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Data of implant stability after minimally invasive plate osteosynthesis in dogs

KEYWORDS: MIPO, plate span ratio, screw density, dog

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ABSTRACT *Relative stability promotes a flexible fixation with postoperative early mobilization of the limb allowing micro-movements in the fracture site. Through this study, we aimed to highlight data of minimally invasive inserted plates selection. When compared to classical techniques which tend toward absolute stability with its advantages and disadvantages, MIPO technique (Minimally Invasive Plate Oseteosynthesis) aims to promote relative stability. So, sole purpose of MIPO is to restore axis, restore rotational alignement and respect fragment biology.*

The study was conducted in the Department of Surgery, Faculty of Veterinary Medicine from Timisoara and integrated 10 patients with long bone fractures. They underwent MIPO. We investigated as stability indices the screw density (SD) and the plate span ratio (PSR). Data from MIPO was compared to a 10 dogs group that underwent ORIF, as a regular procedure.

INTRODUCTION

Stability, in orthopedics, is defined as the degree of displacement between the fragments involved in a fracture and stiffness as the capacity of the implant to oppose deformation (Wagner & Frigg, 2006).

Absolute stability means lack of displacement and demands interfragmentary compression (Wagner & Frigg, 2006). Relative stability promotes a flexible fixation with postoperative early mobilization of the limb allowing micromovements in the fracture site. Perfect apposition of the fragments is not necessary and the expected large amount of callus is that to fill and cover the fracture line restoring mechano-biological environement of the bone (Wagner & Frigg, 2006; Tong & Bavonratanavech, 2007).

Stability provided by plate-screw assembly applied through minimally invasive technique, characterized by several indicators (in particular, the plate span ratio and the screw density) shows data related to the degree of motion in the fracture site, the rotational and bending stiffness and the capacity of implant to compensate alterated bone function until healing.

Through this study, we aimed to highlight data of minimally invasive inserted plates selection. When compared to classical techniques which tend toward absolute stability with its advantages and disadvantages, MIPO technique (Minimally Invasive Plate Oseteosynthesis) aims to promote relative stability. Therefor, sole purpose of MIPO is to restore axis, restore rotational alignement and respect fragment biology (Babst & Bavonratanavech, 2012).

Selection of plates for minimally invasive ostesynthesis is based on choosing an assembly ready to offer relative stability and, at the same time, to minimize the risk to failure.

MATERIALS AND METHODS

The study was conducted in the Department of Surgery, Faculty of Veterinary Medicine from Timisoara and integrated 10 patients (dogs) X-ray diagnosed with diaphyseal comminuted fractures of long bones (humerus, radius, femur and tibia), resolved by applying metal plate-screw assemblies by minimally invasive technique. They were compared with data obtained from cases solved by conventional surgical technique (Open Reduction Internal Fixation) with same fracture pattern.

Immediately postoperative, we calculated two parameters cited in the literature as leading indicators in the selection of metallic implants in humans:

- Screw Density (SD) - represented by the number of screw and number of holes ratio.
- Plate Span Ratio (PSR) – represented by plate length and fracture length ratio; expresses how many times the plate is longer than the fracture.

Fracture length is expressed in millimeters and it is measured as the distance between the most proximal and most distal point of the fracture. The plate length is distance between the proximal and the distal end of the plate. The degree of countering of the plate alterates the length of the plate reffered by the manufacturer.

Radiographic evaluation was carried out by conventional radiography using this Siremobil Compact L (Siemens) device (intraoperatory assessment of fracture reduction) and radiological facility type Multix Swing (Siemens). Image processing was done via the computerized radiography (CR) CR Vista Direct View (Caresteam) and AQS Vet Standalone software (Arzt + Praxis GmbH).

Statistical analysis of data was performed by ordering basic mathematic indices and comparing the two groups.

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RESULTS AND DISCUSSION

Our results are submitted in the following table (Table 1):

Table 1. Mean values of screw density and plate span ratio

INDICE	ORIF		MIPO	
	Mean	StDev	Mean	StDev
SD	0,69	0,15	0,44	0,06
PSR	8,92	7,54	7,12	4,93

Both screw density and plate span ratio are two indicators that are needed when determining the ideal length of the plate. Basically, plate span ratio shows the ability of the plate to cover the fracture. Some authors state, from their own experience, that this indicator should have values greater than 2 or 3 for multifragmentary fractures and higher values 8 or 9 for simple fractures (Wagner & Frigg, 2006; Tong & Bavonratanavech, 2007). In our study, PSR values were above 7, namely, 8.92 for ORIF group and 7.12 for MIPO group, meaning that in case of ORIF, the plate is 8.92 times greater than the fracture and in case of MIPO 7.12 times (Fig. 1).

Screw density. SD value for MIPO group was 0.44 and 0.69 for ORIF group (Fig. 2). Authors recommend values less than 0.5 - 0.4, expressing the fact that in less than half of the holes in the plate are inserted screws (Tong & Bavonratanavech, 2007).

These two indicators are useful (sometimes required) for the selection of the plate because every implant must meet specific biomechanical requirements of each type of fracture. In terms of mechanical concepts, loading of the plate and screws should be minimal in order to avoid failure of the assembly beacause of repeated stress or loss of screws due to individual overload (Wagner & Frigg, 2006; Tong & Bavonratanavech, 2007).

