Form and Function of the Saddle on a Horse's Back

"'A problem isn't really a problem until you perceive it as such."

Mark Rashid,
Considering the Horse
Tales of Problems Solved and Lessons Learned

"Perception is the truth."

Norman Fillion

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Keen riders knows that saddle fit is of utmost importance because they know that an ill-fitting saddle can lead to horse problems. While saddle fit is not rocket science it requires some understanding of horse and human anatomy; knowledge of saddles and how they are built; knowledge of the function of the horse who is destined to wear that saddle; and knowledge of the biomechanics of locomotion and that of saddle as it interacts with the horse and rider. Only once we have an understanding of all of these factors can we make an informed decision on the saddle's fit. In this report we will examine the horse and the saddle structures and will generally ignore the factors that are brought by and through the rider.

Horse anatomy

Biomechanics of locomotion refers to how gait movement happen. As soon as a horse moves it creates a muscular reaction (Appendix A). Knowing how action causes reaction and movement in a horse's body will help us figure out how to select the best fitting saddle for our horses.

The first thing to know and keep in mind it that every cell in the horse is kept alive by oxygen and nutrient rich blood which is brought by the circulatory system. Each cell is also connected to the nervous system, which basically is a communication system. Excessive pressure on an area restrict blood flow and restrict or stops the nerve impulses to those cells. Without an impulse to and from the cell, the rest of the body doesn't know the cell exists and will not supply it with blood, without blood the cell dies; this is true for all cell types. Dead cell are useless cells. It is said that pressures of 1.5 psi (pounds per square inch) should be the maximun applied to the horse (http://www.flair.uk.com/flair/flair%20why.htm). However, more recent information indicates that pressures of less than 3 psi are unusual under saddle and 3 psi may be acceptable (conversation with Gayle Ecker), but pressures above that can be problematic. The ultimate goal in saddle is to reduce pressure points and to even out pressure over the largest possible area to reduce the psi. It is generally recognized that the lower the pressure the better since pressure lead to cell death and muscle atrophy.

Pressure happens when a force goes against another. In the case of a horse and rider, the opposing forces come from the horse and its movements on one side and on by the saddle, its structure and the rider on the other side. Pressure from riding bareback absorbed in the movement of the horse and rider because one is generally moving in response to the other and pressure is equally absorbed by either side. There is a natural synergy that is being created. A saddle placed between the horse and rider becomes a restricting barrier between the two forces. To better understand this concept, place your open hand between your hip and rib cage, fingers pointing to your belly button, put a little pressure and make some movements, bend forward, backwards and sideways. You should be able to feel your hand but there shouldn't be any areas where you feel pain. Now take a small hard cover book or cassette case. Place it in the same spot and do the same movements applying the same pressure with your hand over the book. You likely will feel some pressure points and a restriction in you range of motion. This is somewhat similar to what happens to a horse under saddle. The aim of saddle fit is to reduce the areas where your horse feels the high pressure, even the pressure over a wider area and lessen the restrictions to its movements. In short it's to find a happy medium between what you felt with your hand on your side and what you felt with the book.

Placed on the back of the horse, a saddle touches the hair which touches the skin, which touches muscles which are interlaced with tendons, ligaments, nerves and blood vessels. Tendons attach muscles to bones; ligaments support and stabilize joint structures; nerves communicate information; and, blood vessels supply all tissues with nourishment and oxygen. Muscles,

tendons and ligaments act upon receipt of nervous impulses. They contract and release, providing movement of which ever part they are attached to. The muscles which are directly affected by saddle pressure are the thoracic trapezius and the deltoids which are situated on the side of the withers and over the scapula; the longissimus dorsi, which is situated along the back by the spine and the thoracic spinal muscle which is at the base of the withers. Muscles and fascia in the loin area could also be affected if the saddle doesn't fit properly. The ascending pectoral muscle and underlying structure could be affected by the girth.

