



TECHNICAL PERFORMANCE ANALYSIS

The application of advances in computer technology have aided in the analytical study of sport in general. Increasingly, it provides for a more in-depth understanding of the physiological, psychological and biomechanical aspects of all sports. This has led to improved techniques, coaching methods and improved equipment design, resulting in superior performances and in addition, assists in the prevention of sport related injuries.



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TECHNICAL PERFORMANCE ANALYSIS

1-General

Archery, like any sport, has evolved over the years into a science using the advances in technology and latest analytical methods to develop a more in-depth understanding of the physiological and biomechanical aspects of the sport. An enormous amount of research has been and continues to be conducted worldwide, through sports institutes, universities and various other sport related bodies, especially in the evaluation of current practice to seek new and better techniques and equipment design to achieve superior results.

Since the appearance of the South Korean archers at the Los Angeles Olympics in 1984, when SEO Hyang-Soon won the Gold medal and Kim Jin-Ho the Bronze Medal in the Ladies division, Korean archers have achieved outstanding successes on the world stage. As such, the rest of the archery world has paid a great deal of attention to their techniques and training methods, often referred to as the Korean way. Even though the training regime may be specifically Korean, the technique however, is based on sound biomechanical principles.

Over the years, and especially since the Sydney 2000 Olympics with Simon Fairweather's Gold medal win, there have been some subtle changes in the shooting techniques employed by the majority of Australia's elite archers, which has produced some notable international performances.



2–Most Common Observed Technique and Faults

When observing archers at clubs and tournaments world wide, the majority, with some exceptions, seem to be plagued to various degrees by some or all of those faults described below:

- The drawing elbow is too high above line of arrow, hampering the lowering of rear scapula and preventing the efficient use of the lower trapezius.
- The front and rear shoulder are generally too high, to be able to use big back muscles more efficiently.
- Too much hand on the bow, creating torque.
- Chest sticks out too much, creating a hollow back, which is not only biomechanically weak, but can result in lower back pains.

The archers in these two pictures, display nearly all the common faults.

- The string is touching the center of the chin, which makes it difficult to get in-line, if not impossible.
- Too much weight is placed on the



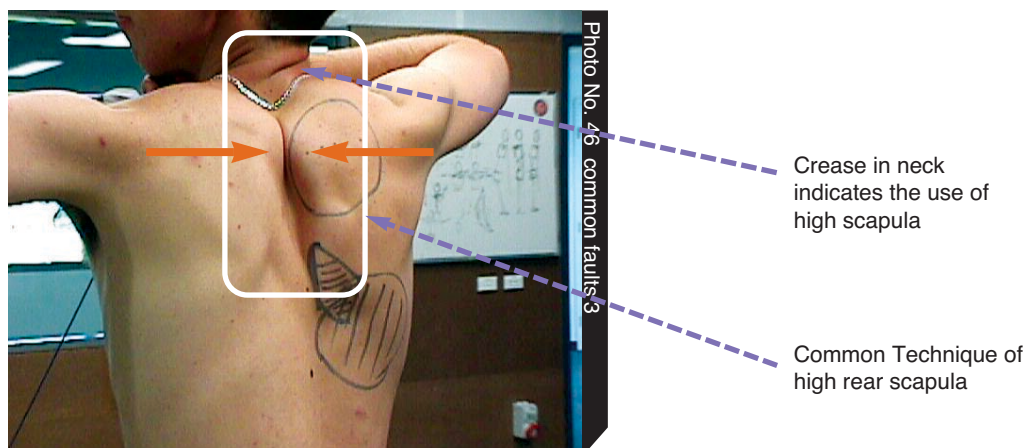
Photo No. 44 common faults 1



Photo No. 45 common faults 2

heels, preventing maximum horizontal force to be generated most efficiently.

- No set-up position used in draw cycle, requiring too much body rotation during draw, resulting in an inconsistent draw.



- Scapulae set up too high, preventing use of lower trapezius.
- Continuous pulling with no holding position being achieved, not allowing the tension in hand and forearm to be transferred to back muscles.
- Aiming too early and losing connection with the back muscles due to wrong focus.
- Stance y-shape, irrespective of open, closed or parallel, creating unwanted tension in legs.
- Joint of inner drawing arm rotated too much upwards, creating weak connection with shoulder joint. Lack of sufficient follow through, due to “dead” release.



