit straight, shoot straight and be honest*” is also thought to refer to this straight line (Ghoorchian 2016). With a short reflexed bow it is more challenging to reach this line than with a longer bow, but it is still an important principle for example in the traditional Middle Eastern styles where short traditional bows are used. (Swoboda 2002: 56-59)

2.3 Muscle functioning

When the bow is drawn properly the large muscles of the back are used primarily to rotate the draw hand shoulder blade towards the spine while pushing the bow arm towards the target. In archery this is often referred to as back tension. At full draw the muscles continue to work throughout the holding phase, so that the draw does not get shorter during the holding and the release is cleaner. (Sawyer 2016: 215-216) When shooting with a short reflexed bow and a thumb ring, the forearm muscles must also be used when drawing, which is usually avoided in archery. However, when reaching the holding phase the

unnecessary use of force is transferred from the arms to the back muscles to form a strong straight line of bones. (Swoboda 2012: 56-57, 108)

Archery, like all other movements, is the output of many muscles working together at different levels, involving both large movements and stabilizing joints. However, an overview of the function of the most important muscles in archery can be made. On the bow hand side, *m. Deltoideus* and *m. Triceps brachii* raise the upper limb so that the bow can be lifted up and held firmly towards the target. *M. Serratus anterior* produces pushing the bow towards the target. The shoulder is stabilized by *m. Latissimus dorsi*, *m. Teres major* and *m. Trapezius*. On the draw hand side *m. Rhomboideus Minor* and *Major*, *m. Levator Scapulae* and *m. Trapezius* pull the scapula towards the spine. (Sawyer 2016: 214-216) Specifically the activation of the lower part of the trapezius as a shoulder stabilizer has been shown to improve archery performance (Shinohara 2017). The middle and lower parts of *m. Trapezius*, *m. Triceps brachii* and *m. Deltoideus* play a key role in achieving back tension and straight line of the bones, "the barrel of the gun", even though all the back muscles play some role in archery (Krueger 2013: 32, Lee 2013: 47). On both sides the rotator cuff muscles support the shoulder in the correct position. Figure 3 shows the superficial muscular layer of the back and the shoulder girdle in the full draw position.

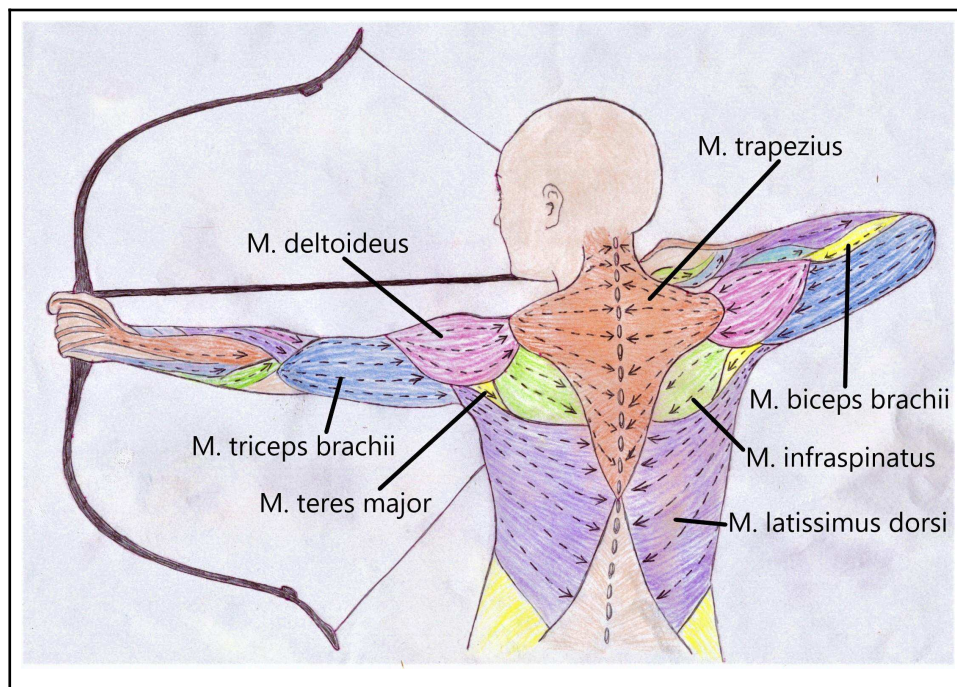


Figure 3: The superficial muscular layer of the back and the shoulder girdle in the full draw position. Picture: Anna Minkkinen 2019.

This thesis is focused on the working of upper body muscles in archery. However, the muscles of the abdomen also play a very important role in all archery as they provide a solid base for the upper body work. (Niestroj, Schjöll & Küpper 2018; Sawyer 2016: 216) In addition in horseback archery the muscles of the legs are used to stabilise the up-and-down movement of the horse to gain the upper body stability for shooting.

According to Saracen Archery, when shooting with a short reflexed bow the archer should have muscle tension in the bow hand side in the little, ring and middle fingers, wrist, elbow and lower forearm, both shoulder blades, spine, abdominal muscles, pelvis, and on the draw hand side in the wrist and thumb and the middle, ring and little fingers. In the contrary, the

bow hand side forefinger and thumb, the upper forearm (wrist and the area of ulna), the shoulder of the bow arm, the draw hand forefinger, and the medial tendon of the forearm, the waist and the lumbar area on the bow hand side, the neck, lips, and facial muscles should be relaxed. Incorrect tension or relaxation can lead to poor arrow flight or in the worst case in injury. These instructions are specifically for shooting with a thumb ring and a short reflexed bow made of traditional materials. In modern archery for example the arms are much more relaxed than described here. (Swoboda 2012: 139-144; Latham & Paterson 1970: 111-113) Both traditional and modern methods are used in horseback archery, depending on the bow, style and technique.

To better understand the movements in archery, it is more useful to focus on the directions of the movement rather than the tensing of certain individual muscles. The difference can be seen, for example, by first flexing the elbow focusing only on the reduction of the biceps. Next, the forearm can be flexed by focusing only on the movement of the forearm towards the upper arm. Focusing on the movement is more natural and smooth, and causes less activation on the biceps, as several smaller muscles also contribute to the movement. For this reason, archery uses the term LAN 2, which is an area about the size of a dollar in the draw arm triceps muscle at approximately where the T-shirt sleeve ends. By focusing on the movement in this area, you can easily move both the shoulder blade and the forearm as a one unit, using the strong muscles of the body and producing a smooth movement. (Krueger 2013: 32, Lee 2013: 47) Otherwise, the archer may move the shoulder blade without moving the forearm of the drawing arm, or, conversely, move the forearm alone without moving the shoulder blade. By focusing on the movement of the LAN 2 area, the bow can be drawn to full draw in a circular motion. This helps saving the draw hand shoulder and results in correct way of holding and releasing. There is no need to tension or squeeze the area, just move it. (Lee 2013: 47, 66) The LAN 2 area is shown in Figure 4 below.

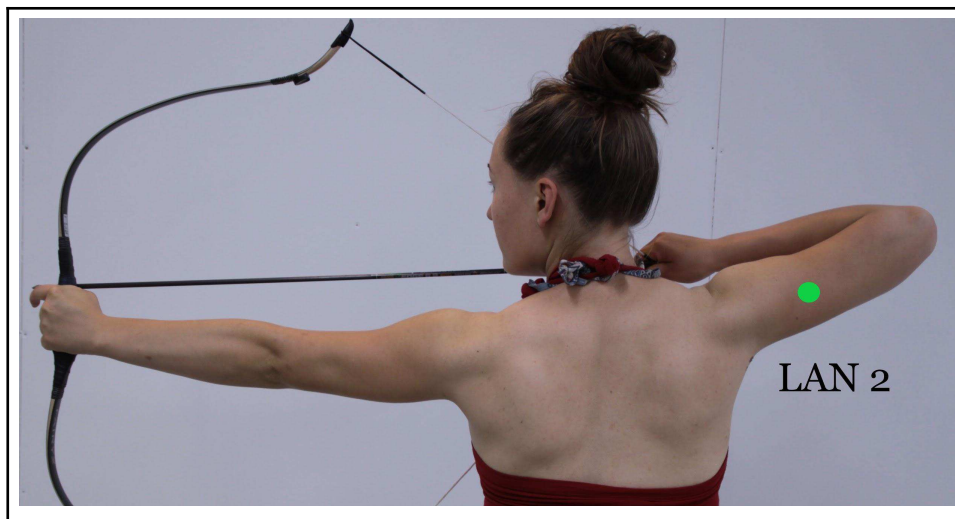


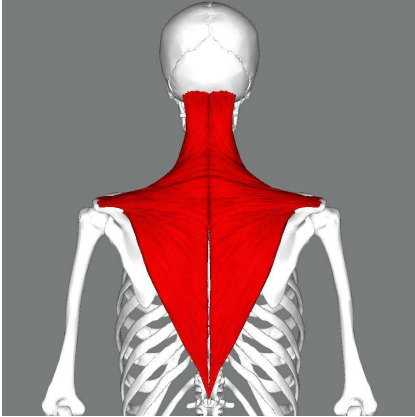
Figure 4: LAN 2 area in the draw hand Triceps. Picture: Timo Rantanen 2019.

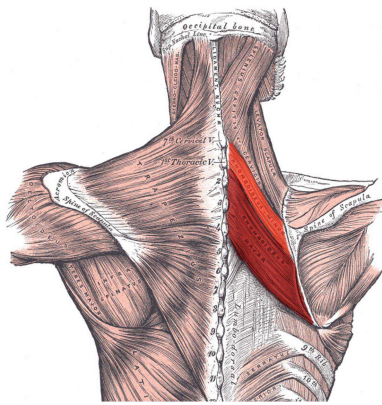
Archery is very monotonous and asymmetrical movement. For the muscle balance it is very good for a right handed archer to draw the bow with left hand after every round, and vice versa for a left handed archer. So in practice, when you have shot for example six arrows, then take your bow to the other hand and draw it six times to full draw and back before collecting the arrows. (Némethy 2018)

Table 1 below shows the most important upper body muscles in archery, their function and importance for archery. The largest and most important muscles for the archery performance

are selected in the table. The selected muscles are those mentioned by several sources as essential for archery. Some auxiliary muscles have been omitted, such as *m. Subscapularis*, *m. Infraspinatus*, and *m. Teres minor*. Although only the muscles of the shoulder girdle are selected for the table, forearm muscles such as wrist flexors and extensors, and finger muscles such as finger flexors and extensors are also involved in the archery performance. (Ergen & Hibner 2004).

Table 1: Muscles of the upper body that play an important role in the archery performance.

