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NEW TECHNIQUE IN EQUINE SPLINT BONE REMOVAL

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TAKE HOME MESSAGE

Partial splint bone amputation with an oscillating saw, compared to a technique using chisel and mallet, leads to significant less callus formation. Excessive callus formation can be avoided using amputation with an oscillating saw.

SUMMARY

This study contains a comparison between two different techniques of splint bone amputations in horses. It compares the amputation technique using chisel and mallet and amputation using an oscillating saw. The different amputation techniques are described and the extent of the surgical trauma and secondary bone remodelling of the remaining splint bone stump is reviewed. The study is based on 215 splint bone amputations. These 215 amputations are divided into two different groups. 116 amputations were carried out with a chisel and 99 amputations using an oscillating saw. The evaluation is based on pre- and repeated post-operative radiographs. The period of observation lasted up to 6 months. The radiographic criteria were, the regularity of the remaining splint bone stump, fissures, splintered edges or sequester formation on the stump, damage of the cannon bone and post-operative appearance of callus formation. Immediate abnormal post operative lesions on the remaining splint bone e.g. sequester - is related to a high risk of excessive callus formation. 50 % of post operative irregular amputation areas react with abnormal callus formation. Looking at the amputation plane it seemed that we get 32.8 % irregularities after using chisel amputation whereas we only saw 6.1 % with the oscillating saw. A damage of the cannon bone occurs in 2.6 % after the operation with the chisel and in 4 % after the operation with the oscillating saw. Two cases of cannon bone damage with the oscillating saw resulted in a fatal fracture during recovery from anaesthesia. Damage of the cannon bone with the oscillating saw occurred in the very early stage of this technique and could be completely prevented later on by a more careful surgical procedure. The study shows a direct connection between the frequency of callus formation and the particular amputation technique. Within a period of 2-3 month after chisel surgery we observed it in 42.2 % of the cases. Whereas we saw only 23.7 % after surgery with the oscillating saw. Excessive, uncontrollable callus formation was more often seen after the chisel technique.

INTRODUCTION

The splint bones (metacarpal bone / metatarsal bone II and IV) are medial and lateral palmar or lateral plantar to the cannon bone and are connected to it through the interosseus ligaments. These ligaments start ossifying at the age of 2 years onwards.[1]

Fractures and exostosis on the splint bones of the horse appear quite often and can occur on every splint bone.[2, 3]

The fractures are most often in the distal area.[3] Fractures are classified as involving the proximal, middle or distal third of the bone.[4] Proximal fractures only appear rarely, their share is mentioned as, approximately 5%.[5]

Distal and proximal fractures of the splint bone can result from an external trauma.[3] Especially on the distal third of the splint bone one can find fractures, which are caused by an internal trauma. It has often been described that fatigue fracture of the splint bone is caused as a result of cyclic bending through the suspensory ligament.[3,6,7,8,9] A new study describes fatigue fracture resulting from the pulling force on the splint bone buttons transmitted by the deep layer of the digital fascia. This fracture is considered to follow the repeated overload of the suspensory apparatus.[10]

Exostosis is more often seen in younger horses and mostly on the front legs.[11] They are classified related their locations. In the area of the interosseus ligament we talk about "true splint", if raising axially we talk of a "blind splint". Furthermore there are exostosis, which are created by splint bone periostal proliferation. The reason for the formation of an exostosis is a provocation of the interosseus ligament as the result of an overload onto the splint bone or an external trauma involving the periost.[3] Exostosis can also be a result of a healed up fracture of the splint bone.[5, 12]

Most authors see a fracture as a main indication for splint bone amputation because of the risk of an excessive callus formation.[1,13,14,15] The callus and secondary pseudarthrosis can interfere with the adjoining suspensory ligament.[3] One author describes that irritation of the suspensory ligament due to the callus is unlikely because it is being formed by the movement of the tendons.[2] In case of exostosis, it is recommended remove this particular exostosis.[16,17] Some authors point out that in case of excessive callus formation on the fracture side, the amputation should be more proximal, including the callus.[15,18]

Most authors describe the splint bone amputation with the chisel.[1, 3, 4, 12, 14,16,19,20] It is pointed out that the use of the chisel has to be very carefully, because “microfissures” can occur on the cutting edge. This will result in secondary new callus formation.[21] Some authors describe amputation with a wire saw[1, 22] or a bone cutting forceps.[1, 12] Splint bone amputations with the oscillating saw are not mentioned in literature at all. Comparing studies of cutting bone with either the chisel or the oscillating saw on dogs, describe smaller and delayed formation of endosteal callus using the saw. They saw decreased number of new vessel formation at the cutting edge and delayed consolidation by using the oscillating saw.[23] This effect is based on heat development during amputation which denaturates remaining bone stump.[24]

Most authors advice stabilisation by internal fixation when more than two thirds of the splint is resected. Complications after screw fixation are described by different authors.[4, 13, 15] In comparison of different methods of internal fixation, advantages have been seen using plate fixation rather than screw fixation.[25, 2 6, 27]

As a post-operative complication, a haematoma, seroma or fistula in the area of the wound have been described.[1] The most frequent complication is excessive callus formation in the area of amputation.[1, 8, 12, 15] The reason for this complication is seen in the more active periost of young horses.[4]

The aim of this study is to compare two different amputation techniques.