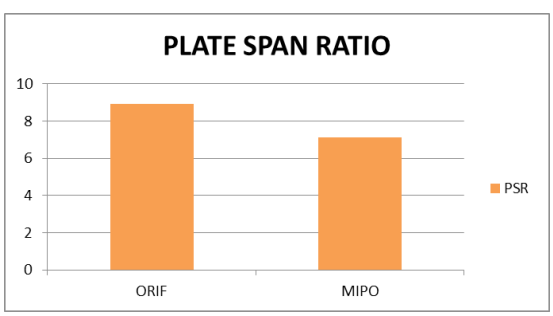

Figure 1. Graphic rendering of PSR mean values for MIPO and ORIF groups

Overall, for MIPO it is recommended to use the longest possible plates, supporting the principle that the higher stability is and the weight-bearing function is more efficient as the plate is longer. Basically, there is no advantage in the using a shorter plate since the plate is inserted through same size incisions (Tong & Bavonratanavech, 2007).

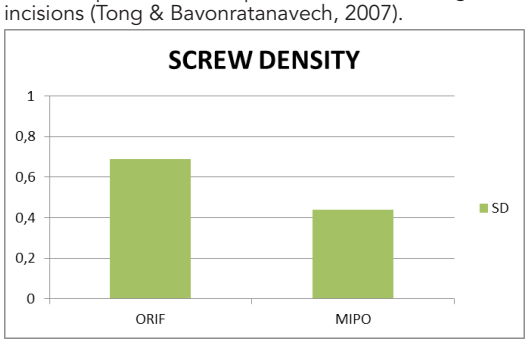

Figure 2. Graphic rendering of SD mean values for MIPO and ORIF groups

From the biomechanical point of view, two screws in each main fragment would be enough. But a screw overload and, ultimately, failure leads to destabilization of the whole fixation system. It is recommend to insert three screws (Tong & Bavonratanavech, 2007; Pozzi *et al.*, 2008; Hudson *et al.*, 2009). The number of screws will be reduced in epi-/metaphyseal sites and will be increased when bone quality is low (osteoporosis) (Tong & Bavonratanavech, 2007).

Ideal implants used to achieve relative stability are Locking Compression Plates (LCP). They can be used as compression plates when the screwss are inserted into unthereaded holes (Ruedi *et al.*, 2007). Therefore, LCP can accommodate both a conventional screw and a locking head screw (LHS) (the head of the screw is conical and threaded). So, half of the hole has the standard design for LC-DCP (Limited Contact – Dymanic Compression Plate) and DCP (Dymanic Compression Plate) - compression screw and the other half of the hole is for locking screws, which ensures the angular stability (Johnson *et al.*, 2005).

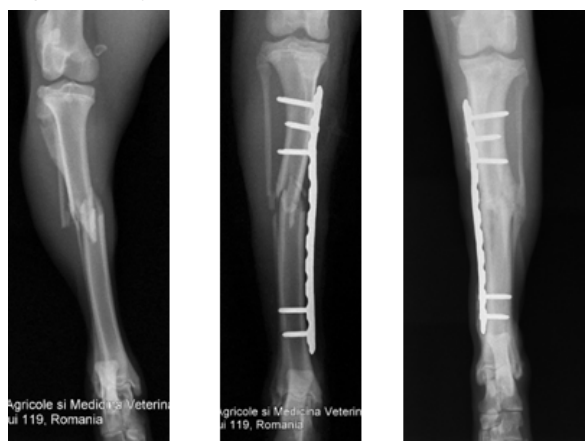

Figure 3. Displaced, mid shaft, comminuted fracture of the tibia in 2 years old, cross-breed dog. (a). Preoperative image. (b). Imediately postoperativ. (c). 7 weeks postoperativ.

MIPO has all the biomechanical advantages of the classic method, the aim of absolute stability being replaced with a more „elastic", more flexible fixation that allows micromovements in the fracture site promotting indirect healing and massive callus formation (Nikolaou *et al.*, 2008) (Figura 3). Flexible fixation favorizes callus formation, while closed, indirect reduction, although, less precise, reduces iatrogenic trauma during surgery (Perren, 2002). According to some authors, this type of fixation is more resistent/solid when compared to methods that promote primary/ direct healing with minimum callus (Nikolaou *et al.*, 2008).

Hass *et al.*, 2003 cited by Igna (2011) states that secondary bone healing takes place when the method of fixation allows a certain degree of instability. Radiologically, there it is noted a solid periosteal callus (Igna, 2011) (Figure 3).

CONCLUSIONS

Both groups showed adequate values of the plate span ratio (7.12 - MIPO, 8.92 - ORIF), greater than 2.

Screw density value was 0.44 for MIPO group falling within the limits given in the literature (under 0.5 - 0.4), while the ORIF group (0,69) has exceeded the recommended screw density.

The two indicators may be used in the selection of plates for both MIPO and ORIF in veterinary orthopedics as in human medicine.

These indicators should be considered as an important step in the preoperator planning for MIPO.

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