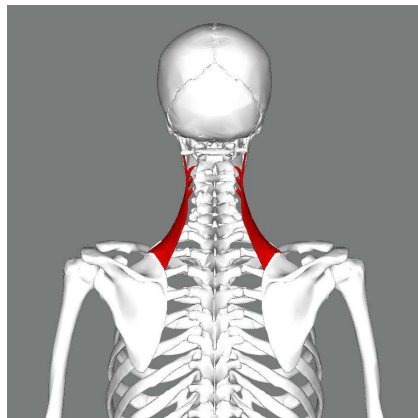
Picture	Explanation
 <p data-bbox="325 1032 715 1066">Picture: Wikimedia Commons</p>	<p data-bbox="767 584 938 618"><i>M. trapezius</i></p> <p data-bbox="767 622 1394 1935">The trapezius muscle is located in the superficial muscular layer of the back. It can be divided into three parts: the upper, middle and lower. The whole muscle stabilises the shoulder blade against the thorax. The upper part draws the shoulder blade diagonally upwards, rotates the glenoid of the shoulder joint upwards, tilts the head to its side and rotates the head to the opposite side. The middle part draws the scapula medially towards the spine and the lower part draws the shoulder blade to middle and downwards towards the spine. (Gilroy ym. 2013: 300) On the bow hand side <i>m. trapezius</i> takes part in stabilizing the shoulder blade against the ribs and the lower part assists <i>m. serratus anterior</i> with the outward rotation of the shoulder blade. On the draw hand side the middle and lower part of <i>m. trapezius</i> bring the shoulder blade towards the spine and keep it against the ribs. (Ergen & Hibner 2004, Sawyer 2016: 216) The lower and middle part of <i>m. trapezius</i> play a key role in forming the back tension and "the barrel of the gun" (Krueger 2013: 32, Lee 2013: 47). The archer should focus mainly on feeling the draw side Triceps and the lower and middle part of Trapezius while drawing the bow (Krueger 2013: 32). The activation of the lower part of the <i>m. trapezius</i> as a shoulder stabilizer has been shown to improve archery performance (Shinohara 2017). Impingement syndrome, which is a typical problem within archers, has been found to reduce the activity of the lower part of <i>m. trapezius</i>. (Shinohara 2014). In the chapter 3.1 you can find more information about impingement syndrome.</p>



Picture: Mikael Häggström 2014

M. rhomboideus minor & major

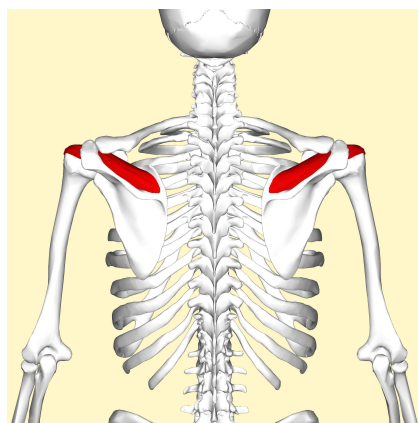
The rhomboid muscles are located in the deeper muscular layer of the back under *m. trapezius*. Upper *m. rhomboideus minor* and lower *m. rhomboideus major* stabilize the shoulder blade and move it to the middle and upwards to the spine. (Gilroy ym. 2013: 300) The rhomboid muscles move the draw hand shoulder blade towards the spine together with *m. trapezius* and *m. levator scapulae*. (Sawyer 2016: 216). On the bow hand side the rhomboid muscles assist the adduction of shoulder blade towards the spine when the bow arm is lifted to the level of shoulders. (Ergen & Hibner 2004).



Picture: Wikimedia Commons

M. levator scapulae

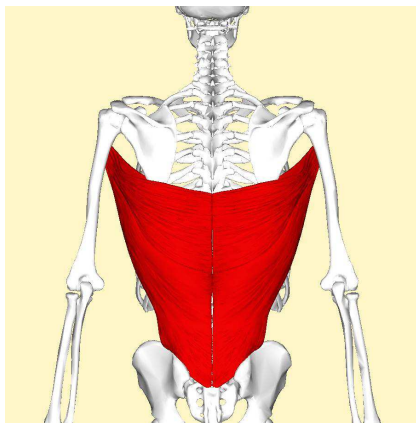
M. levator scapulae is located in the deeper muscle layer of the back under *m. trapezius*. It moves the shoulder blade up and towards the spine at the same time rotating the lower angle of the shoulder blade to the spine. It also tilts the neck to its side. (Gilroy ym. 2013: 300) *M. levator scapulae* assists *m. trapezius* and *m. rhomboideus* to move the draw hand side shoulder blade towards the spine. (Sawyer 2016: 216, Cole 2017)



Picture: Wikimedia Commons

M. Supraspinatus

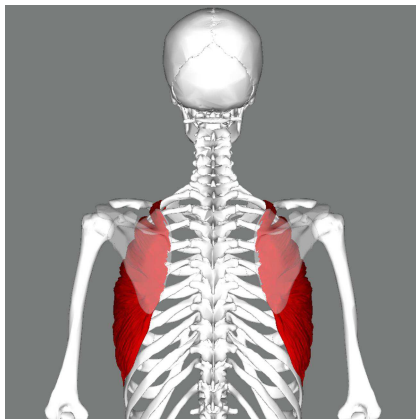
M. supraspinatus is located in the deeper muscle layer of the back under *m. trapezius* and *m. deltoideus*. It produces abduction of the arm (Gilroy ym. 2013: 297) and assists *m. deltoideus*. It participates elevating the upper limb and maintaining the shooting posture in both draw hand and bow hand sides. (Ergen & Hibner 2004). It also draws the head of humerus to the glenoid, which makes it possible to "lock" the bow arm shoulder during full draw to achieve great bow hand stability. (Cole 2017) One of the typical overuse injuries between archers is an impingement syndrome, which is caused by the irritation of *m. supraspinatus* tendon by repeated elevation of the shoulder. The classic sign of this syndrome is pain when elevating the upper limb laterally above the shoulder level. (Shinohara 2014) In the chapter 3.1 you can find more information about impingement syndrome.



Picture: Wikimedia Commons

M. Latissimus dorsi

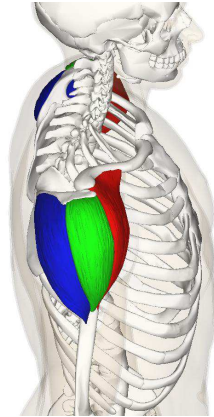
M. latissimus dorsi is located in the superficial muscular layer of the back. It produces inwards rotation, adduction and extension of the humerus and acts during breathing, for example in coughing. (Gilroy ym. 2013: 301) On the bow hand side it participates in stabilizing shoulder blade against the ribs (Sawyer 2016: 216), assists the middle part of *m. deltoideus* to support the head of humerus in the glenoid and creates more stability for the bow arm. It also produces the small inwards rotation of the bow hand shoulder. (Ergen & Hibner 2004) On the draw hand side it assists the back part of *m. deltoideus* with extension of the humerus, and simultaneously rotates the humerus inwards. (Cole 2017) If the draw is done correctly with an angular movement, the upper part of *m. latissimus dorsi* rotates to the back side. The muscle should not be tensioned, but it's only a checking point to see if the draw has been done correctly. (Lee 2013: 66)



Picture: Wikimedia Commons

M. serratus anterior

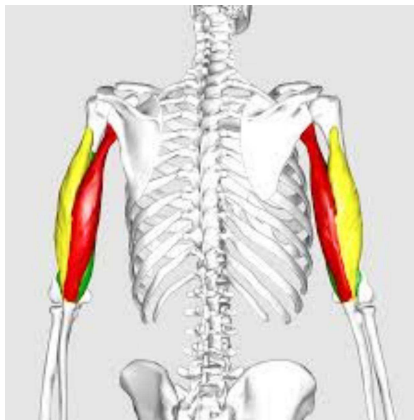
M. serratus anterior is located in the deep muscular layer under the shoulder blade and the pectoralis muscles, against the ribs. It has three parts: upper, middle and lower. The whole muscle draws the shoulder blade sideways and forward, it elevates the ribs when the shoulder blade is fixed. The upper part lowers the elevated arm and the lower part rotates the shoulder blade laterally. (Gilroy ym. 2013: 299) *M. serratus anterior* makes it possible to push the bow hand towards the target (Rüster 2016).



Picture: Wikimedia Commons

M. deltoideus

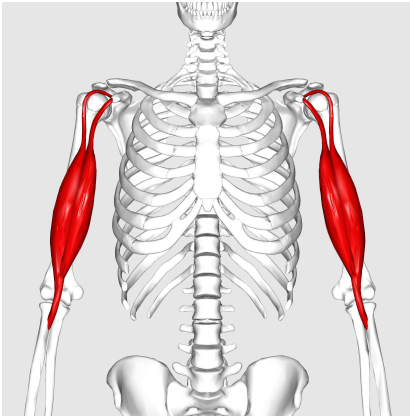
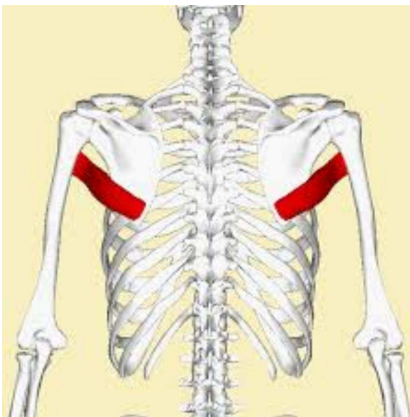
The deltoid muscle is located in the superficial muscle layer and it has front, middle and back parts. The front part produces the flexion, inward rotation and adduction of the arm. The middle part produces the adduction of the arm and the back part the extension, external rotation and adduction. (Gilroy ym. 2013: 296) On both sides the deltoid muscles elevate the upper limbs to the level of the shoulders and keep them in position during shooting (Sawyer 2016: 216). On the draw hand side the back part of *m. deltoideus* makes it possible to come to full draw. On the bow hand side the front part of *m. deltoideus* is used when lifting the bow up in the early part of the shooting cycle. (Cole 2017)



Picture: Wikimedia Commons

M. triceps brachii

M. triceps brachii is located in the superficial muscle layer of the arms, but the upper tendons are covered by *m. deltoideus*. It produces extension of the elbow and the long tendon produces extension and adduction of the arm. (Gilroy ym. 2013: 303) The bow arm triceps raises the arm up for shooting and makes it possible to extend the arm towards the target (Sawyer 2016: 216). The triceps play a major role in forming back tension, because they create stability and a channel to connect the bow arm and draw arm to the muscles of the back (Lee 2013: 64). The archer should focus mainly on feeling the draw side triceps and the lower and middle part of trapezius while drawing the bow. LAN 2 area is located on the draw arm triceps at approximately where the T-shirt sleeve ends. (Krueger 2013: 32)

 <p>Picture: Wikimedia Commons</p>	<p><i>M. biceps brachii</i> <i>M. biceps brachii</i> is located in the superficial muscular layer of the arm, but the tendons of the upper part are covered by <i>m. deltoideus</i>. It produces flexion and external rotation of the elbow and flexion, abduction and internal rotation of the arm. It also stabilizes the head of humerus when <i>m. deltoideus</i> is active. (Gilroy ym. 2013: 302) Even though many people believe that the biceps should be fully relaxed in archery, engaging the biceps in the shooting position is necessary. Flexion of the draw hand side forearm towards the arm activates the biceps. The bow hand side biceps is in extended position but it is active and supporting the position of the arm. (Lee 2013: 64) However, it is important to use the strong muscles of the back to draw the bow instead of the muscles of the arm (Sawyer 2016: 213). Many typical mistakes in archery are caused by activating the biceps too much.</p>
 <p>Picture: Wikimedia Commons</p>	<p><i>M. teres major</i> <i>M. teres major</i> is located in the deeper muscular layer of the back under <i>m. latissimus dorsi</i>. It produces internal rotation, adduction and extension of the arm. (Gilroy ym. 2013: 301) On the bow hand side it participates in stabilizing the shoulder blade against the ribs (Sawyer 2016: 216).</p>

2.4 Importance of Breathing

The role of breathing is naturally to supply oxygen to and remove carbon dioxide from the bloodstream, but for archery there are other important functions as well. Breathing helps you to relax, relieves muscle tension, and slows both heart rate and breathing rhythm, so it has a big impact on the archer's achievements and results. (Swoboda 2012: 145)

The body responds to an exciting situation with a quick inhalation and in turn relaxes with deep exhalation, meaning that inhaling increases tension while exhaling reduces it. (Kassai 2002: 54, Axford 1995: 70) KiSik Lee recommends that during shooting, the lungs should not be breathed completely full, but that the breath is flowing naturally and not too deep. However, you may breathe a few times deep before the actual shooting. (Lee 2013: 82) Swoboda, in turn, recommends deep breathing with the diaphragm to be used during

shooting. Also known as Zen breathing, this type of breathing is the basis of many martial arts. (Swoboda 2012: 145-147)

All interviewed horseback archery teachers consider breathing rhythm during shooting to be important, some emphasizing it more than others in their teaching. Most teachers recommend that the correct breathing rhythm is to breathe in through the nose while drawing the bow and out through the mouth during or after release. (Kassai 2002: 54) In many cultures, release is accompanied by a cry, whereby the breath is discharged at the moment of the release.