3-Recommended Technique and KSL Back Tension Method

- Open stance with the back foot parallel or slightly closed to the shooting line, but not open. The front foot at approximately 30 - 40 degrees; legs about shoulder-width apart; anymore and tension will be created in the front knee and upper leg.
- Lean the body as a whole slightly forward to create a pressure distribution of 60-70% on the balls of the feet and 40-30% on the heels, allowing maximum vertical and horizontal force to be generated.
- Hips open to the target with the upper body rotated from the waist to align shoulders with the target, creating a little tension just below rib cage for greater stability.
- Set both shoulders down in a natural position commencing set-up.
- Bow arm rotated in, so that upper and lower arm joint is near vertical for a stronger biomechanical structure.
- Chest tucked in with sternum pushed down towards navel, creating stronger power-zone.
- Hips forward inline with body, i.e. buttocks tucked in to prevent hollow back.

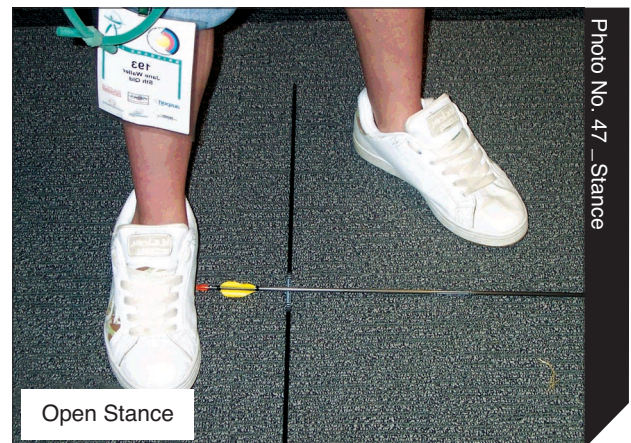


Photo No. 47 _Stance

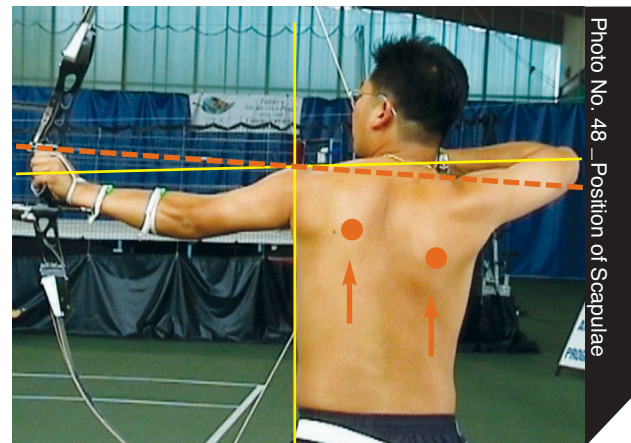


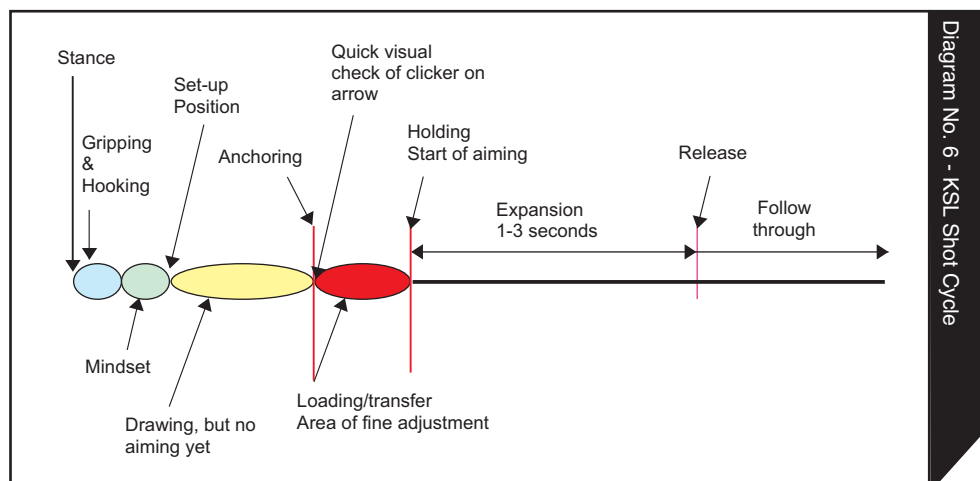
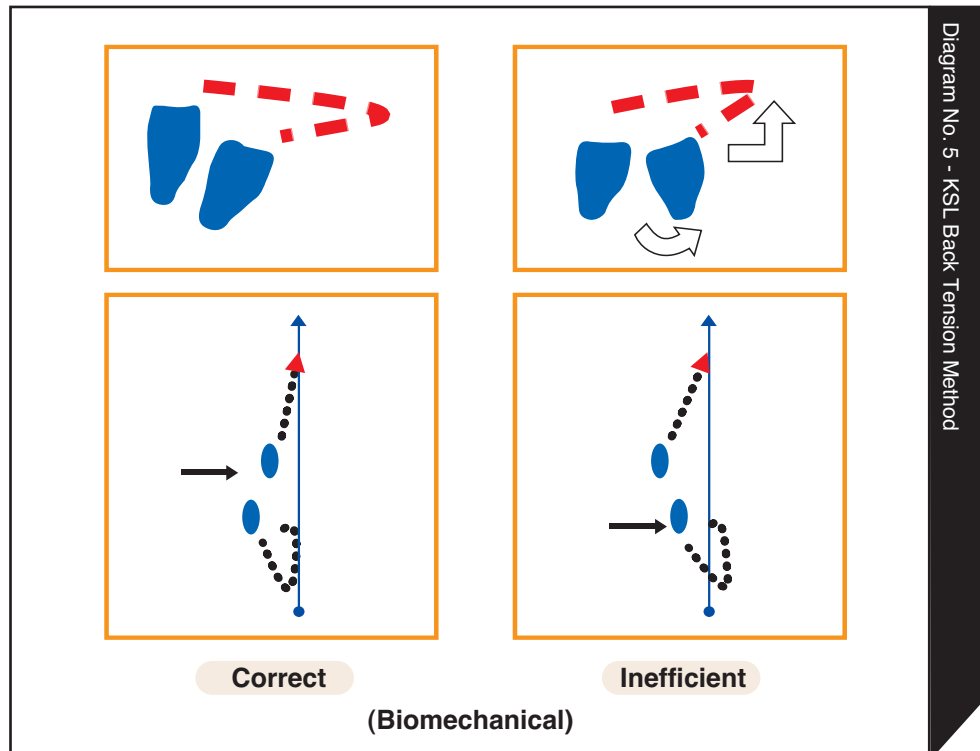
Photo No. 48 _Position of Scapulae

- Set the rear scapula down and back to bring drawing elbow as much inline with the arrow as possible. The front scapula is to be set in towards the string as close as practically possible, without the string hitting the bow arm.



- The major and most important difference is the location of the Scapulae. As can be seen on Diagram No.5, KSL Back Tension Method on the following page, the front scapula is more in towards the string and the rear scapula is set further back, resulting in a much stronger biomechanical configuration.
- The procedure of the shot itself should follow the steps as per Diagram No.6, the KSL Shot Cycle on the following page and as described in detail in Chapter 3, The Shot and Chapter 4, Biomechanics.

Even though the main differences between the most common and recommended techniques have been explained, it is important to again stress some significant differences with reference to the KSL Shot Cycle, Diagram No.6 on the following page.



4–Major Differences between Common and Recommended

1. The most common method does not use the set-up position and has a significant amount of chest and rear shoulder rotation when drawing. This makes it much more prone to variances from shot to shot.
2. Aiming starts too soon, generally as soon as the draw commences or when anchoring; the focus is then being placed on keeping the bow aligned on the target, thereby losing the time required to get the connection with the back.
3. Due to the continuous draw being taught there is no loading/transfer phase and as such, holding is never achieved. This will result in more tension in the muscles of the draw arm and the fingers on release.
4. The expansion from holding takes usually more than 3 seconds, which is too long and again focus will be lost.