Under the skin and muscles are the rigid and semi rigid structure made up of bones and cartilage. The mains skeletal support system for the saddle are the vertebral column and the rib cage. The vertebral column is divided into five distinct areas but the saddle typically sits on the thoracic vertebraes just behind the withers, up to the lumbar area. The vertebrae are joinded by intervetebral discs of fibrocartilage "Movement of vertebral joints (except the atlantoaxial joint) are dorsal, ventral and lateral flexion and limited rotation." (Horse Anatomy a Colouring Atlas, plate 7) This means that the vertebral column is a semi-rigid structure that can flex up, down, left, right and have some rotation and twist due to the cartilage that joins each vertebrae. The rigidity of a saddle interferes with the horse's natural movement. Reducing this interference is an additional goal of saddle fit.

The vetebral column houses the spinal cord which passes through an opening in each vertebrae . The spinal cord is basically the nervous system's highway, allowing nerves to carry signals from the brain to and from the the various systems and parts of the body. Being surrounded by bones, it may appear that the spinal cord is well protected, however, pressure on any of the vertebrae can cause pressure on the spinal cord and the nerves it contains. In addition, the weakest point of a horse's back is just past the 18th thoracic vertebrae. No pressure should be placed in that area for fear of causing neurological damage. Pressure on the spinal cord can hinder nervous communication.

Ribs, forming the "barrel" structure of the horse are attached at the top to each of the thoracic vertebras by an atriculation, the last rib being attached to the 18th vertebra. On the underside ribs are either attached to the sternum or to their opposite rib by costal cartilage. The last few ribs (floating ribs) are not attached to anything on the underside. (Horse anatomy, A coloring Atlas, plate 8). The cartilage is what allows a slight in and out movement of the rib cage required for the expansion required for breathing. The saddle should sit on the rib that are attached underneath but not on the floating ribs.

Movement in the forelimb starts at the shoulder (scapula) which is attached to the rest of the body by strong muscles, forming a flexible joint which allows the movement of the forelimbs to be more efficient. The muscles involved in the forelimb motion are the latissimus dorsi and pectoral which pull the lower part of the scapula backwards; the rhomboid, the cervical trapezius, the subclavius and the front part of the serratus ventralis pull the upper part of the scapula forward (course video). In order for the movement to be efficient, these muscles must be allowed to move with little or no hindrance from the saddle or cinch. At different gaits, movement of the hind and forelimbs create action in the back, creating upward and downward movements as well as flexion during turns and on uneven terrains.

Saddle fit

The saddle's main purpose is to provide security and stability to the rider, it adds nothing to the horse's ability to move and perform. Riders are becoming more aware of saddle fit problems and

are now looking for the perfect saddle. The reality is that there is no perfect saddle, only an ideal saddle for the horse and rider combination.

This ideal saddle should sit on the horse's back without causing injury to any of the structures or restrict the horse's movement. The front of the saddle should sit about one inch behind the scapula to allow movement of the forelimbs. A horse that displays a lot of muscle movement in that area should have a saddle that either sits further back or be made of a material that has more give to the movement (the moving scapula and muscle slide in and out under the saddle). It should not extend past the 18th thoracic vertebrae to ensure no pressure is placed on the weak link between the thoracic and lumbar area. The saddle should have a channel (the gullet) over the entire length of the spinal column and it should be high and wide enough to provide clearance for the spinal column of the horse in movement. A well fitting saddle should sit on thoracic trapezius muscles (situated on each side of the withers) and the longissimus dorsi muscles (which basically follows the vertebral column along the side of the horse. The angles of the fork (the upside down v angles that you see when looking at the saddle from the front) have to be parallel to the angle of the back and withers of your horse. A horse with shallow angles needs a shallow angled saddle, one with deep angles needs deep angles in the saddle. Incorrect angles will either pinch if too narrow or create pressure points if too wide. The rock, the lengthwise curvature of the tree of the saddle, has to match the curvature of the horse's back and be able to accommodate the changes that occur when the horse is in motion. A very swayed back horse needs a saddle with a deeper curve than a flat back horse would. A saddle with low rock on a deeply curved back will cause bridging (pressure at the front and back with no contact in the middle) while a deep rock on a flat back will cause the saddle to rock and put only pressure in the middle. Finally panels need to be as wide and as long as possible so that they can distribute weight over the largest area without hindering the horse's lateral movements. It is important to note that panels can only distribute weight when they are in direct contact with the horse.