MATERIALS AND METHODS

Clinical material

We evaluated within a period of 6 years 215 partial splint bone amputations in 202 horses. The evaluation was set up retrospectively. The patients consisted of 99 geldings, 76 mares and 27 stallions. The most common breed was Warmblood with 156 horses; furthermore there were 25 Thoroughbreds, 8 Ponies, 6 Trotters and 7 Iceland ponies.
149 splint bones of a front leg and 66 of a hind leg were afflicted.

Clinical diagnostics

Diagnosis was made up by routine clinical examination and radiographs. The degree of lameness varied from recurrent-moderate to moderate lameness. Higher degrees of lameness were seen in combination with proximal, compound fractures of the splint bone. Soft tissue swelling was often seen in the area of the afflicted splint bone. In 157 cases the splint bone was fractured, in 83 cases combined with callus formation. In 58 cases the splint bone showed an exostosis. The cause of the lameness was ensured with a digital nerve blocks and/or local anaesthetic infiltration and by exclusion of other lameness reasons.

Groups

The splint bone amputations were divided into two groups by means of the operation technique. In group I we had 90 horses with a total of 99 amputations using the oscillating saw. Group II consisted of 108 horses and a total of 116 amputations with chisel and mallet. Both groups contained roughly the same distribution of sexes and breeds. The age of the horses treated in both groups ranged from 1 to 23 years. The average age in group I was 8.4 years and in group II 7.6 years. In group I a total of 99 splint bones were afflicted. Of these,

65 splint bones at the front leg and 34 at the hind leg were operated on. At the front legs in 41 cases the medial and in 24 cases the lateral splint bone was afflicted. At the hind legs 9 medial and 25 lateral splint bones showed a fracture or exostosis. In group II a total of 116 splint bones were afflicted. Of these, 84 splint bones at the front legs and 32 at the hind leg were operated on. At the front legs 64 cases occurred at the medial and 18 at the lateral splint bone. At the hind legs 6 medial and 28 lateral splint bones showed a fracture or exostosis. Of these, the left hind lateral splint bone with 17 cases was most often afflicted. In group I a total of 72 fractures were seen. Of these, 7 were located in the proximal, 33 in the middle and 32 in the distal third of the splint bone. A total of 27 exostosis were operated on, of which 4 occurred in the proximal, 14 in the middle and 9 in the distal third of the splint bone. In group II a total of 85 fractured splint bones were seen. Of these, 11 were located in the proximal, 35 in the middle and 39 in the distal third. A total of 31 exostosis were operated on, of which 2 occurred in the proximal, 24 in the middle and 5 in the distal third of the splint bone. A accompanying desmitis of the suspensory ligament was seen in 26 cases in group I and in 32 cases in group II. Compound fractures occurred in 5 cases in group I and in 15 cases in group II.

Surgical technique

Surgery is performed under general anaesthesia. The horse is in lateral recumbency with the affected splint bone up. The leg is fixed onto leg support of the operating table. Haemostasis is achieved by a tourniquet. The surgical area is prepared aseptically and covered with a sterile disposable plastic wound drape. The skin incision is made dorsal to the splint bone and extended distal-parallel. It exceeds the fracture side or the exostosis and the splint bone buttons. The skin is dissected dorsal and palmar/plantar from the underlying subcutaneous for about 2 cm. The subcutaneous tissue and the fascia is sharply incised and the wound is held open by the help of wound distractors. The periost of the splint bone has to be handled gently. The interosseus ligament is sharply detached starting from the location of amputation distal to the buttons. Major vessels and nerves are avoided. For the amputations of group I an oscillating saw [a] was used with a blade [a] of 6 mm width, 26 mm length and a cutting edge of 0.6 mm thickness . About 1 cm proximal of the fracture or exostosis a periosteal elevator or a scalpel blade (size 21) is inserted into the interosseus ligament. This protects the particular cannon and helps preventing upon amputation. The splint bone is cut through with the oscillating saw in an angle of 90° transversely to the longitudinal axis of the bone. During sawing rinsing with a sterile Ringer-solution helps to prevent overheating of the bone. In all our cases we use intra operative fluoroscopy to prevent injury of the cannon bone. After complete transverse dissection of the splint bone the distal portion is detached and removed, either sharp with a scalpel, or a chisel [b] and a mallet.