From the point of view of muscle engagement, it is more natural and effective to do arm lifting movements while inhaling and lowering arms while exhaling than vice versa, because the work of the respiratory muscles then supports the movement and does not work against it. In this case, one option would be for inhalation to occur during the initial drawing of the bow when the bow is raised slightly upward and for exhalation when the bow is lowered into place while being fully drawn before release. In this case, exhalation increases the relaxation of the full draw position before the release. (Axford 1995: 70-71) Swoboda also says he uses this breathing rhythm when shooting with a traditional short reflexed bow. He adds a deep inhalation and exhalation while he is nocking the arrow and a deep exhalation immediately after shooting. (Swoboda 2012: 146-147) According to Lee, in recurve archery, the archer should inhale during the drawing phase and exhale slightly whilst holding and anchoring. The archer should hold their breath during the hold, expansion, release and follow-through. (Lee 2013: 82)

In horseback archery the shooting rhythm is significantly faster than in other archery styles and the use of the leg muscles while riding can easily get the horseback archer out of breath. Therefore, breathing rhythms otherwise recommended for archery may not be suitable on horseback. However, the importance of breathing is emphasized especially in long runs, such as riding a more than one kilometer long Polish Track. Some people tend to hold their breath during archery, which makes the performance stiffer and the archer more tired. In this case, it is good to pay attention on your breathing while shooting. Focusing on your breathing rhythm can also help you relax, for example, in a competition situation.



Picture: Timo Rantanen, 2019

3 Typical mistakes and injuries in archery

3.1 Typical pains associated with archery

Based on a survey conducted in the spring of 2017, 34% of the respondents experienced horseback archery related pain. In addition to the pain caused by riding accidents, pain was experienced especially in the thumb or fingers of the draw hand and in both shoulders. Muscle stiffness or tenderness related to archery was experienced by 44% of the respondents, particularly in the shoulders and the shoulder blades. 75.5% of the respondents say that the pain had none at all or a very little effect on their training, 17% have some effect on the training and 7.4% have a great deal of pain, even so much that it is not possible to practice.

In archery, the most common cause of pain is poor technique; pain should not be part of the sport. Sometimes pain has a logical cause, such as mild muscle aches when starting a new hobby. The skin of the thumb or fingers can be overloaded by drawing the string, so it is advisable to protect them with a leather protection or sports tape, if necessary, so that the minor pain does not affect the shooting performance (Némethy 2018). Careful greasing of the hands with hand oil helps to prevent blistering or cracking of the skin, so that the skin remains soft even when thickened or calloused by archery practice (Rantanen 2019). Damage to the skin of the fingers can also be caused by various mistakes in the finger positions, such as pressing the forefinger of the draw hand too strongly against the bow string, opening the thumb of the draw hand before the index finger during the release or by having a bent position of the thumb in the release. Also, cold weather or hot weather that causes your hands to sweat can increase the sensitivity of your skin to pain and damage. (Swoboda 2012: 127-129).

Horseback riding always involves the risk of falling off or other accidents related to the horse. This thesis does not go into them in detail, but it is good to remember that although riding does not require great strength or agility, these abilities are needed if you ever have an accident (Kassai 2002: 43). Thus, maintaining good body condition is important for all riders. In addition, since a tense body is usually more vulnerable to injury than a relaxed one, for example Kassai recommends practising falling and overcoming the fear of falling, so that a possible accident can be avoided with lesser consequences (Kassai 2002: 43). Acute archery injuries are almost always caused by equipment failure, so to prevent them, it is important that the equipment is well maintained and checked before and after each training and competition. Athletes should also always wear appropriate protective equipment. (Niestroj et al. 2018)

Incorrectly selected equipment can cause pain. A typical example is a bow that is too heavy for the archer to perform a good shooting technique. Particularly when starting the hobby, the bow should be a little too light rather than too heavy. According to Kassai, a bow has a suitable strength when the archer can shoot 3-400 arrows a day without problems (Kassai 2002: 50). If you shoot irregularly, it is important that the bow is enough light to draw. Moving to a heavier bow is advisable only when the amount of training increases and the muscles get used to the load (Rantanen 2019). The typical draw weight of the bow was 25-35 lbs among those who responded to the initial survey for horseback archers. Pain can also be produced by a bow, that begins to load too soon, before the archer reaches his own draw length, so that the archer cannot use the strength of the bones in the shooting position and more pressure is applied to the soft tissues (Némethy 2018). The feathers of the arrow can

scratch the bow hand in the release and cause bleeding if the nocking point is set too low on the string or if the grip from the handle is incorrect. (Swoboda, 2012: 129-130).

Typical problems for archers include overuse injuries and errors in technique, which lead to improper body strain. A German study found that 84% of competing archers had experienced some form of an overuse injury. Most of the injuries occurred in the shoulders, especially in the draw hand shoulder, or the second most commonly in arms. The overuse injuries caused damage to tendons, ligaments and joints, but most of them were not serious. (Niestroj et al. 2018) The risk of overuse injuries is created by repetitive, similar movements under a load. Incorrect shooting technique is one of the biggest risk factors for overuse injuries, so to prevent injury, the archer should focus on perfect shooting technique and adequate muscle strength, including abdominal stability. (Niestroj et al. 2018)

One of the typical overuse injuries for archers is shoulder impingement syndrome, which is caused by irritation of the supraspinatus tendon with repeated shoulder elevation. The discomfort, also known as "electrician's shoulder", is characterized by pain when raising the upper limb laterally above the shoulder. Impingement syndrome causes changes in the kinematics and muscle activity of the shoulder region, for example, by reducing the activity of the lower part of the trapezius compared to asymptomatic archers. Thus, in addition to treating the impingement syndrome itself, the shooter should practice the lower part of the m. Trapezius during rehabilitation. The muscles that are used can also predict the occurrence of impingement syndrome. (Shinohara 2014)

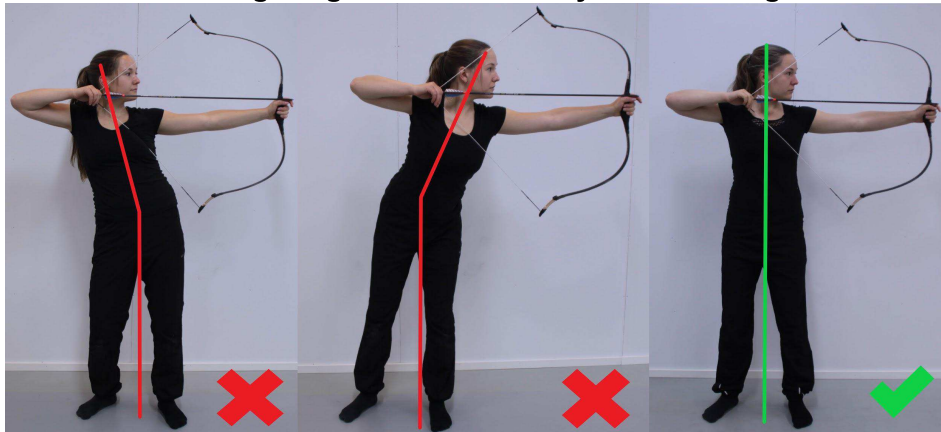
3.2 Typical mistake positions in horseback archery

The table below illustrates commonly seen incorrect postures or technique in horseback archery, which load the body sub-optimally and can lead to pain. For the sake of clarity, the postures are quite exaggerated. Often these errors occur in milder forms, but also then they put a strain on the body. The optimal shooting technique will vary slightly depending on the archer's physique, style and preferences.

Most of the mistakes that strain the body involve breaking the strong line of the straight bones, "the barrel of the gun", shifting the load from the bones to the muscles and soft tissues. This increases the risk of overuse injuries and soft tissue damage. Also the repeatability and the accuracy of shooting will reduce when muscle fatigue occurs or for example under competition stress.

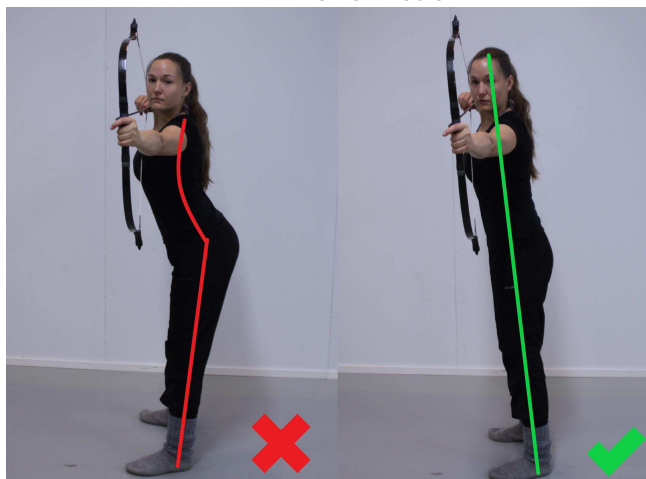
Most common errors in technique

Shifting weight toward or away from the target



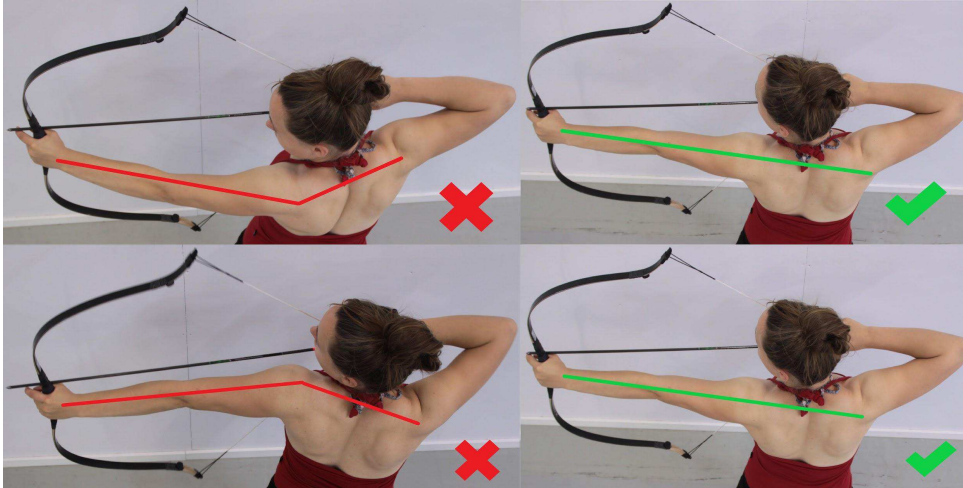
In the shooting position the body weight should be distributed evenly on both legs so that the body does not tilt on either side (Sawyer 2016: 200-201, Bussey & Percival 2013: 31). According to a 17th century Chinese archery guide, shifting weight away from or towards the target is a typical mistake for novice archers and should be corrected as soon as possible before it becomes a habit (Tian & Ma 2014: 134-135). For example a bow that is too strong can cause the mistake. When the body weight is not evenly distributed, the shoulders will tend to rise upwards and the shooting will become unstable. (Bussey & Percival 2013 31-41). Linear drawing can also cause errors in weight distribution (Lee 2013: 66). Exceptions are when executing the “front shot” and “back shot”: When shooting forwards body weight may become more on the left foot and similarly when shooting backwards it may come more on the right foot for a right-handed archer (Sawyer: 306-309, Némethy 2018).

Hollow back



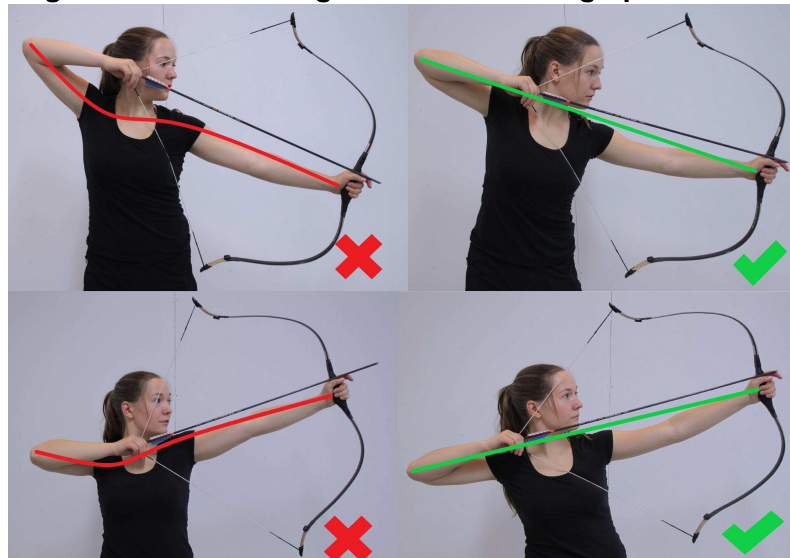
According to a 17th century Chinese archery guide, having a hollow back and pushing the buttock backwards is a typical mistake for novice archers and should be corrected as soon as possible before it becomes a habit (Tian & Ma 2014: 134-135). In shooting position the pelvis is turned under the torso and the chest is brought down with a slight activation of the abdominal muscles (Lee 2013: 48-49; Rüter 2016). The activation of the muscles of the abdomen ensures that the lower back does not become hollow (Lee 2013: 48-49; Eriksson 2018). Arching the lower back leads to an unstable position that is difficult to reproduce and can expose the lower back to injuries. The cause of this error may be leaning forward, moving the head towards the bow string during the draw, too short draw length or errors in the starting position, especially in the pelvis position. (Bussey & Percival 2013: 39) At worst, the lack of abdominal muscle support can lead to development of a hernia (Swoboda 2012: 142).