5–Pilot Testing EMG Comparison - Common Vs Recommended

Since 1984, extensive research has taken place in Korea to gain a fuller appreciation and understanding of the biomechanical principles relating to archery, rather than just considering an anatomical approach. This research has resulted in biomechanical sound techniques being developed, which has led to the Korean dominance.

This focus on fully exploiting the human muscular and skeletal system in the most efficient manner, has led to develop a different way to set up the scapulae for best performance.

The success of this unique technique became evident at the 2004 World Junior Championships when 17 year old Tim Cuddihy from Australia won the Gold



Medal. It added to his Gold medal from the 2002 Junior World Championships, where he became the Cadet World Champion. This was followed up in 2003 at the Open World Championships in New York, when 17 year old Australian Dave Barnes and 16 year old Tim Cuddihy met in the Bronze medal match, which ultimately was won by Dave Barnes. Dave Barnes followed this up a month later by defeating current World Champion Michelle Frangelli for the Bronze Medal in the 2003 Athens pre-Olympic Tournament.



Photo No. 50 - '03 WAC

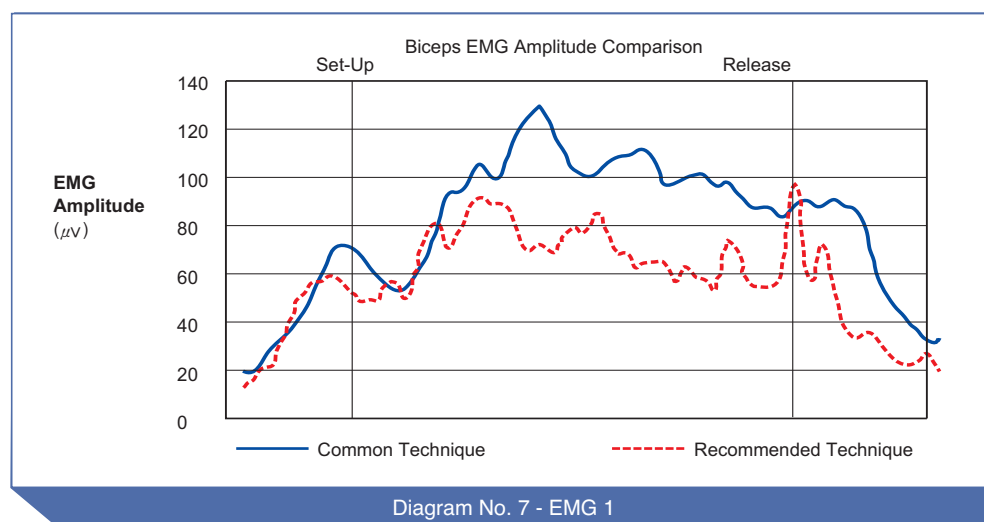
Again at the Athens 2004 Olympics, Tim Cuddihy with a brilliant display of controlled technique won the Bronze medal, equaling the Olympic Record of 115 in his semi-final match and setting a new Olympic record of 340 for the three final matches.