For the amputation in group II an osteotome [c] was used. Approximately 1 cm above the fracture or the exostosis the splint bone is cut through. The amputation plane is as small as possible to reduce the surface for secondary periostal generation. At the end of each amputation the amputation space of the splint bone stump is checked for small bony fragments followed by excessive lavaging with Ringer-solution. If small fragments are left back, this can initiate uncontrollable ossification processes. Very proximal amputations, can lead to instability of the remaining connection between the splint bone and the cannon bone. In these cases we fixed the splint bone stump to the cannon bone with either one or more 4,5 mm cortical screws in neutral fashion In case of a chronically desmitis of the suspensory ligament, a longitudinal splitting is done simultaneous.

Figure 1: Oscillating saw used for splint bone amputation

[a] Synthes Product, manufactured by Mathys Medizinaltechnik AG, Güterstrasse 5, CH – 2544 Bettlach, Switzerland

[b] Mini Lambotte “8mm width”, manufactured by Medicon eG, Postfach 4455, D – 87509 Tuttlingen, Germany

[c] Osteotome “12mm width”, manufactured by Medicon eG, Postfach 4455, D – 87509 Tuttlingen, Germany

For wound closure neither periost nor fascia is sutured. The subcute is closed with absorbable suture material. In case of infected wounds, a Penrose drain was placed for 3 consecutive days. The skin was stapled [d] with skin staple device. The wound is covered up with sterile gauze and a padded bandage is put applied, which as a rule staid on for one week. The horses were medicated with tetanus prophylaxis and if needed with parenteral antibiotics. Staples were removed 10 days after surgery. The horses were kept in a stable for 3 weeks. After this a period of 3 weeks walk in hand twice daily is followed by 3 weeks of riding walk. All horses were re-checked after 0-4 days and 2-3 month after surgery.

Criteria for the observation of the operation

By the means of the operating reports and the post-operative X- rays the area of the splint bone amputation, the angle of the cut and an eventual screw fixation was recorded.

Criteria for observation of the follow up studies

The first postoperative check up was after 0 to 4 days (period I). Further check followed after 2 to 3 months or 61 to 89 days (period II), and after 3 to 6 months or 90 to 179 days (period III). Individual patients records served for monitoring lameness, wound healing and a abnormal sensitivity of the amputation area.

The X- rays were examined for and rated as:

1: No abnormality detected
2: Irregularity on stump
3: Fissure(s) at stump
4: Sequester in operated area
5: Splintered edge at stump
6: Damage of cannon bone
7: Callus formation at the stump

In case of callus formation, the size of the callus was measured and subdivided in: low degree, middle degree and high degree. In these subdivisions we look especially at callus development exceeding the size of the remaining stump. The assessment “low degree” is given for new formation of bone, which was 0.1 to 0.5 times bigger in size than the diameter of the splint bone. ”Middle degree” corresponded to a new formation, which was 0.6 to 1 and “high degree” was more than 1.1 times bigger than the splint bone. The formation of callus distal to the amputation area and therefore in the former location of the splint bone is assessed “low degree“, regardless of its size.

RESULTS

In group I a total of 99 splint bones were partially amputated with the oscillating saw. Of these, 31 amputations were in the distal, 44 in the middle and 24 in the proximal third of the splint bone. In group II a total of 116 splint bones were partially amputated with the chisel, of which 31 were in the distal, 62 in the middle and 23 in the proximal third of the splint bone. The angle of the amputation as a rule was 90° with the oscillating saw; in 7 cases an angle of 80° was achieved. The amputation with the chisel was in an angle between 10 and 80°, with an angle of 55° mostly used. In group I - 4 splint bones stumps were fixed with a screw. In 8 cases of group II the splint bone stump was fixed with a screw to the cannon bone.

Disorders of wound healing like a haematoma or a seroma appeared in group I in 9 cases.

One horse developed a fistula, which had to be treated surgically. In group II haematoma or seroma formation developed in 21 horses. Two horses got a fistula, which also had to be treated surgically.

SUMMARY OF RESULTS

An irregularity on the amputation stump was noticed post operatively in 6.1 % within group I and in 34.5 % within group II. Group II showed significantly ($p < 0,01$) more irregularities. In half of the cases in both groups a callus formed after a post-operatively irregularity.

An early callus formation did not appear in group I, but did in 6 % of the horses in group II. A callus formation up to period II happened with 24.0 % of the splint bones in group I and 42.2 % of group II. A callus formation appeared significantly ($p < 0,01$) more often in group II.

