Treatment of Distal Phalanx Fractures Type 2 and 3

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Abstract

Introduction: This is a study of farriery treatment for distal phalanx (P3) fracture Types 2 and 3. The prognosis for Type 2 and 3 fractures has previously been reported to be 69.6 % and 74.1 % respectively. The best treatment option was box rest without shoes; surgery, had a poorer outcome. A pilot study to ascertained clip position and number was undertaken prior to the main study.

Aim: The aim of the study was, 1. to find out if the position of clips, *in vitro*, affect distraction of Type 2 and Type 3 fractures; 2. to treat cases using the *in vitro* findings and compare to current treatment outcomes.

Hypothesis: The hypothesis was that four clips positioned with regards to the appearance of the fracture will stabilise the fracture better than just box rest without a shoe and/or two clips.

Methods: Ten cadaver limbs were used to assess the importance of clip placement, using fluoroscopy and to see whether incorrectly placed clips can impair fracture healing. A retrospective group, n=15, was treated with a bar shoe, two clips and box rest. These were compared to Group 2, n=15, shod according to a shoeing protocol with four clips, bar shoe and box rest.

Results: 67% of the horses in Group 1 fully recovered, compared Group 2 where 100% fully recovered. In Group 2, the degree of pain was less compared to Group 1.

Conclusion: Horses with P3 fractures of Type 2 and 3, treated conservatively with corrective shoeing and box rest according to the shoeing protocol used for the Group 2 horses, seem to have a very good prognosis for a full recovery. The major benefit of conservative treatment is that the horse does not need to be exposed to the risks of general anaesthesia and surgery.

Key words: Distal Phalanx, P3, Coffin bone, Fracture, Shoeing, Limb, Hoof.

Declaration

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……………………………......................................Signed by the candidate.

Introduction

The third phalanx, also known as the distal phalanx, P3, or coffin bone is the most distal bone in the equine limb. Even though the hoof is the hardest working part of the horse, a fracture of P3 is a quite rare diagnosis (Petterson 1976, Bretone 1996, Stashak 2002). The diagnosis has been reported in a frequency of around 0.3 % of all cases (Yovich 1982, Scott 1979) to 0.7 % of all lameness cases (Pettersson 1979) entering equine hospitals. However, a fractured P3 can end the career, or even the life of the horse if not treated in an appropriate way.

The methods for treating P3 fractures and the prognosis varies depending on how the coffin bone is fractured. To describe the different type of fractures, and to simplify the comparison of treatment outcome between authors, the following classification has been used for the last 25 years, (Honnas *et al.* 1988, Stashak 2002, Kidd 2011) (Figure 1).

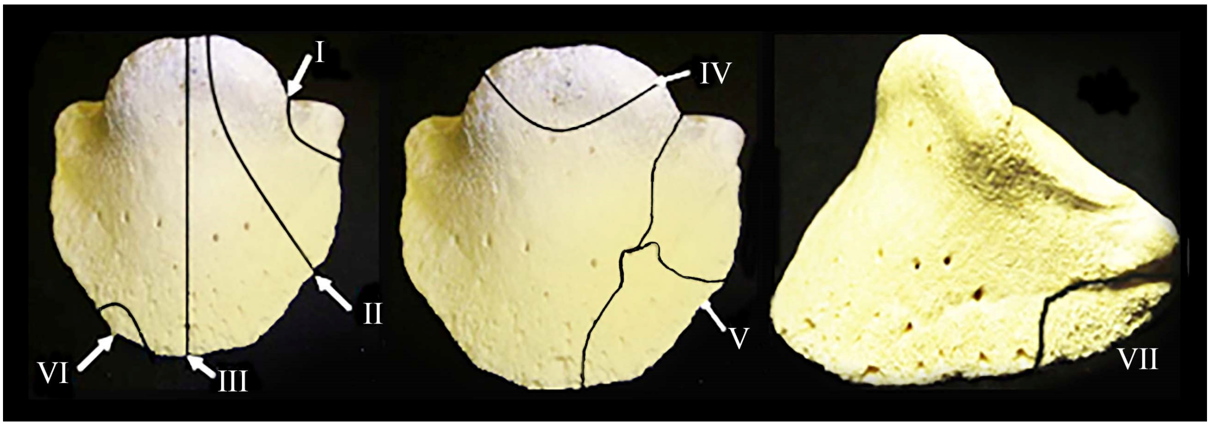

Figure 1: *Fracture of the distal phalanx are classified as follows:*
Type I. Non articular fracture on the lateral or medial aspect of P3
Type II. Articular fracture medial or lateral.
Type II. Called midsagittal fracture, splits the P3 into two equal parts.
Type IV. Fracture of processus extensorius
Type V. Comminuted fracture, when three of more fragments of the P3
Type VI. Fracture of the solear edge, also known as chip fracture
Type VII. Non articular fracture of the palmar aspect of P3, also known as foal fracture.
(Photo courtesy Ove Wattle)

Even though all breeds of horse can suffer from P3 fractures, the horses age, breed, use, type of surface, shoeing and the form of the hooves can be predisposing factors and affect both the incidence and type of fracture (Linford 1987, Honnas 1988, Deschant 2000). In adult horses, the fracture aetiology is nearly always trauma.

