DEVELOPMENT OF ORTHOTIC BRACE FOR A CANINE VALGUS DEFORMITY

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Development of Orthotic Brace for a Canine Valgus Deformity

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Angular forelimb deformities are common in canines. The forelimb or antebrachium is comprised of two bones: the radius and ulna. During the growth stage of an immature animal, these two bones maintain a synchronized developmental pattern. This normal developmental pattern may be disrupted due to trauma, congenital malformation, metabolic deficiencies, or fractures of one or both of the bones. To date canine angular limb deformities are corrected by surgical intervention, typically radial osteotomy. However, an alternative treatment option is the use of orthoses. An orthotic is a device applied externally to control or guide a limb or joint. The field of orthotics is relatively new and understudied in veterinary medicine, Practical reasons to utilize a brace are to: 1) avoid the possibility of surgical complications such as infections2) provide a less expensive treatment option and 3) provide a more rapid treatment that does not require postoperative care and rehabilitation. The purpose of this case study is to create a customized orthotic brace for a valgus deformity in the front left carpus of a 2-year-old Rhodesian Ridgeback. Central Texas Orthotics and Prosthetics oversaw the creation of the custom made brace from casting to fitting.

ACKNOWLEDGMENTS

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SECTION I

INTRODUCTION

Orthotics, externally applied devices to support, protect, or immobilize limbs and joints, are widely used in human medicine as an alternative to surgery, however, they are not as commonly used in veterinary medicine. The purpose of this case study is to create an orthotic brace to be used to stabilize and reduce the abnormal stressors on the affected forelimb of a canine with a valgus deformity.

Braces are viable alternatives to surgery for treating angular limb deformities. While surgical intervention is the only way to permanently correct the bone deformity, it does present risks and challenges that some clients are not willing to take. Surgery can be expensive and postoperative complications may arise. In order to repair many of the angular limb deformities, the joint is surgically broken and fixed in place with a metal plate. Utilizing a brace does not require cutting or plating. Instead, "Orthoses provide protected motion within a controlled range, prevent or reduce severity of injury, prevent or relieve contracture, allow lax ligaments and joint capsules to shorten, and provide functional stability for an unstable limb segment."[1] Veterinary orthotics is an emerging field with the same potential benefits as have been observed in human orthotics. Orthotics allow the patient to "allow the time for the completion of growth"[2] of the skeletal bones to full maturity before intervening. If one were to intervene too early the body could naturally cause the deformity to occur again. The orthotic is used to "improve ambulation and reduces energy cost while walking"[3]. For the dog in this case study the orthotic will help displace the weight that is being placed upon the valgus joint where the bones are currently being

crushed. The brace will help reduce the weight placed on the joint and the energy of adjusting the dog's paw. Typically a surgery to correct valgus deformity can be expensive and requires a significant amount of patient recovery time. An orthotic is a fraction of the cost and can be used as an immediate treatment.

SECTION II

METHODS AND MATERIALS

Casting the limb

In order to ensure the final brace will fit the patient properly, a cast is made of the affected limb.

1) A two-inch cotton stocking is placed on the leg starting at the cubital joint and ending just past the toes.
2) Two holes are made in the stocking at the top and bottom so that a cutting strip can be threaded through them. The rubber-cutting strip is used to protect the leg when the cast is removed.
3) Strips of plaster of paris are soaked briefly in water, and wrapped around the leg. The casting process should take about five minutes to prepare and apply and five minutes dry. One should be careful to make sure the leg is in the correct standing position to allow for as little alteration in the model angles as possible.
4) Once the cast is dry, a hook blade was used to remove the cast. A hook blade is used for the proper leverage and to allow for as little danger as possible to occur when cutting. The stocking is stripped out of the cast. The two halves are then stapled together and angles are corrected if necessary. The toes and any weak areas should be sealed with plaster of paris splints. The sealed cast is then wrapped with saran wrap. A soap mixture of commercial grade flake soap (.25 cup) and water (2 quarts), are poured in the cast and poured back out. The soap prevents the plaster from sticking to the inside of the cast.
5) A pancake consistency of plaster is poured into the cast until the very top. A pipe is bent and placed through the angle of the foot. The pipe should not touch any walls, and a pipe

holder should be placed over the top of the pipe allowing it to stay suspended in the plaster as it dries, approximately one hour.