A saddle needs to be tested for fit on the horse it is intended for. Because it is often impossible to bring a horse along to try a saddle the best is to make a mold to try under saddles and assess the eventuality of fit for the horse. The most user friendly static system, the EQUImeasure (TM) kit, will give you a mold of your horse's back at rest. It consists of a sheet made of special material that softens when heated in the oven. The warmed sheet is placed on the horse and molded to take the shape of the back. Once cold, the mold can be removed and taken to various saddle shops or a saddle maker to verify that the length and angles of saddles you are considering will match those of you horse, and that the gullet will clear the spine.

Testing the fit at rest on the horse.

Familiarity with the horse's structure, movement and saddle fit are all required in order to competentily assses the saddle fit. Once it has been determined that the saddle may be a fit for the horse, place the saddle on the horse without cinching it. Feel for the scapula, ensure that there is enough room for its movement, usually an inch is adequate, moving the saddle back ifrequired. Ensure that the back of the saddle rests before the last (18th) thoracic vertebrae. Next put pressure in the saddle (or have a helper do it for you), as you do this, place your hand underneath the saddle to evaluate how the fork angles conform with the horse's angles, the pressure from top to bottom should be even along the thoracic trapezius. Then move your hand laterally from front to back along the panels on each side, there again the pressure should be even along the longissimus dorsi. If the pressure isn't even, assess if you have a rock or a bridging situation and analyze if the situation would worsen with movement. Remember that you want

your saddle to sit perfectly over the rib cage and rest with even pressure along the longissimus dorsi muscles. Ensure that the gullet is high and wide enough for the horse, you should be able to see clear from front to back and have about ½ inch clearance on either side of the spine. The saddle also should sit balanced from front to back and side to side. Evaluate where the girth lies, it should fall near the horse's natural girth groove. If it isn't you may be able to adjust it so that it does. A girth that is not in the right area can pull a well fitting saddle out of position, creating pressure points.

Assessing fit in motion

As we have seen, the horse is used in motion and movement can exacerbate pressure points, adding the rider's weight and movement highly affects the pressure. While there are a number of computer aided systems that use electrodes or thermography to evaluate saddle pressure, those systems are out of reach for the majority of riders. The only system that can help assess saddle fit for the horse in motion and that is marketed at reasonable price for the horse owner is the Port Lewis Impression Pad. Basically it consists of two vinyl panels, filled with a pliable dough, which are joined by velcro along the backbone. The pad is placed directly on the horse and under the saddle. After about 20 minutes of riding at the different gaits, the impression pad is removed and the patterns in the dough are interpreted. If the impression are shallow and uniform the saddle is deemed to be a good fit for that horse and rider. Uneven or bare areas in the dough indicate potential problem areas which need to be addressed (Appendix B). The system can help identify saddle problems and in some cases it can also help identify rider problems. This person should also keenly observe the horse and rider while they are doing the test to ensure that the problems are not rider problems and to note any disruption in the test, such as a stumble, which may affect the dough pattern. Uneven patterns can sometimes be corrected by the use of a padding system. After correction the rider and horse need to do the test again to ensure that the correction is appropriate and is not creating further problems. Any changes in rider or horse or riding conditions should lead to re-evaluation of the saddle fit. The rider should always be on the look out for signs that the horse is not confortable under saddle (see appendix A for a list of signs).

As mentionned the Port Lewis Impression Pad may lead to a recommendation of adding a “corrective” saddle pad under your saddle. Be aware though, that a saddle that is too narrow will likely not be properly corrected by adding padding underneath, that would be like adding shoulder pads under a shirt that is already too tight at the shoulders. Padding a saddle that is way too large may add to the problem by creating new pressure areas or reducing the panels' weight bearing areas.

Saddle types

Now that we have examined the anatomy of a horse that is affected by a saddle, studied the horse's back conformation, compared it to the saddle, discussed pressure distribution and methods of evaluating saddle fit, both on the static and on the horse in motion, we are still left with the question of what is the right saddle. Like any commercial product each saddle type and brand claims to be the best for our horses. Other than the discipline related differences between saddles, there are basically three types of saddles on the market. The conventional (rigid) tree saddles, the treeless saddles and the flexible panel saddles.