A diagnosis is made based on clinical signs, i.e. sudden onset of lameness (often grade 2-5 of 5) an increased digital pulse and sometimes signs of pain when using a hoof tester. Pain is intensified when putting pressure, with the hoof tester, over the fracture line or when heels are pushed together in hooves with a fracture Type 1-3. An increased amount of synovia can often be palpated in the coffin joint if the fracture is articular. During diagnosis it is also important to consider other possible conditions such as hoof abscess, corn, penetrating wounds, etc. However, for a definitive diagnosis radiographs should be taken (Honna 1988). Usually, five radiographic views are used for a full P3 examination; Lateromedial (LM), Dorsopalmar (DPa), Dorsoproximal-palmarodistal (DPr-PaDi), Dorsoproximal-palmarodistal oblique (DPr-PaDiO), and Palmaroproximal-palmarodistal oblique (PaPr-PaDiO).

It is usually advised to treat a fractured P3 (Rijkenhuizen *et al.* 2012) except for cases where the fracture includes severely dislocated fragments at the articular surface or when having open comminuted fractures where the pain or infection cannot be controlled. Treatment methods vary due to the type of fracture but are also dependent upon local traditions. To achieve a good prognosis, broken bones need to be stabilised until they have healed, i.e., built a callus, strong enough to handle the weight and movements they are exposed to. To stabilise fractured bones the fracture fragments are normally stabilised in their normal alignment with either a cast or with internal fixation using implants, such as screws and plates. Stabilising Type 2 or 3 fractures surgically by using lag screw, has been carried out for many years. However, for many reasons this is rarely done in Sweden. The hoof capsule makes it impossible to realign P3 fracture fragments and the bone itself has a very thin cortex. Thus, the anatomical properties of the P3 bone leads to the fact that this expensive technique gives a worse prognosis than just box rest (Rijkenhuizen *et al.* 2012).

Nonsurgical treatments are often a combination of box rest, foot casts, medication with non-steroidal anti-inflammatory drugs (NSAIDs) and farriery. The design of P3 fracture shoes are not well described in the literature. Previous treatments described in past studies are bar shoe variations with clips to reduce movement when the fractured P3 is weight bearing (Rijkenhuizen *et al.* 2012). A full bar shoe with quarter clips, rim shoes or Watts Shoe and bar shoes with multiple clips are also suggested (Kidd 2011, Turner 2017). A study regarding how the number and position of clips might reduce the distractive forces under load is not to be found in published literature and seems mainly to be dependent on farriers and veterinarians own experience.

The prognosis for Type 2 and 3 fractures has been reported to be 69.6 % and 74.1% respectively for a return to the original or expected level of use and the best treatment option was box rest without shoes (Rijkenhuizen *et al.* 2012). In this study (Rijkenhuizen 2012), using a full bar shoe with clips impaired the prognosis significantly.

It is of high importance for the farrier to know where the fracture line(s) is/are before shoeing. Local inflammation in the affected area can cause the horse pain if clips and nails are placed over the fracture, thereby, worsening the prognosis for the horse. For this reason, a pilot study was designed to establish the most efficacious number and position of clips on a full bar shoe and to view how fragments of Type 2 and 3 P3 fractures move when the hoof is loaded. Thus, how to stabilise P3 as optimally as possible for the non-surgical treatment of these fractures.

Aim: The aim of the study was to find out how best to stabilise P3 as optimally as possible for the non-surgical treatment of Types 2 and 3 fractures.

Objective: The objective of this study was to establish the most efficacious position and number of clips in an *in vitro* pilot study and to use that knowledge to further compare *in vivo,* a group (n=15) treated thus with a control group treated without shoes.

Hypothesis: The hypothesis was that clips that are positioned with regards to the appearance of the fracture will stabilise the fracture better than just box rest without a shoe.