Breaking “the barrel of the gun”



In the holding phase, when the bow is at full draw, the shooter should feel "braced inside the bow" so that he can resist the force of the bow by the strength of his bones rather than his muscles. This is possible when the bones are aligned to form "a barrel of the gun". The straight line runs from the wrist of the bow arm through the bow arm shoulder to the draw arm shoulder. When the bow arm shoulder is pushed forwards, it prevents the archer achieving a straight line so they must rely on the shoulder muscles for support. When the archer gets tired, the bow shoulder can often rise up. (Lee 2013: 46) Also the bow string can hit the bow arm and cause bruises (Swoboda 2012: 131-132). The shoulder becomes pushed in a posterior direction when the shoulder blades are pressed firmly together towards the spine and *m. serratus anterior* does not push the bow arm towards the target. In these cases, the stability of the bow arm suffers and errors in the release are more likely. (Némethy 2018) The soft tissues of the bow shoulder are more heavily loaded, become fatigued and more prone to overuse injuries.

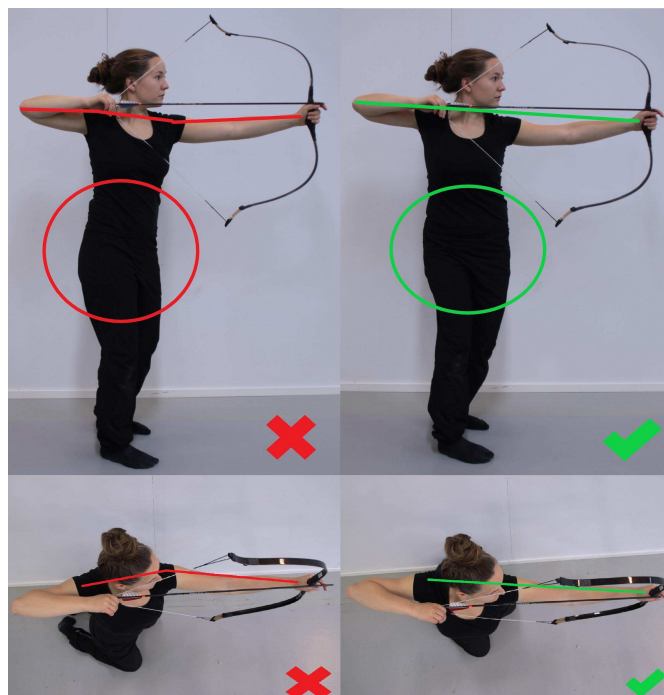
Breaking “the barrel of the gun” while shooting up and downwards



When shooting up and down, you should maintain the same good shooting position as when shooting at your shoulder level so that the draw length and the line of the sight remain the same between shots. The most common mistake is to lower or lift the bow arm rather than bending from the waist and hips. (Ratcliff 1999; Meitin 2018) Shooting downwards is done a lot in horseback archery and the errors in the shoulder line are typical. Kassai recommends that a novice horseback archer should first practice shooting at his shoulder height, as a misplaced target can easily lead to poor posture, which can be difficult to fix later. Once a good posture has been found, one can shoot in different directions and heights (Kassai 2002: 67-70).

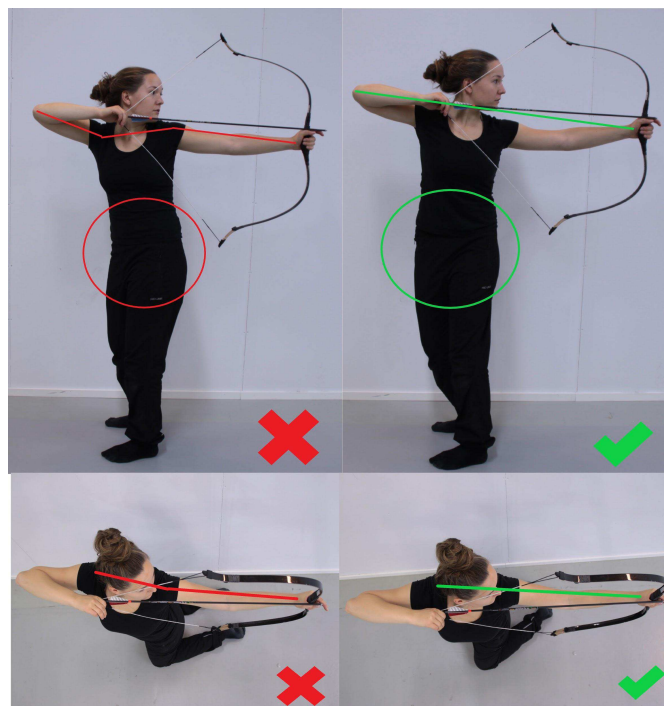
Breaking “the barrel of the gun” in front shot

When shooting forward it's important to maintain a good shooting posture and to keep the head, shoulders and hands in exactly the same position as when shooting sideways (Sawyer 2016: 200, 306-309). In front shots both the shoulders and the hips are turned parallel to the shot so that an imaginary line can be drawn from the target through the bow hand, the bow shoulder and through the spine to the draw hand shoulder. (Sawyer 2016: 29-30) When shooting forward, the typical mistake is to rotate the body too little from the hips, so that the strong line of bones, "the barrel of the gun", cannot be achieved, because the bow hand shoulder is out of the line. In this case, the stability of the bow arm is more challenging to achieve and errors in the release are common. (Nemethy 2018) The soft tissues of the bow shoulder are overloaded, more tired and so are prone to overuse injuries.

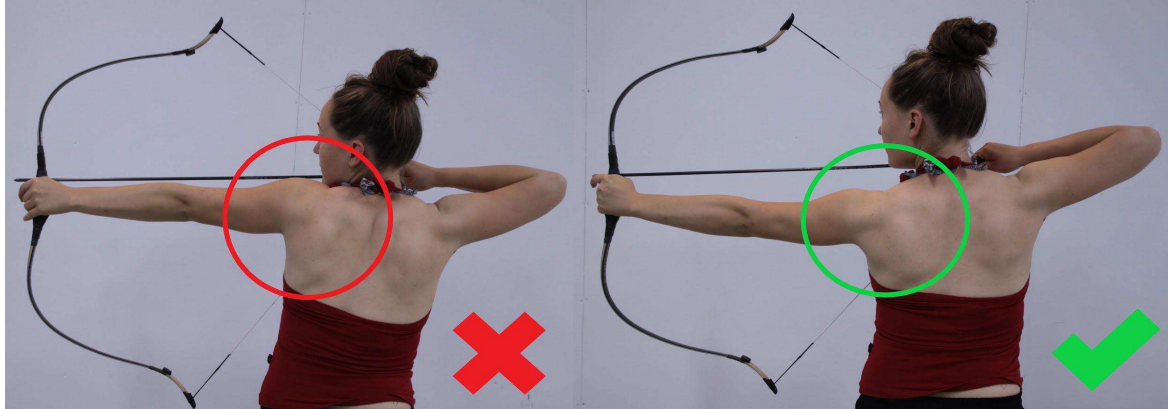


Breaking “the barrel of the gun” in back shot

When shooting backwards it's important to maintain the good shooting posture and to keep the head, shoulders and hands in exactly the same position as when shooting sideways (Sawyer 2016: 200, 306-309). In back shots both the shoulders and the hips are turned parallel to the shot so that an imaginary line can be drawn from the target through the bow hand, the bow shoulder and the spine to the draw hand shoulder. (Sawyer 2016: 29-30) When shooting backwards, the typical mistake is to rotate the body too little from the hips, so that the strong line of bones, "the barrel of the gun", cannot be achieved, because the bow hand shoulder is out of the line. Usually in this case more head rotation is required, which results in more tension in the neck and shoulder muscles. In addition the bow shoulder is prone to be pushed upwards and it is typical that the bow string hits the forearm in the release and causes bruising.

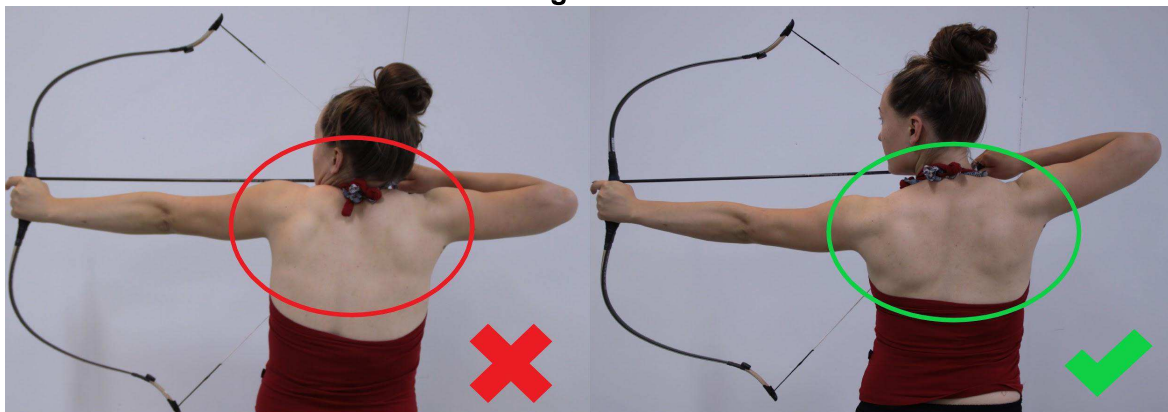


Raising bow hand shoulder



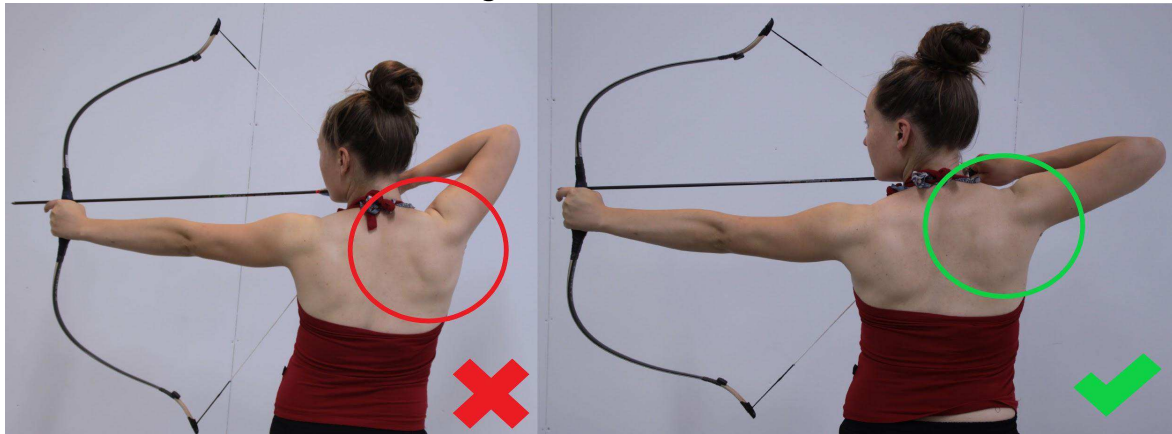
In the 17th century, Gao Ying, author of a Chinese Archery Guide, considered raising the bow shoulder to the ear as one of the most fundamental mistakes of archery (Tian & Ma 2014: 40-42). The bow shoulder should remain low and back, without rising up towards the ear or forward towards the chest. Raising the bow arm shoulder can cause injuries, even long-term damage to the soft tissues of the shoulder girdle. The mistake is typical for beginners and those who shoot with a too strong bow. The bow arm should be pushed towards the target, which will stabilize the bow arm and make it easier to aim steadily to the target through the shot. (Sawyer 2016: 207, Axford 1995: 68) The mistake is particularly prone to happen when shooting downwards, because the archer has the temptation to lower the bow rather than bend from the waist to lower the aim. The force of the bow is then transmitted to the shoulder joint in an angle, that may cause the head of humerus to raise upward in its articular cavity. (Axford 1995: 68) Some body types are also mechanically more prone to have this mistake, especially people with a broad chest, angular shoulder line, short and thick neck and S-form collarbone (Axford 1995: 80-81). The pushing of the bow arm towards the target is produced by m. Serratus anterior, whose weakness or improper use can lead to this error. An elevated bow hand shoulder prevents the use of skeletal strength in shooting, as the straight line of the bones, the "the barrel of the gun", cannot be formed (Sawyer 2016: 207).