Creating the mold

1) The mold is sanded using a drywall-sanding screen to smooth the rasp marks. If any places on the cast are missing, plaster is used to fill it and the smoothing process is repeated.
2) Once smoothing process is done all bony prominences and sensitive areas are circled. These circled areas where the brace is going to cover, will have plaster buildups on them to allow for extra padding and room in the brace to avoid any type of pressure damage to the limb.
3) Once dry the cast is stripped off of the mold. A wood rasp is used to remove any imperfections that occurred during the casting process such as marks from the cutting strip, marks from the socks, wrinkles in the cast, and etc.

Creating the buildups

1) In all places an one-eighth inch buildup will be created on the circled areas. The area where more padding will be placed, a one-fourth inch buildup, will be created where the dewclaw is.
2) Staples were used to make the buildups; a nail wasn't used because the mold is too small. The staple was placed over a corner of the material being used for padding. Then the staple was hammered in until it was tight over the material, the material was then removed.

3) In a small rubber bowl, mix a quarter size splotch of colored paint, half a bowl of water and half a bowl of plaster together to make the colored plaster for the buildups. The plaster is added using a spatula until the head of the staple is covered. The colored plaster is necessary to know where the buildup starts and where the original mold begins. The buildup is smoothed with sanding-screen until the head of the staple appears again. Then the buildup is blended until it is contiguous with the rest of the mold.

Prepping for plastic pulling

1) Once the buildups are complete a nylon sock should be placed over the mold and the mold should be inspected for any imperfections visible through the stocking. If there are imperfections, it should be sanded until not visible anymore.
2) If there are no imperfections the stocking should be tied off at the top of the mold onto the pipe. Then the stocking should be pulled tight across the mold, so there are no wrinkles. Then with the stocking bunched and twisted so all wrinkles form at the top of the toes. Once it is twisted off the stocking should be inverted back over the mold and pulled tight and brought to the top of the mold. Then the stocking should be twisted and brought down one last time. The excess of the stocking should be twisted tight over the top of the toes and stapled in place and the excess of the stocking should be cut off. The reason the wrinkles and excess are at the top of the toes is because there will be no brace in that area.
3) After the stocking has been secured, a piper topper made of stocking should be wrapped around the pipe where the top of the mold starts and then the mold should be placed and secured toes down in the pulling apparatus. Once secured a pipe topper made of

alloplastic is pulled tight and taped around where the open end of the pulling apparatus and the mold meet. The pipe topper is used to keep the plastic that will be pulled from sticking to the metal of the pulling apparatus.

Creating padding for brace

For the brace we will use one-eighth inch bocklite.

1) The one-eighth inch bocklite being used for padding should be measured and cut. The length should equal the largest circumference of the model rounded up to the nearest inch. The height should equal the top of the mold across the back of the leg, including across the accessory carpal bone, to the bottom of the paw, to the tip of the toes, rounded up to the nearest inch.
2) The bocklite should be placed into the oven for approximately fifteen to thirty seconds at four hundred degrees Fahrenheit. Once the bocklite is heated it should be placed on the mold and pulled down over the back of the mold to be pressed together on the front ensuring there were no wrinkles.
3) Then plastic bag should be pulled over and sealed around the mold and the vacuum turned on. The padding should be left for five to ten minutes to cool.
4) Once cooled the vacuum should be turned off and the excess bocklite at the front of the mold cut off. The mold with the bocklite left on should then be wrapped with one tight wrinkle free layer of nylon. The nylon is used to allow the vacuum to have increased function and it allows for the elimination of bubble formation between the bocklite and plastic layers.