Ethical considerations

In consultation with the Swedish University of Agriculture Sciences, it was ascertained that ethical approval was not needed, as the *in vitro* experiments were carried out on cadaver limbs at the University. The death of these horses was unconnected to the study and therefore the University did not require approval.

The *in vivo* study used horses treated at veterinary animal hospitals and at the University using known best current treatments. These treatments have been published in peer reviewed journals.

In vitro pilot study material and methods

In the in vitro study, ten fresh cadaver limbs (six front limbs and four hind limbs) from adult Standardbred trotters and Swedish Warmbloods were used. The limbs originated from horses slaughtered at an abattoir on the day of testing. After trimming the hooves clean and balanced, as for shoeing, a captive bolt was used to create eight Type 2 fractures and 2 Type 3 fractures. The captive bolt was placed in the frog's sagittal plane, at the level of *linea seminularis* (insertion of the deep digital flexor tendon) and aimed so that the bolt should impact this area because this is the most palmar/plantar part of the coffin bones center without sticking into it when fired. The fractures where then confirmed by radiographs (Figure 2). In the study, twenty-five limbs were required to get ten fractures with an appearance comparable to the P3 fractures we see in living horses.

The cadaver limbs were then placed in a hydraulic press equipped with a manometer showing the amount of loading in kilograms (kg), ranging from 0 – 5000kg. The hydraulic press was then connected to a pneumatic pump. This allowed the increase of pressure in a step-less way until the selected pressure on the limb was reached. The load was then decreased by opening a valve to let the air out. The limbs were all loaded up to 300kg to mimic the approximate weight put on a single hoof at walk or when rapidly changing position in a box (Ratzlaff *et al.* 1990).

To achieve a more natural movement of the phalanxes within the hoof capsule, when the limbs were loaded, the flexor tendons was attached to rubber bands to simulate the muscle of the superficial digital flexor tendon (SDFT) and deep digital flexor tendon (DDFT). To simulate the ground/shoe, the hoof was placed on a wooden plate on which metal clips could be placed and fixed with screws (Figure 3A).

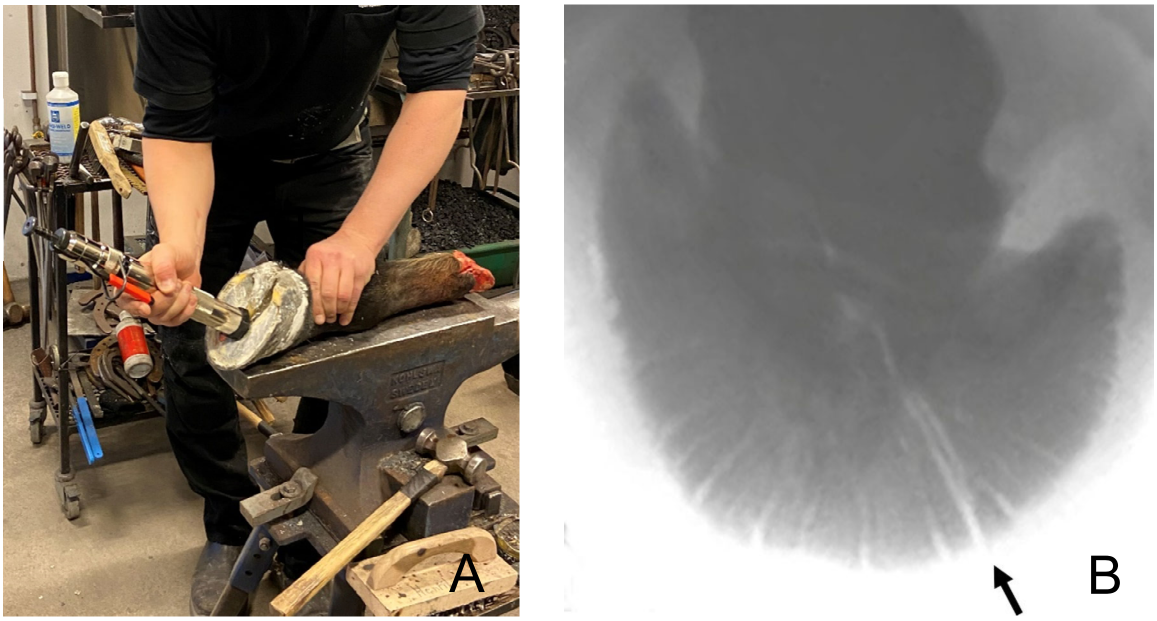

Figure 2: Creating P3 fractures by means of a captive bolt: A) aiming with the captive bolt; B) a fluoroscope radiograph of the Type 2 fractures made in this project. The black arrow indicates the position of the fracture line at the solear margin.