Raising shoulders



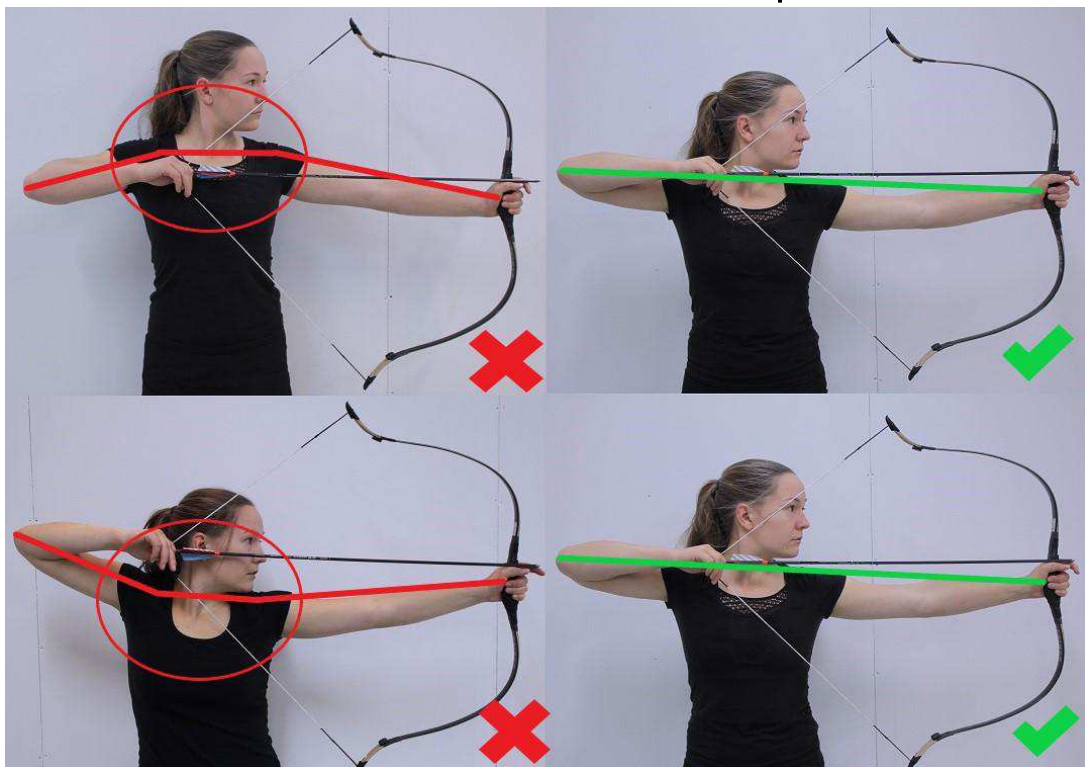
Shoulders should be relaxed and at the same height as each other, not rising up towards the ears. If there is tension in the shoulders in the initial position, the tension will often remain for the rest of the shooting cycle. (Bussey & Percival 2013: 41-42) The middle and lower parts of the m. trapezius should keep the shoulders down and in contact with the shoulder blades in order to form a straight line of bones, "the barrel of the gun" (Lee 2013: 47). The rising of the shoulders towards the ears prevents formation of this line and often causes the muscle shaking even for strong archers (Tian & Ma 2014: 40-42).

High draw hand elbow



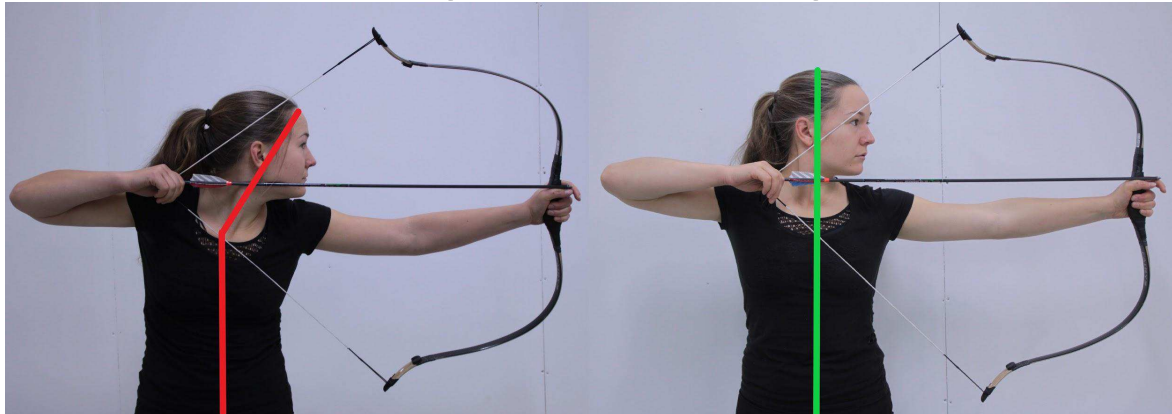
The bow should be drawn with the strong muscles of the back instead of the arm muscles. A very high elbow is often a sign of drawing the bow with the arm muscles and inadequate use of the back muscles. (Sawyer 2016: 213)

Draw force line too down or too up



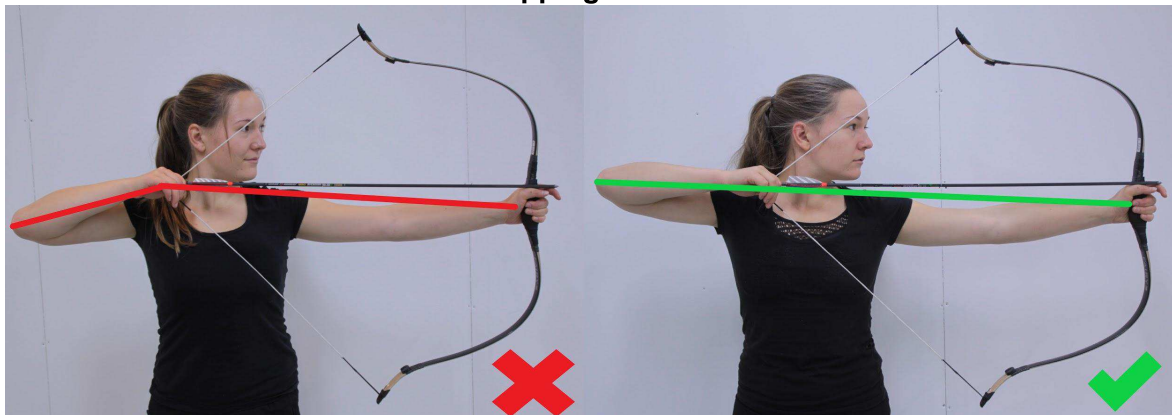
If the draw force line is lower than the shoulder line, it easily causes the shoulders to rise upwards, generating pressure in the shoulder joint and even resulting in impingement syndrome (Lee 2013: 69). In this case the joints cannot be aligned and technique is based solely on muscle strength (Tian & Ma 2014: 132-133). Drawing too low can also cause the bow string to hit the chest during the release and produce bruises (Swoboda 2012: 133). When the draw force line is too high, it typically causes tension in the upper shoulder area, which can lead to neck and headaches. In both cases, the strong line of the bones, the "barrel of the gun", breaks and the load is transferred from the bones to the musculature and soft tissues. The appropriate height of the draw force line depends on the archer's physique, bow, draw length and style, but will often be located close to the shoulder line.

Reaching the head towards the target



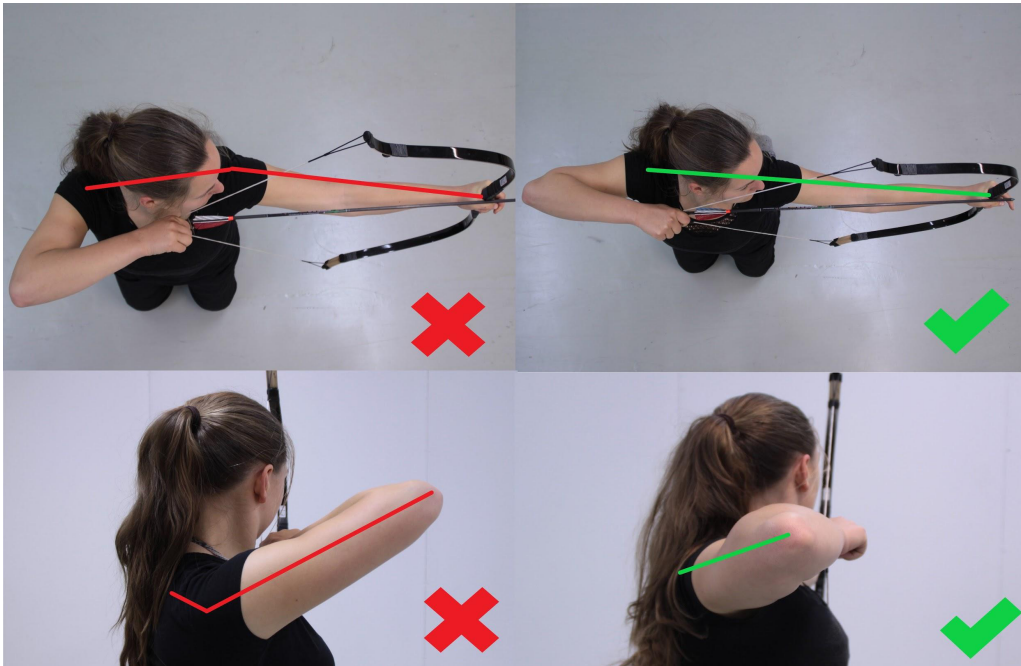
In horseback archery the face is turned towards the target with both eyes open and looking at the target. The head should be relaxed in the centerline, without reaching towards or away from the target. The head should remain in the same neutral position throughout shooting and for a short time after the release (Nichols 2013: 96; Sawyer 2016: 209). Especially if the archer uses a fixed anchor point on the face, he will be tempted to bring the face closer to the bow string when drawing the bow to reach the anchor point faster, and move the head at the release to see the hit. (Sawyer 2016: 209) This movement can cause not only inaccurate hits, but also neck and headaches.

Draw hand elbow dropping below the draw force line



The bow should be drawn with the strong muscles of the back instead of the arm muscles. The draw hand elbow dropping below the draw force line is often a sign of drawing the bow with the arm muscles and inadequate use of the back muscles. Because of the anatomy of the shoulder girdle, if you draw with the bow elbow down, it is very hard to properly engage the back muscles. Therefore it is important to have the draw hand elbow in the correct position when starting the draw. This error is many times accompanied by bending the draw hand wrist. (Sawyer 2016: 212) Dropping the draw hand elbow below the draw force line prevents the formation of the straight line of bones, the "barrel of the gun", because the force of the bow is not transmitted to the muscles of the spine, but unnecessarily strains the arm (Tian & Ma 2014: 46-47).