The conventional saddles are made up of a rigid tree that take into account all the contours and angles of a horse. The saddle also have generous panels. Trees sizes are usually limited and angles are also static; they usually come in small , medium and large and with possibly a few fork angle choices. But once the tree is chosen there is little that can be done to change the rigid

structure. Some custom saddle maker will adjust the panels by flocking them differently to fit the angles of your horse, but after a few lengthy rides, the flocking may compress creating incorrect angles and pressure points. Because saddle makers basically all use the same saddle tree manufacturers, a conventional saddle is only different from one saddle maker to the other in the finished and the way the panels are made. A well fitting conventional saddle can be confortable for the horse however an ill-fitting one can be very damaging and provide little room for adjustements (other than adding padding which typically lead to further problems). The best part of conventional saddle is the pressure dissipating function of the tree.
Treeless saddles have no rigid tree, they are light weight and most require a padding system to balance the saddle and to avoid pressure points. The main problem with these saddles is the pressure points created under the stirrup bars since there is no rigid structure to distribute the weight placed in the stirrups. Treeless saddle were created to accommodate the lateral flexion that is present in the moving horse, something the conventional saddles do not accommodate. Treeless saddle have no structure to spread out the pressure evenly and pressure from points caused by things such as seams, bolts or flocking is just there, it cannot be spread elsewhere. A flexible saddle seems to make a compromise between the pressure dissipating function of the tree to make room for lateral movement. The best part of the treeless saddle is the lateral flexibility.

Flexible panel saddles are the newest kids on the block. These saddles consist of a rigid tree that is independently attached to flexible panels on each side of the horse's spine basically creating a suspended seat. Flexible panel typically have larger weight bearing surfaces and are somewhat user adjustable.The flexible panels attached to a rigid upper structure provide the pressure dissipation over the larger area and the flexible panel allow the horse lateral flexibility. Because the panels are independently attached their angles can somewhat be modified to accommodate the horse, and the suspended seat between the panels ensure that there is clearance over the spinal area.

Pressure distribution
Anyone who has recently been looking for a new saddle or to improve a current saddle's fit will be aware of the claims made by companies that their product is the best to reduce pressure point. It is crucial to understand that a saddle that causes pressure point will cause pressure point regardless of the material used in the panels. Anyone who has slept on an over or under inflated air mattress understands the lack of comfort provided by inadequate pressure distribution. Any material can work adequately if it used in conjunction with a proper fit. What is important is to ensure that the panels are large enough to distribute the pressure evenly. To figure out the minimun size required for your saddle, add your weight to the saddle's weight multiply by two to compensate for motion and divide this by the psi (pound per square inch) you are aiming for and divide that by two (175*2 lbs/1.5psi/2 panels= 116 square inch) the result is the approximate area on each panel that should be in contact with the horse to dissipate the weight evenly over the horse, if the area is smaller the psi is increased. Pressure, of course will increase as the horse moves and with rider motion. This is however a good indication as to what size the panels should be.

Once all factors have been carefully examined, a saddle should be thoroughly tested on the horse in motion and in all the situation that the horse would be expected to perform, ideally over a minimum of a two week period. In addition a new saddle may seem to be an improvement over the previous saddle, but riders need to be aware that it may take time for old problems to dissapear (atrophied muscles to become working muscles again for example). Careful observation of the horse's movement and behavior under the new saddle should be done