A Siemens Cios Alpha fluoroscope (C-arm) was positioned to acquire images of the coffin bone during the loading sequences (Figure 3B). All limbs were loaded simulating two step cycles at six seconds (s) each. First unshod and thereafter in randomly order with heel clips and with four clips positioned depending upon the location of the fracture line. To conclude, the limbs were loaded without clips again. Every loading cycle was approximately 3.5s from start to maximum loading and thereafter 2.5s decreasing the pressure back to zero. When pressing the first limb, with a Type 2 fracture, the 2-6 clips were placed in several different positions around the hoof circumference to see whether the movement between the two fracture fragments increased or decreased during the loading/unloading, and if this depended upon the clip positions.

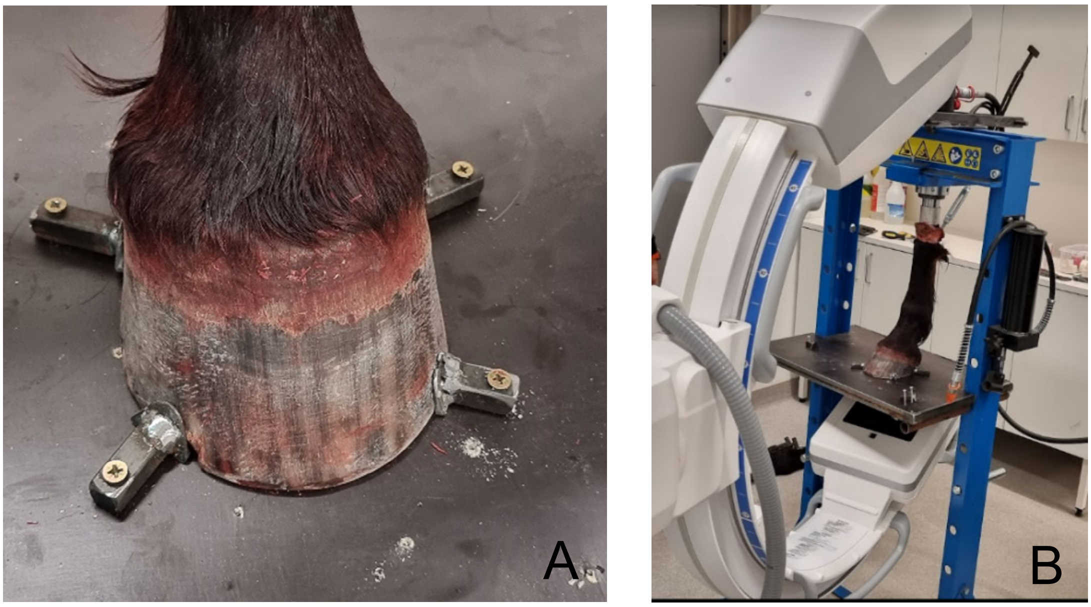

Figure 3: A) two quarter clips and two side clips on a hoof with a Type 3 fracture; B) the set up with a fluoroscope.

The radiographs taken during the loading cycles were collected as avi-movies and transferred to a computer hard drive for evaluation. The avi-movie sequences of the loaded P3 fractures were then evaluated individually by one farrier and two veterinary surgeons independent from each other.

Results of the *in vitro* pilot study

Since the clips are visible in the avi-films, the in *vitro study* cannot be done completely blinded. Further, since the fluoroscope only gave us 2-dimensional (2D) pictures of a 3-dimensional movement, it was impossible to do a fully objective analysis of movement of fracture fragments, i.e., the effect of the distraction forces, during the loading cycle of the cadaver limbs. However, for all ten samples the three evaluators could note an obvious movement between fracture fragments while the limbs were loaded (Figure 4). For all ten samples they also independently assessed the movement between fracture fragments as bigger when using a full bar shoe with heel clips compared to unshod (Figure 5). When using four clips, two positioned behind the hooves widest point and two positioned further dorsally depending on the position of the fracture line, the movement between fracture fragments were equal in seven and less in three of the cadaver limbs when compared to using no clips at all.