Draw hand elbow out of the draw force line



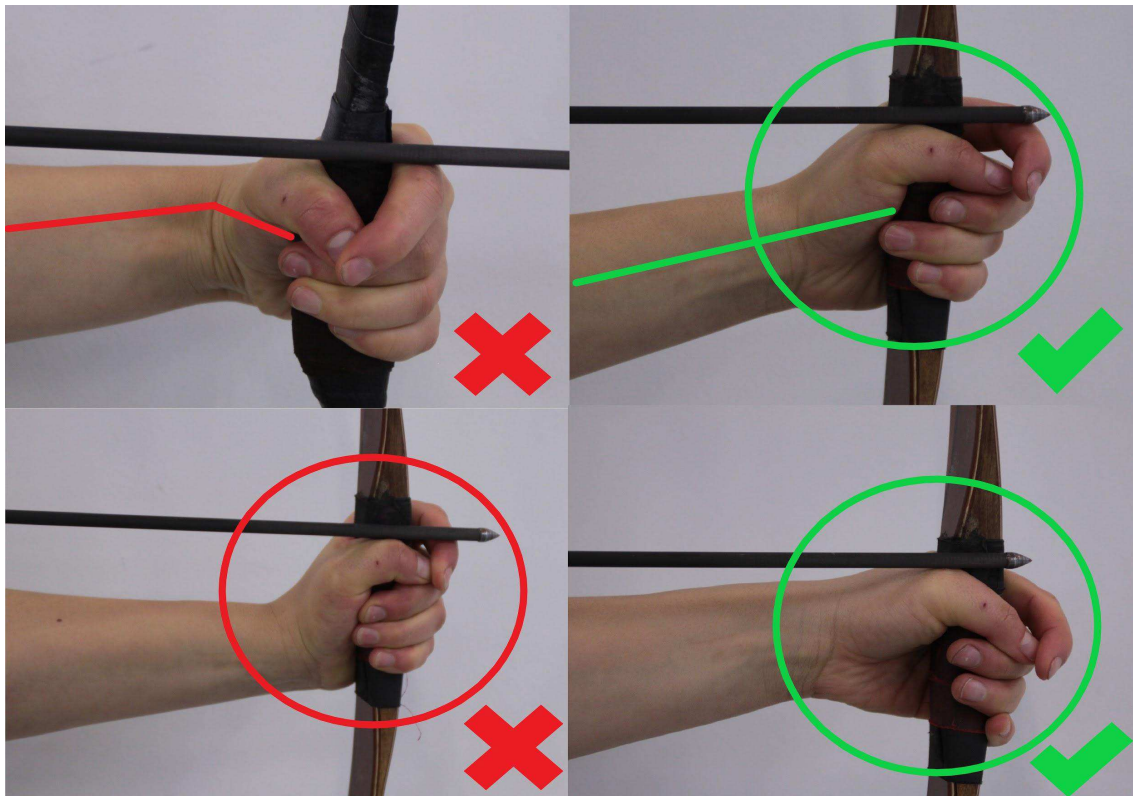
The bow should be drawn with the strong muscles of the back instead of the arm muscles. The draw hand elbow pointing out, away from the draw force line, is often a sign of drawing the bow with the arm muscles and inadequate use of the back muscles. A straight line from the wrist, through the bow hand shoulder to the draw hand shoulder can't be created, so the "barrel of the gun" is not formed and the strength of the bones cannot be optimally utilized. (Sawyer 2016: 212-213) Although it is sometimes necessary to use the arm muscles when drawing a strong, traditional short reflexed bow (such as a Turkish bow) at full draw the muscle involvement should still transfer to the back muscles as much as possible. Drawing towards the chest or right shoulder is a mistake. (Swoboda 2012: 56-60)

Locked or too much bent bow arm elbow



The bow arm elbow should be straight but not locked, as a locked forearm increases the risk of injury. A locked or over-extended bow arm elbow can easily cause the bow string to hit the forearm during the release and produce painful bruising (Swoboda 2012: 131). Also, the elbow of the bow arm should not be bent (Swoboda 2012: 59). A bent elbow shortens the draw length, strains muscles and makes it more difficult to repeat the technique. (Sawyer 2016: 206) The forearm of the bow arm should be lightly rotated inwards with the head of the elbow pointing almost horizontally, however, at a maximum of 60-90 degrees from the relaxed position where the elbow is pointing downwards. This way the head of the humerus locks into its glenoid, allowing it to form a straight line of bones. At the same time, the bow string is prevented from striking the forearm during the release. (Lee 2013: 56)

Bent bow hand wrist and pressing the handle too tightly



The grip from the bow should be firm but at the same time relaxed. (Bussey & Percival 2013: 35) In horseback archery the grip must be strong enough, as there is no time between shots to fix the grip. A bent wrist, such as shown in the up left picture, increases strain on the muscles. At full draw the wrist should be straight in a longitudinal direction to be able to use the strength of the bones. The bow arm wrist is the first part in the straight line of the "barrel of the gun", so if the wrist is twisted it will force the archer to use muscles and rely on soft tissues. The exact grip and finger positioning depends on the archer's style and preferences as well as on the shape of the bow grip. (Sawyer 2016: 202) When shooting with a thumb style, the grip is held by the little and ring fingers, while the middle finger, index finger and thumb are relaxed and just rest around the handle, as shown in the up right picture (Tian & Ma 2014: 58-61). This causes the "khatra" movement, or tilting of the bow towards the target at the release. (Swoboda 2012: 125-126) When doing khatra, it is good to be careful that it does not result in the entire bow arm dropping down during the release. (Sawyer 2016: 224-226) In the Hungarian style, the wrist is kept very straight, as shown in the down right picture. The thumb and forefinger grip prevents the bow from dropping from the hand while shooting, while the other fingers are more relaxed and make it possible to hold many arrows in the bow hand (Némethy 2018). A typical mistake for beginners is to grip the bow too tightly, so that the bow hand is not relaxed, the wrist can easily flex during shooting causing the flight of the arrow to be disturbed, as shown in the down left picture. (Tian & Ma 2014: 58-61; Rantanen 2019) The grip of the bow is the only body part that remains in contact with the bow throughout the shooting cycle. Therefore, it is important that it is positioned correctly as it will have a significant impact on overall performance. (Axford 1995: 114-115)

4 The principles of training horseback archery

4.1 Warming up

Warming up puts the body and the mind in the best possible state for training or competition. Warming up should not be a reluctant necessity, but a planned and important part of exercise. A good warm-up, that includes both general warm-up exercises and movements specific to archery, stimulates blood circulation, breathing, the nervous system, flexibility and state of mind. As a result of a good warm-up, the effectiveness of training improves, ie the training time is used more efficiently and the risk of injury is significantly reduced. The warm-up should last at least 15 minutes. In cold weather and, for example, in the mornings, warming up should take longer than usual to achieve the same benefits. (Saari et al. 2009: 3-27)

At rest most of the capillaries are closed and blood circulation is concentrated in the internal organs. Muscle work during the warm-up opens the blood vessels and activates the blood flow to the muscles, delivering more oxygen, energy and hormones and removing metabolic waste. The temperature of the muscles and the whole body rises while the heart rate and metabolism increase. As a result of these changes, muscle performance and recovery are improved, and in addition, the elasticity of the muscle is increased. (Saari et al. 2009: 3-4) In the initial survey done for the horseback archers, 50 respondents tell that they do stretching as a warm-up. In a warm-up the stretches should be short-duration functional stretches, which, when properly performed, will condition the muscles and enhance the elastic energy utilization of the muscle. Functional stretching involves alternating constriction and stretching of the muscles, producing a stronger and faster contraction than passive stretching. In functional stretching, it is advisable to practice the muscle chains by different types of muscle working: eccentric, concentric and static muscle work. (Saari et al. 2009: 3)

During warm-up, both respiratory rate and breathing depth increase. (Saari et al. 2009: 3) It is advisable to elevate the heart rate and the level of breathing several times during warm-up to the peak level anticipated during exercise. This way the body is prepared for the exercise and fatigue will be experienced later during the exercise. (Laine 2018) When shooting from the ground, the heart rate is usually quite low, but it often rises on the horseback when working on the large muscles of the legs. Also nervousness linked to a competitive situation increase the heart rate.



Picture: Johanna Borgelin

As body temperature rises due to the muscle work, the speed of nerve impulses between the muscles and the brain also increases. In practice, muscular power and proprioception are enhanced, resulting in significant improvements in speed, responsiveness, balance, explosiveness, and economy of movements. Typical warm-up movements also accelerate metabolism in the brain and effect its movement and control. (Saari et al. 2009: 4)

A good warm-up sharpens vision and coordination between different parts of the central nervous system, resulting in greater alertness. Improved alertness and focus increase coordination and accuracy of motor function. A standardised warm-up also serves as an aid in preparing for optimum performance, as it is a ritual for the athlete to focus his attentiveness before the performance. (Saari et al. 2009: 4)

When practicing or competing outdoors, it is important to maintain muscle warmth during the exercise and between breaks so that it is a bit too hot rather than too cold. Sufficient clothing and a new, slightly shorter warm-up after longer breaks will help to keep your body in a condition for top performance. (Ronkanen n.d.)



Picture: Johanna Borgelin

In the survey for horseback archers, 11% said they did not warm up at all before training. A surprisingly large number of respondents say that they are warming up and the usual warm-up methods are stretching, warming the neck, shoulders and fingers, doing muscular movements, aerobic exercise and mental preparation. However, 30% of horseback archers only warm up by shooting, riding or taking care of the horses. These are also ways of warming up the body, but the benefits from this kind of warm-up are less than the benefits of systematic comprehensive warm-up, unless the same principles are combined with stable work, horse care and riding.

The downside of using archery as a warm-up is that shooting with an unprepared body and mind is almost inevitably done with lower quality than with a well-prepared body. Often the archers do not require as good performances from the first rounds and the accuracy and the

technique start to improve as the body warms up. However, the brain records both bad and good performances into muscle memory, so all shots should be fired in a fully focused state of mind (Kassai 2002: 101-102) with the highest quality technique.

All the interviewed horseback archery teachers consider warming up to be important, though some admit that they do not warm themselves up well enough. Used and recommended forms of warm-up include running and rotating the upper limbs (Ghoorchian 2018, Novotny 2018, Eriksson 2018), moving from a lighter bow to a stronger one (Cozmei 2018, Kassai: 167), as well as archery warm-up exercises, such as nocking and drawing the bow without an arrow (Cozmei 2018). Some groups, such as the Némethy Horseback Archery Academy in Hungary, have developed very comprehensive and versatile warm-up routines that pay great attention to the preparation of the entire body system.

The warm-up can be started with a 2-minute low-intensity exercise, such as jumping jacks, jump rope and twisting the body like a helicopter. You can then move on to the dynamic stretches on different parts of the body. (Krueger 2013: 136-140) Lee recommends warming up with specific archery exercises, such as shooting with a rubber band (for example, in front of a mirror), shooting with a light bow and training with a static strap. The static strap can be a rope that is tied in a loop, and it can be used to practice isometric power generation because it does not stretch. Shooting from a close range is also recommended, as it allows you to focus more on the technique rather than the hits, much like the 17th-century Chinese practiced in front of a *gaozhen* hay bale. The warm-up can also be combined with specific exercises designed to improve certain physical skills or attributes important in archery. These include a holding drill, in which you hold a full draw for 15 to 45 seconds, and a power drill in which the bow is drawn to the full draw length where it is held for 3 seconds, then slowly let down to a half draw and again pulled to full draw for 3 seconds. (Lee 2013: 119-128)

It is a good idea to try different warming up methods and develop the optimum one for you. The ideal warm up may vary in duration and effectiveness depending on the individual. It is recommended to periodically review and modify the structure of the warm-up to keep it motivating. (Saari et al. 2009: 5)

4.2 Cooling down

Cooling down is just as important a part of the training session as is the initial warm-up. The cool down refers to the movements that are done immediately after the exercise phase, the purpose of which is to help the body to recover as well and quickly as possible, so that it is ready to exercise again sooner. A good cool down facilitates elimination of accumulated metabolic waste, restores muscle fibres closer to their resting length, enhances nervous system recovery and provides a good opportunity for mental recovery and exercise evaluation. (Saari et al. 2009: 31-34)

Lactic acid, or lactate, increases the acidity of the muscle and impedes the flow of nerve impulses and muscle contraction. The higher the intensity of the exercise, the more lactic acid is formed in the muscles. Fast-twitch muscle fibres are mainly responsible for producing lactic acid, while slow-twitch muscle fibres are better able to reuse lactic acid for energy recovery. (Saari et al. 2009: 31) In horseback archery lactic acid builds up particularly in the legs and core during intense riding, but also in the upper back and upper arms, especially if the archer's style is based more on muscle strength than skeletal strength.