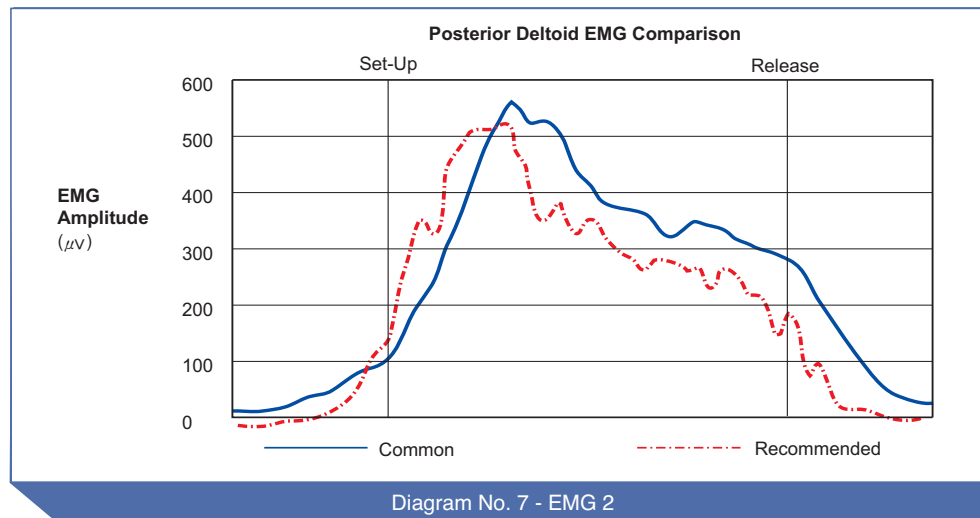
Photo No. 51
Athens 2004 Olympics

To be able to demonstrate the major differences between the Common and Recommended methods, an EMG comparison Pilot testing program was carried out in Australia.

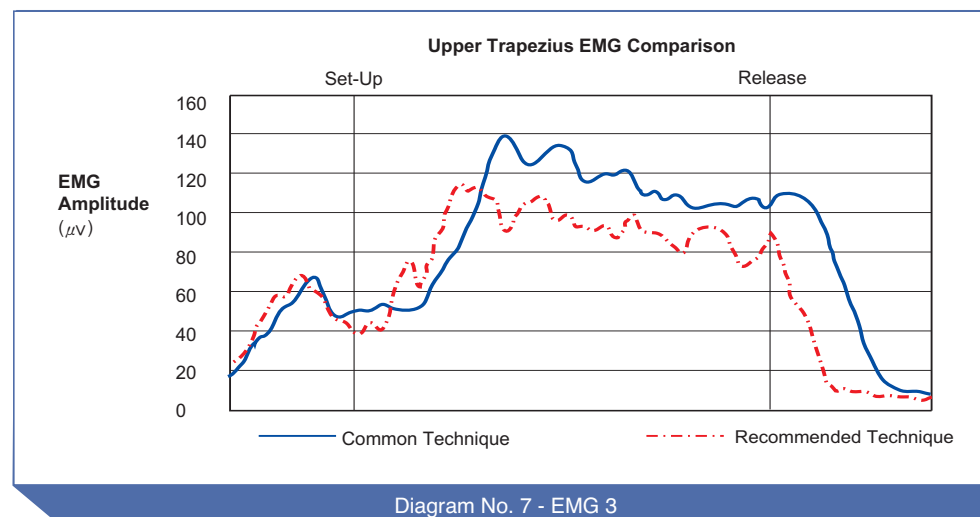
Shown below are an assortment of EMG amplitude comparisons of the various muscles, firstly using the Common technique and secondly the Recommended Technique. Each graph has comparison notes, highlighting the differences between Common and Recommended.



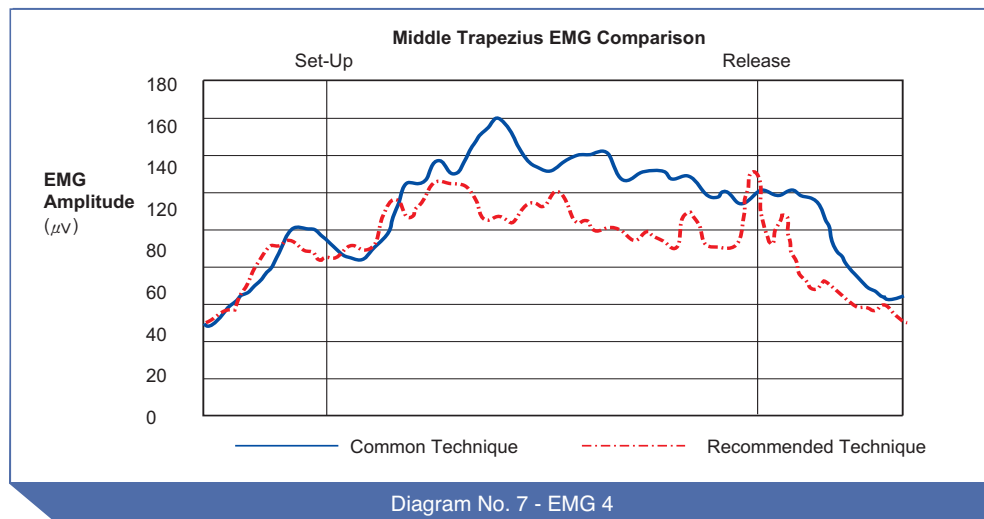
- 1. Biceps** - The EMG shows a reduced tension using correct technique. There is an overall greater relaxation taking place during the transfer/expansion phase, followed by a distinct peak on release. This is possibly due to a slight reduction of the angle between the lower and upper arm when the hand follows the contour of the face. There is a noticeable sudden sharp drop off on release indicating the follow through is coming from the back muscles and not the biceps.