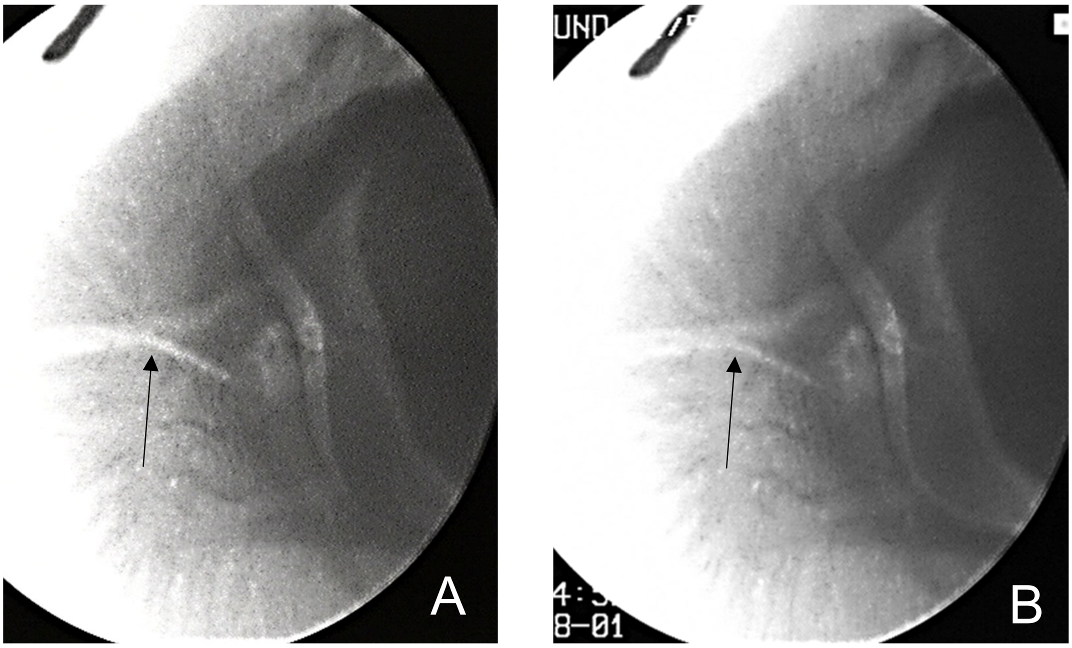

Figure 4: The difference in position of fracture fragments in; A) unloaded versus B) loaded hoof.