Plastic pulling

1) The one-eighth polypropylene plastic length and height should be measured the same way the bocklite was. The plastic should be sprayed with silicon spray on the side that faces the oven. In cases where transfer paper is used, both sides should be sprayed and the side of the transfer paper with the design should be sprayed as well.
2) The plastic should be heated in the oven for approximately twelve minutes in the oven. For the transfer paper the clear plastic should be pulled out at approximately eleven minutes and the design applied. At approximately twelve minutes the design should be taken off and the plastic used. The plastic should be removed from the oven when all cool spots are transparent.
3) The plastic is laid over the back of the mold in the same manner the bocklite was laid. Once the plastic is pulled to meet it's other side at the front of the limb, the vacuum is turned on to create a seal and excess plastic should be cut off. The plastic is then left until it is cooled.
4) Once cooled trim lines are drawn, anterior to the midline of the side of the leg, and the topline would be in the middle between the cubital and carpal joints. The trim lines on the foot should be made proximal to the metacarpal heads.
5) The rough product should then be taken to the grinding machine and the top of the brace should be made level.

Polishing brace

1) Next the corners of the brace are rounded to allow for a better fit.
2) The polishing machine is used to finish smooth the edges.

3) The rough cone should be used to remove all plastic spurs and partially smooth the edges.
4) Then the soft cone should be used going from inside to outside to smooth the edges even more, now the edges should become rounded.
5) Lastly the tycro polish cone should be used to polish the edges smooth to be contiguous to the smoothness of the rest of the plastic.

Door fabrication for the brace

Next the clamshell door should be created.

1) The bocklite should be cut to be one inch overlapping the brace on each side and from the top of the brace to where it starts to curve. The bocklite is heated, placed over the opening of the brace, which is upon the mold, and pulled with the plastic bag in the same manner as before. Then the excess bocklite should be cut off from the outside of the creases created when it was pulled and the edges should be smoothed.
2) A foam cutting strip is then attached on the back of the brace on the mold on each side all the way to the toes to allow for the next plastic layer to be cut off. Then a nylon stocking should be pulled and tightened wrinkle free over the brace and bocklite.
3) Then another sheet of plastic of the same size as before should be heated in the same size as before.
4) This time it should be pulled over the mold with the toes up and the plastic meeting on the back of the mold and the vacuum turned on to have the plastic pull tight. The plastic should be left to cool. Once cooled the plastic should be cut on the cutting strips using a cast saw.

5) The clamshell door trim lines are then made an inch from each side of the creases and where the plastic curves for the foot. The plastic door should be cut from the top layer of plastic and edges smoothed in the same process the bottom braces edges were smoothed. The two pieces should be able to snap together.

Strapping the brace

Now the straps should be attached.

1) The clamshell door should be visibly divided in half, and then on each half a dot placed in the middle, this is where the straps should attach. Holes are then drilled where the dots have been placed.
2) The one-inch wide Velcro loops straps should be measured from the hold drilled, wrapped around to the dot times two, plus an inch extra of material, for both dots. A two-inch strip of one-inch wide Velcro hooks should be sewn on top of the looped side of one end of the looped strap.
3) A hole should then be punched through that sewn end to allow the strap to attach to the brace.
4) Two copper syncs should then be placed, inserted from the bocklite side, in the holes. The straps then the one-inch wide chafes should then be placed in that order on the sync on the plastic side of the clamshell door. The chafe and strap should be going in different directions.
5) A small copper washer should then be placed on the end of the sync and hammered down so the chafe and strap have minimum movement. The excess sync should be cut off, and then the bit remaining should be hammered and spread to keep the washer in place.

Rocker bottom formation

A rocker bottom allows for a natural rocking motion of the foot.