In group I - 67.7 % did not develop a callus formation up to period I, 24.0 % form a “low degree“callus and 8.3 % are lost for follow ups. A “medium degree“or “high degree“callus did not occur. In group II, during the same period of time, no callus was formed in 46.6 %, a “low degree“ callus developed in 36.2 %, a “medium degree” callus in 4.3 %, a “high degree“ callus in 1.7 %. In 11.2 % no follow ups were available. The testing of Significance is done by students p-test.

Figure 2: Amputated splint bone stump using oscillating saw, postoperatively,

[d] Royal 35 W Single use skin stapler, manufactured by United States Surgical, a division of Tyco Helathcare Group LP, Norwalk, Connecticut, 06856 USA

Figure 3: Splint bone stump with excessive new bone formation after amputation using chisel

DISCUSSION

The distribution of the patients into group I and II seems to be roughly equal. Especially the number of the proximal, medial and distal located amputations was balanced. This seemed to be important, because proximal fractures do more often create post operative complications.[25, 28]. The number of the infected wounds in both groups was different. There were three times more infections in group II than in group I.

Post operative complications, seroma and haematoma appeared in group I in 9 cases and in group II in 21 cases. In both groups this complication occurred because of wound infection before surgery. The greater occurrence in group II was related to three times higher number of infected wounds.

Another complication frequently mentioned in literature is a callus formation at the splint bone stump.[1, 4, 8, 12, 15] This can lead to irritation of the adjoining suspensory ligament.[3] The most frequent complication in this study is abnormal callus formation. An amputation area, with irregular appearance after surgery, reacts in half of the cases with callus formation. However in group II irregular amputation area is 5 times more frequent. A regular amputation plateau is more difficult to achieve using a chisel than an oscillating saw.

In spite of no obvious radiographic abnormality after surgery some of the cases do develop a callus. In group I, 22.0 % react like this and in group II 34.0 %. An early callus formation within 2 to 4 days after amputation was only seen in group II, in one of these cases, it was related to a damage of the cannon bone. The other 6 cases did not show any abnormalities on the amputation stump.

In group II callus formation happens in one case after a fissure and in one case after a sequestrum. This does not happen in group I. Problems related to callus formation are especially seen, if there is an *excessive* production of callus.[1, 8, 12, 15] An excessive callus production appears more often after the chisel technique. After the amputation with an oscillating saw callus is formed in one case (1.0 %) in a “medium degree”. In all other cases of callus formation a “low degree” callus appears. After the chisel technique, 7 cases (6.0 %), appear with a “medium degree” and 3 cases (2.6 %) with a “high degree” callus formation, in all the other cases “low degree” callus developed.

In group I a total of 3 horses required a second operation to remove this callus. In group II this number is with 6 horses much higher. In addition to this, 2 more horses had to undergo peripheral neurectomy.

A young and active periost is presumed to be the reason for a callus formation at the splint bone stump.[4] This can be contradicted by this study, because the average age of the horses with a callus formation after surgery, in both groups, is 7.7 years and therefore only just under the average age of 8 years for the entire group of patients in this study.

The present study shows, that there is a direct connection between the amputation technique and callus formation. In case of an amputation with the chisel callus formation appears significantly more often and more excessively, than with an amputation by the oscillating saw. Irregular amputation, splintered edges or fissures in the area of amputation can be reason for increased callus formation. For cases, that did not show any irregularities of the stump, but still show callus formation, hidden or non detectable stump lesions can be presumed. Some authors already presumed, that the appearance of “microfissures” after the use of a chisel, could lead to a callus formation.[21]

Damage of the cannon bone is seen in both groups, although the damage in group I, caused by the oscillating saw, was in two cases so severe, that a fracture of the cannon bone resulted. In the other cases, the cannon bone reacted with a callus formation. The damage to the cannon bone, caused by the oscillating saw, occurred during the introduction of this new technique. This fatal complication can be avoided by a more careful surgical procedure including significant protection of the neighbouring cannon bone. Intra-operative fluoroscopy can act as a major tool in preventing iatrogenic cannon bone damage.

On the basis of this study the splint bone amputation by an oscillating saw is recommended. The good results of this amputation technique are based on a more regular stump and therefore a smaller area for a callus formation. The amputation area is much smaller than the amputation area created with a chisel. In case of an amputation with a chisel, a transversal amputation is not possible and therefore a larger space of amputation is produced. Especially because of the small amount of callus formation and a smaller extent of a callus production, the oscillating saw technique is recommended. The influence of heat development and resulting denaturizing of the cutting edge by the oscillating saw[24] was not looked at in this study. This could be an additional effect for the good results achieved with the oscillating saw.

References available from author upon request.