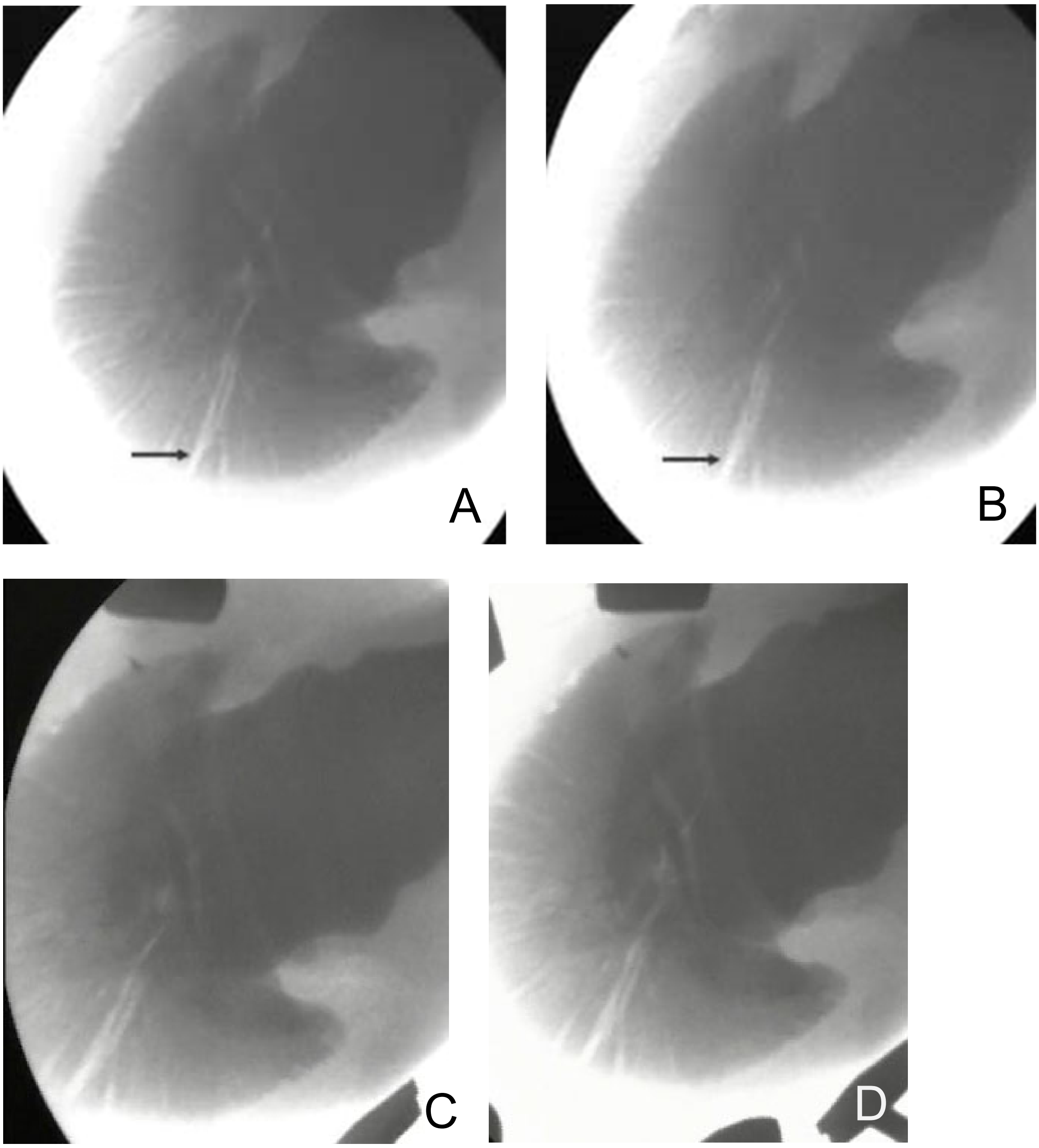

Figure 5: A Type 2 fracture (arrow). A) is noticeably narrower unloaded and without clips, than B) loaded without clips; C) loaded with quarter clips appears to be wider than D) loaded with four clips.

Conclusion from the pilot study

The results indicated that compared to unshod hooves, using four clips can decrease the mobility between fracture fragments in some cases. Using only quarter clips seemed to increase the movements between fracture fragments in all cases when the hoof is loaded. When using four clips, all clips must be fitted tight against the hoof wall to decrease distraction of fracture fragments.

The main study

Methods and materials

In the *in vivo* study, all data originated from patients of the University Animal Hospital, Uppsala Sweden. Data was collected regarding; the place of injury, clinical signs on the day of injury, how the signs developed and how the horse was treated until diagnosis, gender, breed, age when injured, treatment and if the horse made a full recovery. As P3 gets its shape through development and adaptation during the first two years of the horses life, only horses ≥2 years of age were included.

A total of thirty horses diagnosed with Type 2 or 3 P3 fractures were included in the study. These were divided into two groups. Group 1; f horses treated with box rest for two to three months and shod with a full bar shoe with two quarter or two heel clips for six to nine months. These horses were all treated before 2009 and therefore the data was collected retrospectively. Group 2; the first fifteen horses with Type 2 or 3 fractures that came into the Equine Clinic at the Swedish University of Agricultural Sciences (SLU), after the above-described test with cadaver limbs was finished.

Group 1 consisted of ten Standardbred trotters, four Warmbloods and one Arab with a mean age of 5.8 years (range 2-12, median 5 years). There were five mares, five geldings and five stallions, thirteen had Type 2 fractures and two Type 3 of which six of the fractures involved a front limb and nine a hind limb.

Group 2 consisted of four Standardbred trotters, six Warmbloods, two Icelandic horses, two mixed breed and one pony with a mean age of 10.5 years (range 4-17, median 10). There were eight mares and seven geldings of which twelve had Type 2 fractures and three Type 3 fractures, four of the fractures involved front limbs and eleven hind limbs. All horses where initially two to five degrees lame at walk.

Shoes and fitting

Following the protocol decided by the pilot study, clips were placed as follows; two were placed caudal of the hoof´s widest point, i.e., one on the medial and one on the lateral heel. Two clips were placed dorsally to the hoof´s widest point, i.e., between the first and the second nail hole. However, if the fracture line was localised in the same area the clip was moved palmar/plantar to leave 1cm from the dorsal edge of the clip to the injured area. The quarter clip on the opposite side was not moved. The clips were, from the base to the tip, fitted tight against the hoof wall, making full contact when the hoof was unloaded. A straight bar shoe was used with a two millimeter (mm) gap minimum between the bar and frog when unloaded. The shoe was nailed to the hoof with a total of four nails, two lateral and two medial, making sure that no nail was placed directly over the area of the fracture line. Hot shoeing was used when fitting the shoes to the hooves. Special attention was made to get full contact between the shoe and hoof (Figure 6).

The cast used, consisted of two to three layers, with a plaster cast reinforced with a plastic cast of normal thickness on top. The reason for using a thin plaster cast innermost, is that it makes it much easier to remove the outer most plastic cast when changing the cast after two weeks. The plastic cast is needed since it can get wet without losing its mechanical properties. To get the best possible support for the pedal bone during the first four weeks of the fracture healing process. The cast was used together with a full bar shoe with four clips.