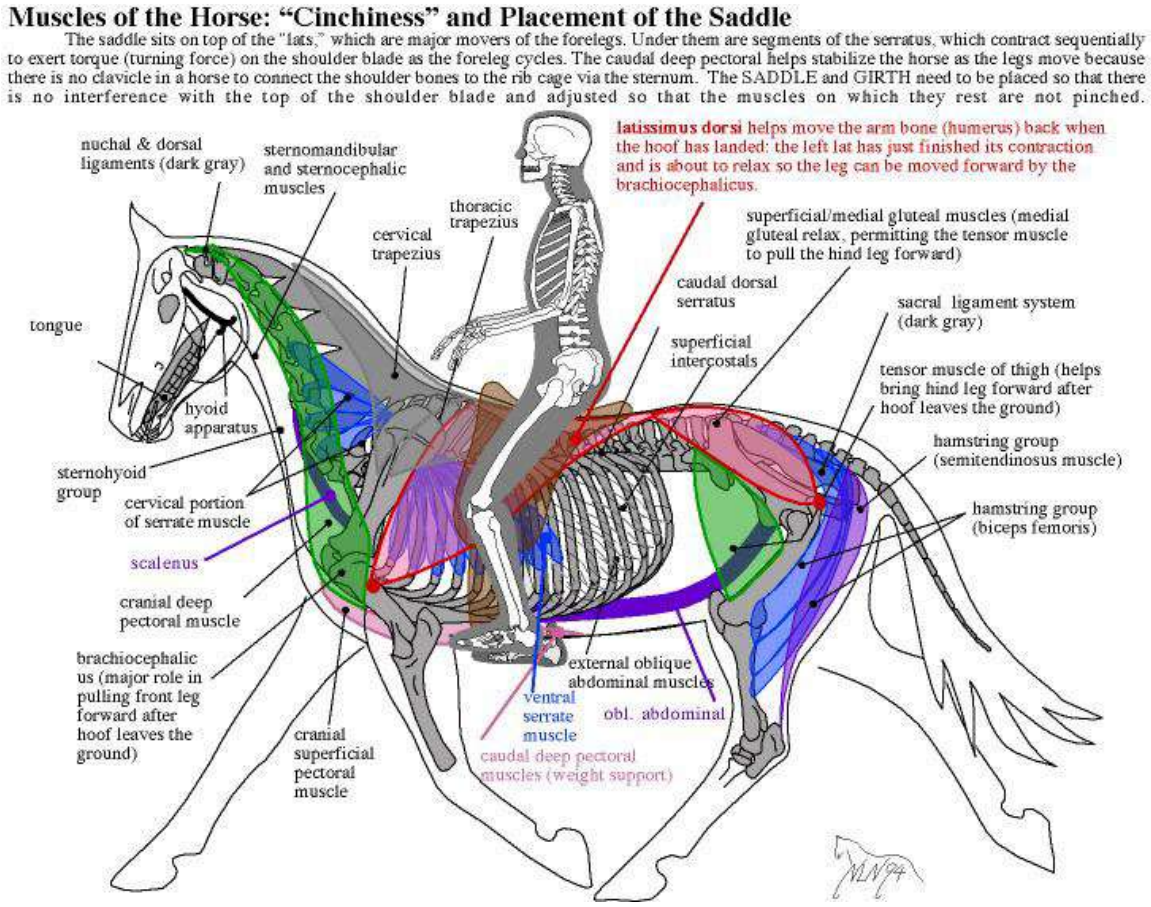
routinely. A list of indicators that may indicate saddle problem can be found in Appendix A.

In conclusion, there are many factors that affect saddle fit. It is my opinion that no saddle maker can make the claim that their saddle will fit every horse or that the material used is the best for all problem resolution. The best person to assess and choose what is the ideal saddle is the rider. I would say that, all other fit factors being equal, the flexible panel type of saddles has the most qualities to be comfortable for the horse to wear. It allows even diffusion of weight over the panels via the rigid tree and allows the flexibility of movement for the horse. While research will lead to better, more confortable saddles for the horse we will never have the perfect saddle. If there was ever to be one, horses would be born with it on their backs!

Appendix A

Signs of an ill-fitting saddle:

-pain in the muscles under the saddle
-ruffled hair under the saddle
-damage to skin or hair
-swelling after riding
-sweat pattern under saddle is uneven
-horse is reluctant to being groomed (due to soreness)
-horse tries to evade being saddled
-horse won't stand still to be mounted
-horse's back feels stiff under saddle (as it tries to avoid pain), hollow back
-horse travels crooked, stumbles or has choppy gaits
-horse tries to bite at the girth area
-horse bucks
-white hair in high pressure area
-asymetry in muscular development
-uneven pressure felt when feeling under the fork or the panels
-saddle extends past the last rib
-girth galls, or other girth related sore



Graphic taken from Dressage a Riders' Atlas -at
http://nicholnl.wcp.muohio.edu/DingosBreakfastClub/BioMech/BioMechSaddling.html

Appendix B

Port Lewis Impression Pad ready for after ride evaluation, pad must be examined on the horse before removal then held up to a source of light for evaluation.

Notice the areas with no dough. These are an indication that the saddle has uneven pressure areas. Careful evaluation of the horse, saddle and rider needs to be done. (This is a not the same impression as above).

Pictures courtesy of Gayle Ecker, ERC- Equine Functional Anatomy, Guest Speaker Forum, Fall 2003

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