It is advisable to perform the cool down at a decreasing intensity, using different muscles of the body. For efficient removal of lactic acid from fast-twitch muscle fibres as well, the cool down should include both fast and relaxed bursts of exercise. It is a good idea to keep your heart rate and respiratory rate high enough to keep blood flow through your muscles' capillaries as good as possible and to maintain perfusion through the muscles that were used in archery. Efficient metabolism speeds up the elimination of metabolic waste. If you pay attention to the large muscle groups throughout the body, recovery begins already during the cooling down period. (Saari et al. 2009: 31-32)

Stretching is an important part of the cooling down process, but if it exclusively involves stretching, it can actually slow down the recovery process. Stretching should be done only after the metabolic waste in the muscles has been mobilized. The purpose of stretching is to restore the muscles to their resting length, to increase the elasticity of the tissues surrounding the joint and to prevent injury. Short stretches of 5 to 10 seconds or medium stretches of 10 to 30 seconds are effective in restoring muscle resting length. Long, static stretches of more than 30 seconds can slow down the metabolism of the muscle and accumulate metabolic waste, so they should be avoided. (Saari et al. 2009: 32-33)

The motor nervous system is restored through efficient muscle metabolism. The sensory nervous system is best restored by stretching and motion training, which normalizes the posture and proprioceptive functions of the body. The sympathetic "fight or flight nervous system" is activated during exercise, but through cooling down it is suppressed and the parasympathetic nervous system is activated. The parasympathetic nervous system plays an important role in relaxation, recovery and sleep. (Saari et al. 2009: 32) Exercise alone will not lead to development without the support of adequate rest and good nutrition. A significant part of memory formation, learning, and repair of tissue damage caused by exercise occurs during deep sleep. (Hämäläinen et al. 2015: 96)

The cooling down routine should be designed to take account the sport and individual characteristics. The structure and content of the cool down should also be changed regularly. (Saari et al. 2009: 33)



Picture: Timo Rantanen, 2019

4.3 Cross-training, strength and conditioning

The well-being and good performance of the archer include, in addition to shooting technique, good nutrition, hydration and exercise. (Krueger 2013: 133)

Endurance exercise that works on the respiratory and cardiovascular system improves stamina. The better the archer's respiratory and circulatory systems are, the better he can handle the stress of a competitive situation. In addition, endurance exercise reduces stress, improves mood, circulates oxygen in the body and can reduce the risk of injury. Recommended sports include cycling, running, walking and swimming, which do not have a high risk of finger injury. The appropriate amount of endurance exercise is unique and is influenced by eg. age, goals, and previous physical activity. (Krueger 2013: 140-141) Also Kassai emphasizes the importance of fitness and of his horseback archery at school has an endurance test, which consists of 10 km cross-country running, 2 hours of riding bareback and shooting 500 arrows from 20 meters to a 60 cm target (Kassai 2002: 101).

The power that is needed in archery can be improved by both refining technique and by strengthening muscle. Strength training is necessary for top-level archers. In addition, strength training is a good tool for mental training as it increases self-confidence and relieves anxiety. Endorphins produced by weight training reduce pain and create a sense of well-being. It is important for the archer to strengthen his whole body and follow a personalized training program that takes into account age, physical fitness, body weaknesses and strengths and the archer's goals. Strength training should be varied and it is advisable to plan the amount, type, and intensity of your training, taking into account the annual archery rhythm. Out-of-season strength training may be more intense, but it should not cause muscle aches that would hamper your archery technique. In the competition season, however, strength training is more supportive and the goal is to keep your body in the best possible condition. (Krueger 2013: 141-142; Ronkanen n.d.)

4.4 Learning horseback archery

Horseback archery combines both riding and archery skills, which are better learned separately first of all and then combined as horseback archery (Kassai 2002: 44). This thesis focuses specifically on the archery and its learning.

Horseback archery and archery are considered to be a skill and accuracy sport, to which the laws of skill learning apply. Skill learning refers to the central nervous system process, which leads to permanent changes in the potential to produce a particular movement. Skill learning involves improved performance, alignment, persistence, and the ability to perform in new environments. Optimizing technique gives you better and more efficient performance. Skill learning requires a lot of work and can take up to decades. (Hämäläinen et al. 2015: 197-204) According to a Chinese archery guide written in the 17th century, it takes an average person from 100 days to a year to understand what archery is all about (Tian & Ma 2014: 20).

It is ideal to practice frequently for short periods of time rather than once for a longer time period (Hämäläinen et al. 2015: 206), for example, 100 arrows daily for 5 days rather than 500 arrows on one day. This is especially important if you are practicing alone without a teacher, who will help you to spot any mistakes as they start to occur (Rantanen 2019). According to the law of three repetitions, after the third repetition, the process begins to be

automatized, so that the task should be varied to make the training the most efficient (Kalaja 2018). In horseback archery this means, for example, that to learn the technique it would be the most effective to shoot three arrow series, so that the concentration is maintained and the process does not become automatic. It is most realistic to shoot each arrow in a slightly different situation, as the same situation is repeated only once on the horseback. (Kassai 2002: 60) In practice, the difference between shots can be very small, for example a small change in the position, distance or target point.

In the early stages of learning archery, students observe and attempt to understand the skill as a whole. The action requires a lot of thinking and observation, and the learner is easily distressed. The performances are clumsy and have a lot of variation. (Hämäläinen et al. 2015: 203) According to Kassai, a novice archer should first learn the release and the shooting technique, then secondly progress to shooting the target and only then, as a third stage, may increase the speed of the shooting (Kassai 2002: 55). Focusing too early on the speed shooting can lead to archery technique that puts extra strain on the body in the short or long term. (Sawyer 2016: 197-198) Shooting at the target begins by learning the basic technique of archery, that is, a side-shot at shoulder height (Kassai 2002: 67). A misplaced target can easily lead to a bad position that is difficult to repair later. Once a good posture has been found, you can shoot in different directions and heights (Kassai 2002: 70). Shooting should focus on proper posture and breathing. The distance of the target can be varied to improve distance perception. Then you can add shooting in different positions so that the balance is maintained and does not affect the rhythm of shooting. (Kassai 2002: 82)



Picture: Timo Rantanen, 2019

Also in the 17th century Chinese archery teacher Gao Ying emphasizes that in the beginning it is important to learn good technique and bring the bones to the line in the full draw. A year's practice with a good technique is much better than a lifetime of practice with a poor technique, although the importance of technique may be difficult to understand at first. (Tian & Ma 2014: 19-23, 143-144) Gao Ying finds it particularly challenging that beginners do not see the difference between the good and bad technique, but easily start copying other

archers who they see can hit the target, even if their technique is not good. It is often not clear to novice archers how many problems a bad technique can cause. (Tian & Ma 2014: 33-34) The body of a young archer will endure the technique that strains muscles and soft tissues, but after 4-5 years, learning will cease to progress, accuracy will begin to be worse, and further training will only worsen the hits. In addition, the body often begins to show symptoms. (Tian & Ma 2014: 19, 139)

During the training phase, the learner is motivated to practice and understand the skill as a whole. There is not much variation in performance anymore, but observation is still focused on the task. (Hämäläinen ym 2015: 203) It is important to make sure that the bow should not be too heavy for the archer (Tian & Ma 2014: 52-53). According to Kassai, the bow of a horseback archer should be of such strength that you can shoot 3-400 arrows a day without problems (Kassai 2002: 50). The most important limitation on the number of shots is that the mind should not wander but every shot should be focused (Kassai 2002: 62). The best way to avoid mistakes is to be mindful of what you are doing (Kassai 2002: 55-56). All arrows should be shot in a fully focused state, as the brain records both bad and good performances mechanically. If you learn the wrong technique when shooting, it is easy to start repeating mistakes and it can be difficult to continue. The better your physical fitness and endurance is, the easier it is to perform repetitions without faults and with focus. (Kassai 2002: 101-102)

Teaching is an excellent way to learn, because teaching gives you a view on the problems from a different perspective (Kassai 2002: 83). Gao Ying recommends that archery should be practiced with 2 to 3 like-minded people, who can support each other and correct technique (Tian & Ma 2014: 66-67).

Gao Ying urges archers to practice in front of the *gaozhen* hay bale, especially in the early stages of their hobby career. This means basically shooting a blank target at a close distance without actually aiming. This allows the mind not to focus too much on the hits, but to the feeling in the body and lets the technique to mature in peace. However, the archer should perform the exercises very carefully so that he does not start repeating mistakes. As the archer starts to take aimed shots and to shoot a longer distance, their technique should be kept exactly the same as when shooting the hay bale. (Tian & Ma 2014: 44-51)



Picture: Timo Rantanen, 2019

Having a feeling on your own shooting is very important in archery. If you practice too irregularly, the feeling may disappear. (Tian & Ma 2014: 61-62) Lee recommends that archers should not have a break for more than two or three days during their training period, because in this time the fine muscles begin to lose their strength and the feeling in the shooting can be easily lost (Lee 2013: 114). However, if the shooter becomes tired or loses motivation, it is important to take a good break from archery. (Krueger 2013: 170-172)

In the final phase of learning a skill, the skill has become a seamless entity and is automatically produced, thus allowing the horseback archer to concentrate on observation of the environment and anticipation of the next shot (Hämäläinen ym. 2015: 203). However, the horseback archer does not need to have a perfect technique, because perfection is more a path to walk on but a goal that cannot be achieved. (Kassai 2002: 56)

Skills are learned on both a conscious and subconscious level. Subconscious skill acquisition is currently an area of focus in models of skill acquisition. Subconscious learning is activated most when occurring alongside positive training experiences and feelings of success. (Hämäläinen ym. 2015: 198) Versatile training creates models for the brain to produce the desired performance in varying situations, rather than mechanically repeating the same exercise to perfection. In practice, from the point of view of archery, this means aiming to practice accurate shots from different positions, speeds and distances, rather than repeating the same performance as much as possible over a given distance. At the same time, the archer's adaptability is increased, which is useful because those who are most successful are those who are best able to adapt to changes in, for example, weather conditions, stimuli and pressure (Lee 2013: 112). Although the performances of a skilled horseback archer are close to each other, in practice they can never be absolutely identical (Hämäläinen ym. 2015: 198) and they do not need to be, since each situation is always different on horseback.



Picture: Timo Rantanen, 2019

Resources

Axford, Ray 1995. Archery Anatomy: An Introduction to Techniques for Improved Performance. London: Souvenir Press.

Bussey, Hannah - Percival, Jane 2013. The Archery for Beginners Guidebook. Shropshire: Archery GB.

Cole, David 2017. Archery Muscles and Exercises from Bowfit™. An internet document. <<https://www.bowhunting.net/2017/02/archery-muscles-by-bowfit/>> Read 19.11.2019.

Cozmei, Mihai 2018. Horseback archery teacher. Living Arrow Horseback Archery. Interview 13.2.2018.

Ergen, E. & Hibner, K. 2004. Sports Medicine and Science in Archery. Lausanne, FITA. <https://issuu.com/davygoedertier/docs/sports_medicine_and_science_in_a> Read 25.11.2019.

Eriksson, Emil. 2018. Horseback archery teacher. International Horseback Archery Alliance. Sipoo. Interview 11.3.2018.

Etelä-Suomen Ratsujousiampujat Ry. 2017. An internet document. <<https://esraja.wordpress.com/tietoa-lajista/>> Read 21.12.2017.

Gilroy, Anne M. - MacPherson, Brian R. - Ross, Lawrence M. 2013. Atlas of Anatomy. Second Edition. New York: Thieme Medical Publishers.

Ghoorchian, Ali. 2016. Horseback archery teacher. Persian Horseback Archery Association. Mäntsälä. Interview 9.6.2016.

Hämäläinen, Kirsi – Danskanen, Kristiina – Hakkarainen, Harri – Lintunen, Taru – Forsblom, Kim – Pulkkinen, Seppo – Jaakkola, Timo – Pasanen, Kati – Kalaja, Sami – Arajärvi, Paula – Lehtoviita, Terhi – Riski, Jarmo. 2015. Lasten ja nuorten hyvä harjoittelu. Lahti: VK-Kustannus Oy.