The cast was changed after two weeks to avoid contraction of hoof width at the heels which may have a negative effect upon the blood circulation of the foot.

Group 2 horses were all treated using the following protocol:

- First day. Diagnosed with radiograph. Trimming and shoeing with a straight bar shoe with four clips combined with plastic cast and box rest
- 2 weeks. Change the cast, box rest
- 4 weeks. Refit the shoe, take the cast away, box rest
- 8 weeks. Refit the shoe, box rest
- 12 weeks. New radiograph, refit the shoe, start hand walking the horse
- 16 weeks. Refit the shoe, gradual increased walking exercise
- 20 weeks. Refit the shoe, increased exercise, small paddock turn-out
- 24 weeks. Refit the shoe, increased exercise
- 26-28 weeks. New radiographs and shod with a bar shoe without clips at the heel, increased exercise, horse let out on pasture with calm friends
- 6-12 months. Bar shoe, now with shoeing periods of 6 weeks, increased exercise, now ridden if not lame
- ≥1 year. Normal shoe with normal shoeing intervals, no restrictions in exercise

Figure 6: *A) Fitting the shoe by hot shoeing. B) Fitting of the proximal part of the clips. C) The heel clips are in full contact with the hoof wall. D) Clips in front and behind the widest part of the hoof.*

Results

Group 1: Three horses (one five years and one nine years old SWB plus one four years old Standardbred) were euthanised within nine months after diagnosis because of persistent lameness. Two of them had Type 2 fractures and one a Type 3. Two horses with Type 2 fractures (one 10 year old Arab and one 6 years old Standardbred) were still lame at trot after a year, became pasture sound, and were kept as company or breeding. The remaining ten horses (67%), showed no signs of lameness when being walked and trotted by hand at the clinic, around nine months after diagnosis. They all returned to the same level of work as before the injury within eighteen months post initial diagnosis.

Group 2: All horses in the group were sound at walk within six months but nine of them were mild to one degree lame on the fractured limb when trotted. All horses were sound in trot within twelve months post injury. All fifteen (100%) had returned to the same level of work as before the injury within sixteen months post diagnosis.

Chi-Square (χ^2) Test

H_0 There is no difference in results between group 1 and group 2.

H_1 There is a difference in results for group 1 and group 2.

The value of χ^2 here is 6. At the significance level α=0.05 where the number of degrees of freedom is the number of categories minus one, thus 1. A table of the χ^2 distribution shows that the critical value at the significance level α=0.05 and number of degrees of freedom 1, is p-value 0.014. Since the value of χ^2 is greater than the critical value, the test confirms that H_0 is rejected in favor of H_1.

Degrees of freedom (*df*)	Significance level (α)							
	.99	.975	.95	.9	.1	.05	.025	.01
1	-------	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086
6	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812
7	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475
8	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090
9	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666
10	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209
11	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725
12	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217
13	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688
14	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141
15	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578
16	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000
17	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409
18	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805
19	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191
20	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566
21	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932
22	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289
23	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638
24	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980
25	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314
26	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642
27	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963
28	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278
29	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588
30	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892
40	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691
50	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154
60	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379
70	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425
80	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329
100	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116
1000	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807

Discussion

Box rest has been proposed to be the most effective measure when treating P3 fractures (Rijkenhuizen *et al.* 2012). When a horse is box rested it can still walk around in the stable. The results of the *in vitro* study showed that there was movement between fracture fragments with unshod hooves, with either a Type 2 or a Type 3 fracture of P3 when loaded with 300kg, i.e., simulating the loading of a hoof that can occur if a horse moves rapidly in the stable (Ratzlaff et al 1990). Since a fluoroscope was used that produced a 2D image, it was impossible to measure the degree of movement between fragments. The research team had to settle for a subjective estimate of the amount of movement shown during loading. However, the opinion of all three evaluators, independently of each other, were consistent that using just two heel clips increased the movement between P3 fracture fragments compared with no clips. When using four clips the movement between fragments were equal or less compared to using no clips. Looking at clinical cases with P3 fractures, the subjective impression is that the horses became more comfortable after being shod with a straight bar shoe with four clips compared to when being box rested unshod, i.e., they felt less pain. This indicated that shoeing with four strategically placed clips can be a positive measure to use when treating P3 fractures. In part 2 of this study we used straight bar shoes with four clips.

