TRAITEMENT DES FRACTURES : QU'EST-CE QUI RESTE PROBLÉMATIQUE ?
QUE SAURA-T-ON FAIRE DEMAIN ?

FRACTURE TREATMENT: WHAT REMAINS PROBLEMATIC? WHAT DO WE NEED TO DO TOMORROW?

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Résumé : Le traitement des fractures a été amélioré chez le cheval au cours de la dernière décennie. La gestion de la fracture commence avec des premiers soins de qualité et le transfert du cheval vers une clinique disposant d’UNE expertise chirurgicale et anesthésique adaptée, ainsi qu’un équipement conséquent. Cette étape doit être suivie de la mise en œuvre des bonnes pratiques d’anesthésie, d’immobilisation de la fracture et de réveil. Elle finit par une bonne conduite post-opératoire à court et à long terme. Si l’une des maillons de cette chaîne manque, le pronostic est gravement obéré.
L’implant le plus prometteur de ces dernières années est la plaque LCP (locking compression plate) de Synthes Inc., qui a été utilisé avec succès dans les fractures du cheval. La combinaison de ce principe avec des plaques plus fortes augmentera les possibilités du chirurgien équin.
Des protocoles fonctionnels pour l’utilisation de facteurs promouvant la rapidité de la guérison de la fracture restent une attente forte. Il ne suffit pas d’ajouter des facteurs de croissance à un os fracturé, mais il est important d’apporter les bons produits au bon moment et à la bonne concentration.
La formation permanente en fixation des fractures – des principes de base comme des techniques avancées – est disponible, mais n’est pas toujours utilisée de façon adéquate par les vétérinaires.

Mots clés : plaque LCP, ciments biodégradables, réveil anesthésique

Abstract: Overall fracture treatment in horses has improved during the past decade. It was realized, that the fracture management starts with the proper first aid treatment and the transport of the horse into a clinic equipped with the necessary surgical and anesthetic expertise as well as the equipment, continues with the actual anesthesia, fracture fixation and recovery form anesthesia and ends in the short-term and long-term postoperative management. If just one part in this chain fails, the prognosis for a successful result is greatly jeopardized.
The most promising implant developed in recent years is the locking compression plate by Synthes Inc, which was successfully applied in equine fractures. The combination of this design with stronger plates will increase the possibilities of the equine surgeon.

Functional protocols for the use of growth factors that may accelerate fracture healing are desperately needed. It is not enough to just add growth factors to a fractured bone, but it is important to provide the right ones at the right time in the right concentration.

Continuing education in fracture fixation – basic principles and advanced techniques - is available but often not adequately used by the veterinary surgeons.

Key Words: Locking Compression Plate, Biodegradable Cements, Anesthetic Recovery

Introduction

Presently there are many equine surgeon and practitioners that perform fracture treatment on more simple fractures with reasonable success. Fracture repair by means of screws inserted in lag fashion are still the most frequently performed fracture fixations. When it comes to long bone fracture, repair things become more complicated. Not only is the surgical expertise of paramount importance but also the availability of adequate implants and of adequate numbers. To have available one plate and 3 screws of each size is often not enough, because in most cases double plating is applied and e.g. in a cannon bone there may be a need of more than 3 screws of the same size. The surgeon should not jeopardize an initiated surgical intervention because of a lack of adequate implants.

This presentation will address the present situation of fracture treatment, illuminate what is desired and how we may reach further improvements.

What have we achieved until now?

First aid and transport of the fracture patient

As it is in human medicine, it is clear that the management of the equine patient doesn’t start when the horse is admitted to a clinic, but it starts out in the field, as soon as possible after the fracture occurred (4). The way the patients is handled and transported plays a key role in the possibilities the surgeon has for the fixation, the postoperative recovery, healing phase and eventually in the prognosis for future use of the horse. In Switzerland, we are in the lucky position of having a professional horse rescue organization, which is able to rescue a horse out of any imaginable situation, provide state of the art first aid and transport to the clinic desired. The use of this organization in the first aid management and transport of horses with fractures has resulted in an improvement of the success rate in fracture treatment at the equine clinic of the Vetsuisse Faculty in Zurich. The horses arrive now generally in good physical condition with excellent external coaptation of the fracture.

Fracture fixation
Great strides have been made in recent years in the technique of fracture fixation and in the development of new implants (1). Synthes Vet (a branch of Synthes Inc. Solothurn, Switzerland) has developed a special Equine limited contact compression plate (LC-DCP), which is 1mm thicker than the regular dynamic compression plate (DCP). This plate is much stiffer than the regular plates and compression can be achieved from either side of each plate hole, which makes the designation of a “middle” of the plate unnecessary. Also the plate is designed such that on every cross-section along the plate the same amount of stainless steel is present, which corrects the previous problem with the standard plates, where the regions of the plate holes had less material, making it to a stress raiser. Therefore this new plate is easier to contour and withstands greater loads. The use of the larger 5.5mm cortex screws in strategic places along a fixation construct also increases its strength (1).

Plate luting has helped increasing the stability of fracture repair constructs significantly and is presently advocated in most long bone fracture repair in adult horses (6).

The introduction of the locking compression plate (LCP) by Synthes Inc has further improved the possibilities of equine fracture treatment. The plate holes are designed such that either a regular cortex screw or a locking screw can be inserted through each plate hole. The heads of the locking screws have threads, which complement the threads in the plate holes. The locking screws can only be inserted perpendicular to the long axis of the plate and transform the construct into an internal fixator, preventing any longitudinal movement between the screw heads and the plate during loading (1) (Fig. 1).

The introduction of this new plate has also spurred the interest in minimally invasive plate fixation, which may further reduce morbidity and mortality in equine fracture repair (5).