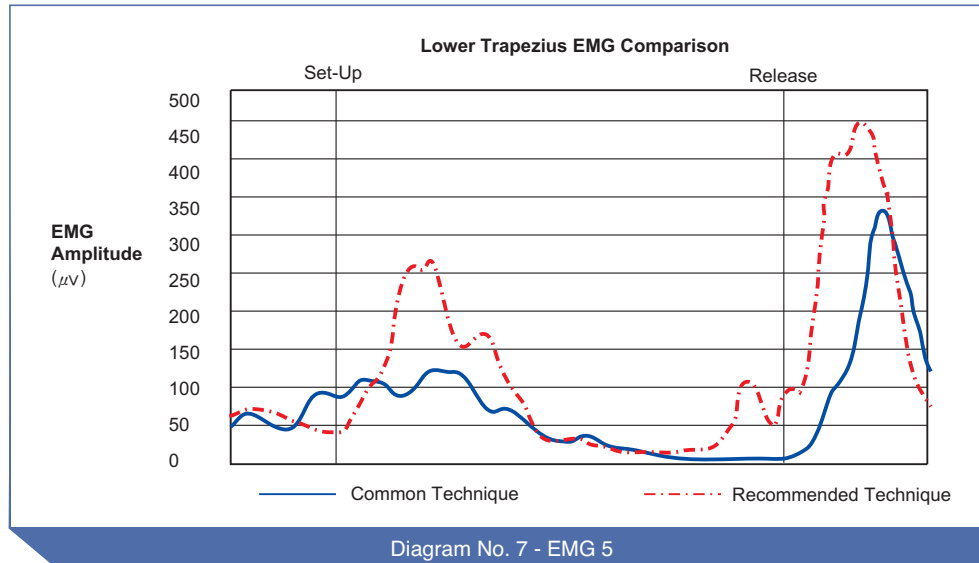
2. Posterior Deltoid - There appears to be an increased tension when drawing to anchor, but that reduces sharply below that of the common method during the transfer and expansion phase. There are some interesting peaks occurring on and after the release, compared to Common method. But as can be seen, there is an overall reduction in tension.



3. Upper Trapezius - During the initial draw to anchor there appears to be more tension, however this decreases significantly after transfer. On release, there is a sudden relaxation over a shorter time span than with the common method.