For maximum stabilization the four-clip bar shoe was used in combination with a plastic hoof cast for the first four weeks, cast was changed after two weeks of box rest. The plastic cast was changed after two weeks to reduce the disturbance of hoof blood circulation that may occur when a hoof is contracted. To avoid too much contraction was also the reason for the four weeks shoeing periods when using clips. Despite using this shortened shoeing interval, the shoes had to be adjusted to fit a narrower foot two to three times during the six-month period of shoeing with shoeing with clips. Usually, it was enough to cut the bar of the shoe, fit the shoe tighter and weld the bar again before nailing. Some of the horses' feet remained a little narrower for two to three years after the injury. This did not seem to have an impact on the future of the Group 2 horses as all fifteen horses had a full recovery and returned to the same level of work as before the injury.

In Group 1 only 66.7% of the horses came back to the same level of work as before the injury compared to 100% of the horses in Group 2. The mean age in Group 1, 5.8 years, was nearly half of the mean age in Group 2. Normally fractures tend to heal faster in younger individuals. For this reason, it is reasonable to conclude that the mean age of 10.5 in Group 2, was not a significant positive fracture healing factor for these horses. Owners of Standardbred trotters normally have high expectations/demands on the horses when they are 2-5 years of age. One might argue that the higher number of Standardbred trotters, ten (in Group 1) compared to four Standardbreds in Group 2 can contribute to the 33.3% difference in results but it was only two of the five horses that did not became sound. Thus, it is reasonable to believe that it was the strict convalescence protocol, including a straight bar shoe with four clips, that was the main contribution to this significant difference in treatment results between Group 1 and Group 2 horses. The 100% return to the same level of work as before injury is also slightly better than what has been achieved by only box resting horses with Type 2 and 3 fractures (Rijkenhuizen *et al.* 2012). The study by Rijkenhuizen *et al.* 2012 reported that the long-term outcome for horses with these type of fractures was 82% with a conservative treatment and 67% when treated surgically. When they only used three months of box resting as a treatment for thirteen horses with Type 2 fractures and four horses with Type 3 fractures, their success rate was 100% and 75% respectively when looking at horses ≥3 years of age. The clinical experience of the Swedish University of Agriculture Sciences is that horses with Type 2 or 3 fractures seem more comfortable, i.e., show less signs of pain, when box rested with a straight bar shoe with four clips then unshod. From an animal welfare point of view, it seems reasonable to recommend the treatment protocol used for the horses in Group 2 since the prognosis is at least as good as just box resting according to the protocol of Rijkenhuizen *et al.* 2012.

To get the shoe in full contact with the hoof bearing surface and fitting four clips in full contact with the hoof wall, seems to be the most difficult part for farriers using this horseshoe. The author's experience is that it is much easier for farriers to forge the clips into place rather than using an arc welder to position the clips. A bad weld can crack, and the alignment against the hoof wall improves with forged clips.

One should not use the four-clip shoe for more than six to eight months since the foot will start to contract too much. This contraction will by itself induce lameness by causing inflammation within the corium or the coffin bone. All the horses in Group 2 appeared to regain width after the clips at the heel were removed. However, not every treated foot returned to the same dimensions that it had before the injury. However, this seemed to be merely a cosmetic effect.

Besides the shoeing and trimming of the horse, box rest for the first three months was regarded as important so the bone could start to heal and get some strength before the start of hand walking the horse.

Type 1, 4, 5, 6 and 7 fractures were not part of this study. However, the SLU equine clinic normally treats Type 4 fractures by surgery or box rest as the straight bar shoe with four clips will not help to stabilise fracture fragments of the *processus extensorius*. The study only included the first fifteen horses that came into the clinic with Types 2 and 3 fractures. Type 6 fractures were not included since these fractures vary greatly from very small fragments that require no stabilization, to large fragments that need stabilisation. Regarding Type 7 fractures; these are only seen in foals and are at our clinic treated with box rest for two weeks, and thus not according to the shoeing protocol used for the fully grown hooves included in this study.

Conclusion

Horses with P3 fractures Types 2 and 3, treated conservatively with corrective shoeing and box rest according to the shoeing protocol used for our Group 2 horses, have a very good prognosis for a full recovery. The major benefit of conservative treatment is that the horse does not need to be exposed to the risks of general anesthesia and surgery. Alongside there being a financial benefit to the client.

Future studies

To strengthen further studies, a suggestion would be to increase the number of horses and hooves. With this in mind, the author and university are currently collecting more data to continue to evaluate if the hypothesis is further strengthened.

An assessment as to whether a straight bar shoe with four clips and an elevated heel could be beneficial for horses with other types of fractures or horses with a fractured navicular bone is planned.

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