**Anesthesia and postanesthetic recovery**

The type of anesthesia administered to the equine patient plays a very important role for the outcome of the fracture repair. It is of utmost importance that the patient is kept in an as light anesthesia plane as possible while making sure that it doesn’t neither move nor feel pain (8). Recently some major advances were achieved with injection anesthesia, which also facilitates a smoother recovery period (2). The term “balanced anesthesia” will become more and more familiar to equine surgeons, because this is what we should strive for. Again, a smooth recovery period with ideally one try to rise to a standing posture is the goal of any anesthesia and can be achieved with balanced anesthesia. Aside from the state of the art recovery box, the recovery pool at the Vetsuisse Faculty in Zurich has proofed to be an excellent investment to which the patients get easily accustomed (3) (Fig. 2). One of the major benefits of this type of recovery is found in the fact that the surgical implants and the fracture repair do not get overly pre-stressed during multiple tries to get up.

**Postoperative management of the fracture patient**
In selected cases, especially in more distal fractures, fiberglass cast are applied for initial postoperative period. It is still advocated to administer perioperative antibiotics and to continue for several days. Patients that tend to lie down and get are better kept in a rescue sling to prevent any excessive stress on the implants. Contrary to earlier believe, most horses tolerate these devices very well.

**Improvement of fracture healing**
Extensive research activities are undertaken to develop materials with osteoinductive osteoconductive, , and osteopromotive properties, as well as protocols for their application in patients. Obviously, BMP’s and other growth factors are also under investigation. PTH in low doses suspended in a hydrogel has shown very good results in the treatment of subchondral bone cysts and possibly can be applied to fractures as well.

**What else is needed?**

**Implants**
To further advance equine fracture treatment we need stronger implants with the LCP design, e.g. the Equine LC-DCP with the combi-holes of the LCP. Additionally the slightly curved human LCP’s should also be available in the same thickness as the Equine LC-DCP. A variable-axis locking screw would be of great benefit and allow the implantation of these screws in any angle desired.

**Biodegradable bone adhesives**
For multifragment fractures in horses the availability of a biodegradable bone glue of superior strength with a transformation to bone within 3 months would be invaluable. With such a material the fragments could be “puzzled” together and subsequently supported by means of internal fixators.

**Acceleration of fracture healing**
The development of effective protocols for application of growth factors, possibly delivered through paramagnetic nano particles to the desired location would be a big help.

**How do we go about realizing it?**

**AOVET & Synthes Vet**
The veterinary members of the AO Foundation throughout the world, also known as AOVET members in concert with the veterinary division of the worldwide leading implant manufacturing company, Synthes Inc. also known as Synthes Vet are continuously working on new implants to improve the fracture management in equine patients. Additionally other creative surgeons together with implant manufacturers are working on new approaches. Hopefully the trend of improved implants continues over the next decades,
Teaching the proper techniques is an important aspect of general improvement of fracture treatment. The above-mentioned groups are regularly organizing basic principles and advanced techniques courses all over Europe and the World to help surgeons to raise their skill levels.

**Research funds**

Development of new implants and fracture healing materials requires large funds. Unfortunately, Equine patients do usually not profit from NIH and/or National Research Foundation funds across the world. To a certain aspect this is ok, because of the ethical aspects of conducting research, which eventually requires euthanasia of the horses. But exactly this aspect also is responsible that the progress is very slow. The Jockey Club, the Grayson Foundation, the Morris Animal Foundation etc. are exception to the above statements, but are mainly accessible to American researchers. Unfortunately it much more “sexy” to sponsor equine events, where the sponsor is in the limelight during the competition and awarding of the prizes, than sponsor and support research for horses. We have to be active to change this attitude.

**Research cooperation with humans**

A good avenue is to conduct research in conjunction with implant- and biomaterial companies and the human patient in mind. To acquire basic information, small ruminants are frequently used where reliable research models are presently being developed. The results are frequently applicable for equine fracture patients, where the can be immediately applied in clinical cases. Duplication of research projects should be avoided, requiring good communication among researchers across the world. However, the ethical aspects of conducting research on animals and horses especially have to kept in mind at all times. It is not acceptable that research projects, which are not accepted in some countries, are being “farmed” out into countries with lower ethical standards.

**Specialization**

To achieve additional progress in the management of complicated fractures, it is important to form specialized centers, such as the Equine Hospital in Zurich, where not only the surgical expertise and necessary implants are available, but also the facilities and the anesthetic expertise. We slowly reach the threshold where we have to realize that an equine surgeon cannot be a specialist in all types of surgery anymore. The present trend in human surgery for a long period of time doesn’t stop when it reaches equine surgery.

**References:**


Figures and Legends

Figure 1:
Graphic representation of the combi hole, which is found in the locking compression plate (LCP) (Synthes Inc. Westchester, PA). A standard cortex screw can be implanted through the left (non-threaded) side of the combi hole, which represents one half of a Dynamic Compression Unit (DCU) hole (below left). A special locking screw with complementary threads manufactured over the screw head to the threads in right (threaded) sided of the combi hole (below right). Obviously only one screw can be inserted through one combi hole.

Figure 2:
Left: The patient is lowered into the recovery pool after internal fixation of a comminuted Radius fracture. Note the fracture site was covered with an Ioban adhesive incise drape and protected with elastic adhesive tape only. Right: The patient rests comfortably in the rescue sling in immersed in the recovery pool. The head is positioned with the help of 4 ropes that are tied to the protective frame located on either side of the pool. The head rests on an inflatable mat, preventing it from aspirating water through the endotracheal tube. Once the horse is able to stand on the table top immersed in the pool, the table is raised the level of the floor and in doing so it pushes the horse out of the water.