Kalaja, Sami 2018. Presentation as a part of VOK1 accuracy sport coach training program. Lohja 21.10.2018.

Kassai, Lajos 2002. Horseback Archery. Budapest: Puski.

Krueger, Guy 2013. Archery. The ultimate resource for recurve and compound archers. Colorado: USA Archery.

Laine, Sanna 2018. Elinjärjestelmien vaikutus harjoitteluun. Presentation as a part of VOK1 accuracy sport coach training program. Kuortane 14.9.2018.

Latham, J. D. – Paterson, W.F. 1970. Saracen Archery: an English version and exposition of a Mameluke work on archery (ca. A.D. 1368). Holland P.

Lee, KiSik 2013. Archery. The ultimate resource for recurve and compound archers. Colorado: USA Archery.

Meitin, Patrick 2018. How to shoot uphill and downhill. An internet document. <<https://www.realtree.com/bowhunting/articles/how-to-shoot-uphill-and-downhill-0>> Read 16.11.2019.

Mero, Antti - Nummela, Ari - Keskinen, Kari L. - Häkkinen, Keijo 2004. Urheiluvalmennus. Jyväskylä, Gummerus Kirjapaino Oy. 245.

Némethy, Christoph. Horseback archery teacher. Némethy Horseback Archery Academy. Helsinki. Interview 5.5.2018.

Nichols, Mel 2013. Archery. The ultimate resource for recurve and compound archers. Colorado: USA Archery.

Niestroj, Claudia K. – Schöffl, Volker – Küpper, Thomas. 2018. Acute and overuseinjuries in elite archers. The Journal of Sports Medicine and Physical Fitness 2018. July-August; 58 (7-8): 1063-70.

Novotny, Lukas. Horseback archery teacher. Saluki Bow Co. Amman. Interview 26.4.2018.

Rantanen, Timo. Archery teacher. Chairman and coach in archery club of Tapanilan Erä. Has been working as a coach of Finnish Archery Association in prominent matches. Helsinki. Interview 20.11.2019.

Ratcliff, Perry 1999. Uphill-Downhill Shooting. An internet document. <<https://www.archersadvantage.com/TipSheets/UpDownHill.htm>> Read 16.11.2019.

Ronkanen, Perttu n.d. Itä-Suomen Jousiampujat Ry. Ohjeita harjoittelun suunnitteluun jousiammunnassa. Internet document. <<http://www.itasuomenjousiampujat.info/valmennus/harjoittelunsuunnittelu.pdf>> Read 11.2.2018.

Rüster, Juhana 2016. Suomen Jousiampujain Liitto. Internet document. <<https://www.sjal.fi/seuroille/ensinuolet/>> Read 13.5.2019.

Saari, Mika – Lumio, Marko – Asmussen, Peter D. – Montag, Hans-Jürgen – Appelqvist, Seppo – Vaismaa, Harri. 2009. Käytännön lihashuolto - warm up, cool down, venyttely, hieronta, urheiluhieronta ja teippaus. Lahti: VK-Kustannus Oy.

Sawyer, Claire - Sawyer, Dan 2016. Horseback Archery: ancient art to modern sport. British Horseback Archery Association.

Shinohara, Hiroshi – Urabe, Yukio – Maeda, N. – Xie D. – Sasadai, J. – Fujii, E. 2014. Does shoulder impingement syndrome affect the shoulder kinematics and associated muscle activity in archers? The Journal of Sports Medicine and Physical Fitness 2014. December; 54 (6): 772-9.

Shinohara, Hiroshi – Urabe, Yukio. 2018. Analysis of muscular activity in archery: a comparison of skill level. The Journal of Sports Medicine and Physical Fitness 2018. December; 58 (12): 1752-8.

Suomen Ratsastusjousiampujain Liitto Ry. 2017. An internet document. <<http://www.srjl.fi/>>
Read 21.12.2017.

Swoboda, Adam 2012. The Art of shooting a short reflexed bow with a thumb ring. Drukarnia Ksiezy Werbistów w Górnej Grupie.

Tian, Jie - Ma, Justin 2014. The Way of Archery - A 1637 Chinese Military Training Manual.
Atglen: Schiffer Publishing.

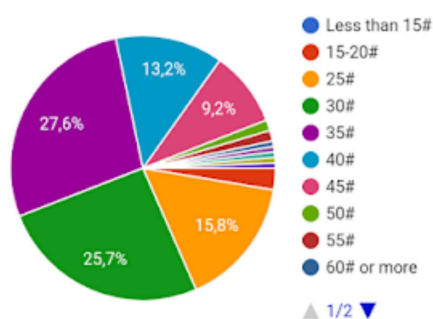
Attachment 1: Questionnaire for horseback archers

The purpose of the questionnaire for horseback archers was to collect information that I can use in my Physical Therapy thesis, which will be about the efficient training and optimal use of the body in horseback archery. The questionnaire was done anonymously with Google Docs and the link to the online questionnaire was distributed to Finnish and international horseback archery Facebook groups. It was open from January 28th to February 4th 2018.

The questionnaire received 152 answers from 21 different countries all over the world. Most of the answerers (69,1 %) were 30-59 years old. 25 % were younger than 29 years old and 5,9 % were older than 60 years old. Most of these horseback archers have picked up the hobby relatively recently: 65,6 % of them have been training horseback archery for 1-5 years, 19,8 % for more than 5 years and 14,6 % less than one year.

How many pounds your bow has? Choose the closest option.

152 vastausta



The thumb draw was the most popular draw and 62,7 % were shooting with it. 28,7 % were shooting with the three finger draw and 3,3 % with the Persian draw. 5,3 % told to use different draws than these, but mostly those were combinations of the thumb draw and the three finger draw. In addition drawing with two fingers and with the Russian Dagger draw were used.

The most typical draw weight for the bows was 25-35 pounds (69,1 %), and between these the most popular was 35 pounds (27,6 %). 2,6 % were shooting with less than 20 pound bow, 22,4 % with 40-45 pound bow and 3,3 % with more than 45 pound bow. The draw length of the answerers varied between 26-33

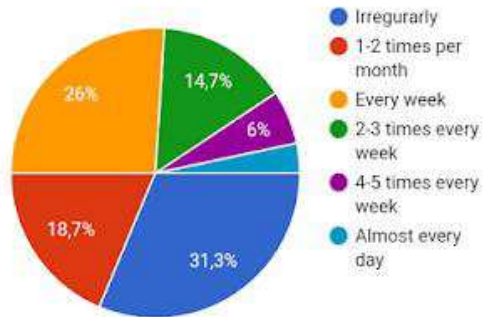
inches. The most common draw length was 30 inches (19,3 %). 56,1 % had less than 30 inches draw length and 24,6 % had more than 30 inches draw length.

50 % of the horseback archers who answered the questionnaire were training irregularly or just 1-2 times per month. 40,7 % were training 1-3 times in a week and 9,3 % 5-7 times in a week. The number of arrows correlated the same: 48 % told that they shoot irregularly or less than 50 arrows in a week, 31,6 % were shooting 50-200 arrows in a week, 13,8 % 200-800 arrows in a week and 3,9 % more than 800 arrows in a week.

Part of the questionnaire was to find out the common goals of the horseback archers at the moment. The most common goal was to get better in horseback archery (40 answers),

How often do you practice archery or horseback archery?

150 vastausta



either by aiming to have a specific score in competition or for example IHAA grading level or just by “getting as good as I can”.

Competing, international competing and succeeding in the competitions were also common goals (32 answers). The answers highlighted also that part of the sport is to have fun, enjoy and to meet friends with the same interests (30 answers). Many horseback archers would like to develop the sport further, teach others or to shed more light to their heritage and culture (13 answers). Some goals were more horse oriented, for example spending more time with horses, training one's own horse, having a better relationship with the horse or starting riding

again (12 answers). Goals including developing in archery were given by 9 answerers.

The most common training plan between the answerers was to train a given amount of times per week (24 answerers) or just unspecificly described that the plan is to “train as much as possible” (12 answerers). The training plan was build around competitions and clinics with 7 answerers and 2 answerers had a plan designed by their teacher or coach. 6 answeres notified seasonal changes in their plan and 6 answeres included other sports and gymnastics. 8 answerers planned to work on exact details or themes one by one in the training and 2 answerer's plan was to train based on the feeling of their body and mind. 49 answerers didn't have any training plan.

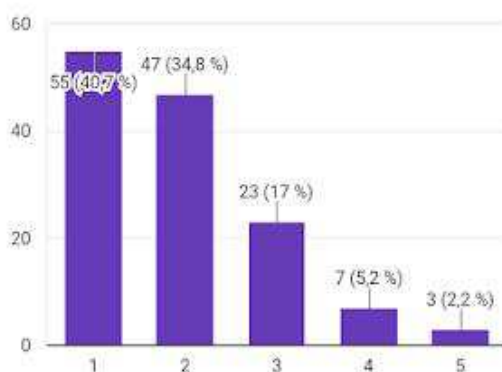
The questionnaire mapped out the common warming up methods between horseback

archers. 16 answerers told that they don't do any kind of warming up, but delightfully big

part of the answerers are doing some warming up before training. On the other hand 38 answerers told that they warm up just by shooting on foot, riding or taking care of the horses, so they don't have proper warming up before shooting or riding. Of course in some cases brushing the horses before riding may serve as a warming up boosting the blood circulation. 50 answerers told that they do stretching before archery. 37 answerers told that they warm up the upper limbs, neck,

If you have pain, how much does it effect your training?

135 vastausta



shoulders, back and fingers and the most common way to warm up was the circular movements with shoulders and wrists. 28 answerers are doing work out movements or aerobic warming up. 8 answerers prepare their mind for practice, 4 with meditation and 4 with plastic band, lighter bow or "shooting with the shadow".

52 answerers reported to have pain that is related to horseback archery. Accidents, most commonly falling from the horse, were the reason for the pains of 14 answerers. Otherwise the most common pain was reported in the draw hand thumb or fingers (13 answers) or in the shoulders: 10 answerers had pain in the right shoulder and 8 answerers in the left shoulder. 7 answerers had pain in the back and 5 answerers in the neck or shoulders. Other reasons for pain were for example the scratches of feathers or bruises caused by the bowstring in the bow hand. The pain does not affect at all or almost at all the training of 75,5 % of the answerers. 17 % of the answerers have some problems with training caused by the pain and 7,4 % have much pain, even so much that they are not able to train at all.

67 answerers told to have tight or sore muscles because of archery. Most common places to feel tightness or soreness were the shoulders (15 answers) and back (14 answers), especially around the shoulderblades. 7 answerers told that the soreness comes only when the training is irregular. Many of the answerers avoided training so much that the muscles would get sore or tight. Most of them also feel that light tightness or soreness is normal and not harmful after a heavier training session.

The last part of the questionnaire was to find out the biggest challenges for horseback archers. Many of the issues that occurred had to do with the training possibilities (52 answers) and the most common challenge was to find time for training (27 answers). In addition the weather conditions, lack of training facilities, lack of teachers and not having enough events were challenges for the answerers. 36 answerers reported archery related challenges, for example learning a good and painless technique (4 answers), maintaining shooting with the full draw also on horseback (4 answers), nocking (5 answers) and generally learning better archery (14 answers). 20 answerers told about challenges that had to do with the horses, for example training and competing with new horses (3 answers), learning good riding skills (5 answers) and co-operating better with the horse (8 answers).

18 answerers reported challenges with their mind, for example finding and maintaining relaxation, calmness, focus and self confidence (14 answers), finding the feeling of safety after an accident (2 answers), keeping up the motivation to train (3 answers), staying with the given plan (2 answers) or training under pressure (1 answer). One's own body was a challenge for 12 answerers, for example being able to train with the old injuries, sickness or pain (6 answers), developing physical capacities such as strength or velocity (3 answers) or training at a certain age (2 answers, one feeling too young and one feeling too old).

The answers gave important knowledge of the horseback archers' common training habits and biggest problems. I will focus on these issues in my Physical Therapy thesis which will be ready in the autumn 2018.