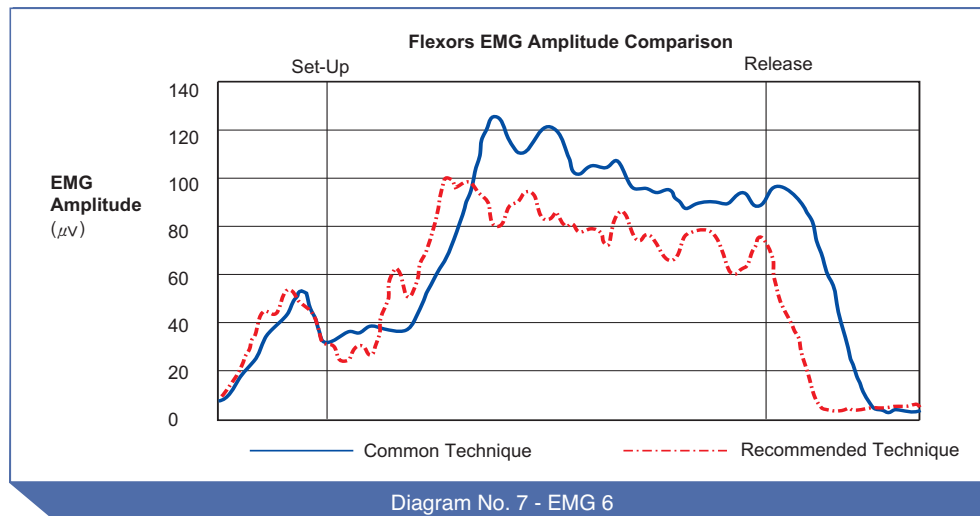


4. Middle Trapezius - This seems to have a similar EMG trace to the biceps, except that the amplitude is greater. Again, a sharp peak is indicated on release. However, it can be seen that the middle trapezius is less activated and as such, less tension overall.



5. Lower Trapezius - We can see a greater and earlier engagement of the stronger Lower Trapezius muscle, when coming from set-up to anchor. This increase in muscle activity will allow reduced tension in the upper and middle trapezius, biceps, posterior deltoid and flexors. We can see a rapid increase in tension during the crucial expansion stage coming through the clicker. This continues sharply after release, indicating a proper follow through.

6. Flexors - The flexors show a small increase in tension during the initial draw, but reduces considerably during transfer and expansion. The release shows a significant and very important difference between Common and Recommended methods. With the Recommended method there is an immediate and dramatic drop in tension over a shortened period, immediately on release.



The common method shows firstly, an increase in flexor tension, which also drops away sharply, but over a longer period. As such, it can be seen that there is much less tension in the drawing fingers on release with the “Recommended” method, which will result in a cleaner release with less archer’s paradox.

7. Conclusion - Analyzing the EMG graphs between the Common and Recommended techniques, it becomes evident that there are some significant variances, especially in the use of the Lower Trapezius muscle and the Flexors. Overall, there appears to be a much more energy efficient use of the muscles being tested, which is attributed to the more efficient biomechanical set up of the body when using the recommended shot cycle.

The understanding of the three Newtonian Laws and when to apply them in the archery shot cycle, is essential for putting into practice this “Recommended”, more efficient and effective energy saving technique.



6_SCATT System Tests



The SCATT system utilizes laser technology and was specifically developed for pistol and rifle shooting.

The SCATT display shows huge amount of data during the shot. Immediately afterwards, the shot and its trace are automatically replayed on

the computer screen. Different colored curves are displayed showing breath movement and the approach to the target; fluctuations are recorded in the second before the shot. Their size and shape indicate the hold area, and location gives the precision of aiming. The firing of the shot marks the shot placement; a different colored curve shows the reaction of the gun with the follow-through.

This system is easily adapted for archery and has been successfully used for training to develop correct release with proper back tension and follow-through.

With this simple data, archers and coaches learn more in a few minutes about shooting technique, than was previously possible with the most exact visual observation. The statistics of all training shots provide further information refinement, and everything can be stored and analyzed at a later time.

7_Force Platform and Insole Tests



There is always much discussion on the pros and cons of the various stances, open, closed or square. Force platform analysis does not indicate any of these stances to be more stable. However,

we must recognize that these experiments were conducted indoors, so there was not any wind impact on

the archers. Most of the world top archers use an open stance, as it provides for a more stable platform, reducing body sway in windy conditions. Some of these archers may open their stance a bit wider in strong winds.

Force platform tests have further shown that using correct back tension will result in increased stability.

8_Heart Rate Monitor Test

Tests with heart rate monitors were conducted already many, many years ago in Korea to check optimum arousal levels. Recent studies, using wireless telemetry heart rate monitoring to investigate stress levels experienced in carrying out closed skill sports, such as archery, have suggested a pattern in which a successful outcome is more likely. The results were fascinating, with an increase in heart rate over the



different competitions being consistent with the predicted effect of stress on an archer. The effects of stress and anxiety on performance have long been a point of discussion. Archers are continuously required to perform very complex skills while under the intense scrutiny of coaching staff as well as the broader public and media.