1) Lastly a portion of sturdy foam traced to the size of the bottom of the foot bed should be glued to the bottom and skived. The skived material should start at the toes and flatten where the dog places most of its weight.
2) After the rocker bottom has been applied a tread of choice should be cut to the size of the rocker bottom. Two layers of glue should be placed on the tread and rocker bottom and let dry. Once the glue is dry, using a heat gun it should be heated and the tread should be stuck to the rocker bottom and edges smoothed contiguous with the brace itself by using the polishing machine.

Brace application

After all work is done the brace should be applied to the dog and checked for the way it fits.

1) The leg should be checked for sores, hair loss or redness.
2) The dog's gait should be observed.
3) The brace should gradually be worn more every day. Starting with two hours and increasing by an hour every day.

SECTION III

RESULTS

Brace with the angle adjusted

For this brace we cut a slice into the cast of the dog's leg that we made and adjusted the angle of her carpal joint to match her natural angle better. We then poured plaster into the cast and let it sit. Once the mold was dry I applied a quarter inch build up over her deformity and an eighth inch build up over other bony prominences and her radial nerve. Then the foam was placed and the plastic was pulled. Once the entire brace was completed we applied it on the dog. The brace was a little difficult to put on but after a little bit we got it on but the dog seemed to be uncomfortable. We took off the brace and measured the parts of her leg because normally a brace goes on smoothly with little to no resistance and this one had a lot of resistance. It turned out when we adjusted the angle it caused the length to change and the brace in turn was too short. Therefore we had to revert to the original pulled brace and use some ingenuity.

Brace without the angle adjusted

When casting the brace we did not account for the dog pushing away so the angle of her carpal joint was more than natural but we decided to make a brace for this angle just in case. I made the build ups and pulled this brace in the same manner as the other. Since this brace was over extended we cut the foot base off. By cutting the foot base off we were able to keep the most important structural portion of the brace. The brace now resembles more of a hard knee brace than an ankle foot orthotic. The knee brace structure allows there to be support around the deformity but still lets the paw move freely. We did run into a problem with the brace rubbing

on the dog's deformity and causing a pressure sore. To correct this problem we created a foam donut insert to be placed where the brace came into contact with the deformity. The inside of the foam donut where the hole is was placed over the protrusion of the deformity.

The final brace inhibits the dog from abducting her paw. She can tolerate the brace for long periods of time and there are no signs of overt discomfort. The dog does not chew or bite at brace and will willingly wear it for long periods of time. Pressure sores did occur so a circle of foam with the middle hole cut out was placed where the brace would contact the deformity and no more sores have occurred. The brace has been worn over daily the course of 3 months. After 3 months the brace has minimal wear and tear. The brace is currently being worn by the dog when physically active in activities such as going to the dog park, going on walks, and playing with other dogs in the home.

SECTION IV

CONCLUSION

Orthotics and prosthetics clinician opinion

In the opinion of the orthotist overseeing the project the brace was designed properly and adequately to provide the needed support of the deformity. The orthotist assisting in the fabrication of the brace believes the brace is a good fit on the dog and prohibits further abduction of the carpus. The brace was seen to not cause any sores or redness and was approved for the usage on the dog

Orthopedic veterinarian opinion

The veterinarian assisting in the care of the dog believes the brace should help slow further damage to the carpal joints and may even prevent any further damage. The veterinarian was skeptical of the brace but once it was applied it was approved as an alternative to the surgery he would have performed. He said it was a good solution to having an expensive surgery that would cause the dog to no longer have mobility of her carpal joint.

Both professionals agreed the dog has had a decrease in fatigue of the joint and can stay mobile for longer. The brace has also allowed the dog to bring her foot more in line with her midline and for the dog to shift more weight steadily on the injured limb. So far only these short-term results have been seen. The long-term plan is to continue monitoring via physically exam and radiographs with the expectation that the bone degeneration will be slowed due to the brace

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