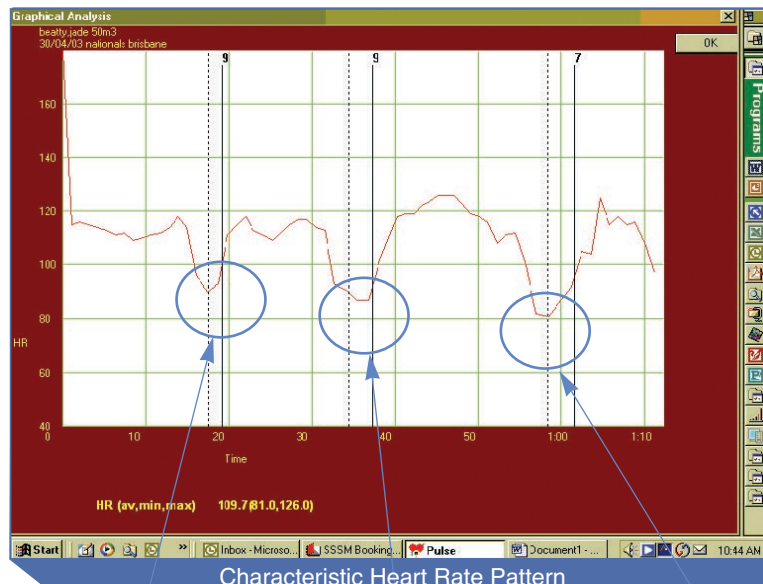
During the recent World Championships, the archer tested had a massive heart rate increase, yet there was no drop in performance. Furthermore, the heart rate pattern throughout the shot remained consistent and predictable. The result suggests that this is partly due to the rigid training routine, which ultimately created an air of confidence and reduced the fear of failure. All archers monitored mirrored this result seen during the world championships. This suggests that a desired heart rate pattern could be expected from elite archers; in addition, it is possible to know predicted heart rate patterns and educate junior archers in creating this pattern.

In general, archers will be able to develop an understanding of the heart rate patterns and the effect of stress on these patterns. They will then be able to use this information in their training to develop strategies to ensure the most appropriate pattern is used during competition.

Further, additional research established that it was also possible to verify when the holding phase was achieved.

A typical heart rate pattern is shown in the diagram on the next page. The drop in heart rate, as shown in the diagram, appears to be due to the relaxation caused by the change in the breathing pattern, as the breath is let out slowly during the transfer/loading phase. When it reaches a natural state of equilibrium, it must now be held from holding until the release.

A slight rise in heart rate will be observed before the release. This is due to the energy being used by the core muscles to bring the Scapulae together and to open the chest, to move 1.5 -2mm of the arrow through the clicker.



A. No Holding

B. Achieved Holding

C. No Holding

* Dotted line denotes Holding and solid line denotes Release

Notes:

1. As can be seen in A & C above, the heart rate increase after the holding position has been reached, indicating that there was no holding. However, In B a drop in heart rate is shown after the holding position, indicating that proper holding was achieved.

9_Sports performance and the menstrual cycle

Stress can either shorten or lengthen the menstrual cycle. All sport is stressful, and usually lengthens it. It is important for a sportswoman and her advisers to know what is going on in her body and at what stage the cycle is at.



There are four distinct stages in the menstrual cycle, which are pre-ovulation, ovulation, post ovulation and menstruation. The timing of these stages can be checked by basic body temperature measurements early in the morning before rising. These tests were done leading up to the 1988 Seoul Olympics to determine the best performance during training and competition of the various archers during each of the four stages of their monthly cycle. It was found that this was very individual. Three months before the Seoul Olympics, the stage of the menstrual cycle for each individual archer was adjusted to coincide with their best performance achieved during the previous seven months of testing.

It is interesting to note that at the Seoul Olympics Korean women won individual Gold, Silver and Bronze and Team Gold.

10_Summary

There are many scientific tests available for coaches to improve their coaching knowledge and understanding, as shown above, such as, EMG, SCATT, heart rate monitors, force platform, Insole system, including medical tests. Coaches need to have an open mind and be aware of other scientific research being conducted in other sports, as it could be applicable to archery. Further, coaches need to provide scientific tests as bio-feedback to the archers so the archers can fully understand what the coach is trying to achieve.

References:

- Heart rate diagram and related discussion extract, from article “Measuring Anxiety in Archery” by Gavin Freeman, Sports Psychologist.