MECHANICAL DURABILITY OF TWO EXTERNAL FIXATOR CLAMPS FOR JAM FIXATOR IN SMALL ANIMALS

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Introduction

External skeletal fixation has become a well established treatment modality for many traumatic and degenerative orthopaedic defects in dogs and cats. During the last decade many of the significant developments in external skeletal fixation has been introduced [1-2]. The changes including improvements in implants, new materials for fixator elements and new fixators based on high technology. The JAM external fixator is one of the most popular fixator for fracture treatment in small animal orthopaedics. It is simple, but versatile modular construction, which allowed to construct complex frames for fracture treatment, traumatic luxation, arthrodesis and other diseases where the multiplanar configuration of fixator is necessary. The JAM fixation clamps have a two-piece clamp body, which allowed to remove or add fixation clamp from the frame at any time [3].

The paper present the biomechanical study of two different clamps of JAM (Meynard) fixator.Two external stabilizers have been investigated for their mechanical durability and suitability in orthopaedic surgery of small animals. Two JAM Meyerd stabilizers were compered the first with standard steel clamps and the second with polymer clamps (polyamide 66, PA 66). It has been shown that in spite of poor mechanical performance, polymer stabilizer may be an alternative to conventional steel clamps.

Materials and Methods

Meynard type stabilizer clamps made of medical grade stainless steel (316L) and polyamide (PA66 Termoplastik) clamps (supports/screws) were tested. Mechanical testing of the stabilizer was performed on a model system during cyclic axial load testing (stretching and compression) of the device. Cycles illustrated the effects of loading bone during real convalescence. Three basic parameters were analysed:

- plastic deformation energy (dissipate energy) (ΔW_{pl}) - determined surface area of the hysteresis loop recorded for a single cycle,
- difference in plastic elongation (ΔL) - read for a force equal to 0, for three random loops from each turn,
- maximum strain (F_{max}) readings for single hysteresis in load cycle.

All tests were carried out on the universal machine Zwick 1435.Matlabsoftware was used to analyse the mechanical results (bubble test for data sorting). Origin software for mathematical data processing was used.

Results and Discussion

All mechanical results are presented in TABLE 1. It's shown that better mechanical parameters then traditional stainless steel clamps. Fixator with polymer clamps characterised higher elasticity and lower stiffnes. This means that the fixator with PA66 will maintain the specified gap to an accuracy of 0.3mm for shorter time than the steel fixator. The indicated differences do not significantly affect the quality of the machine throughout the fatigue test (1000 cycles under the same conditions). Higher system flexibility and lower stiffness of the stabilizer with polyamide clamps compared to the steel stabilizer are limits the number of applications. However, due to its lighter construction and X-ray transparency in contact with PA66, it is an alternative to steel fixators used for osteosynthesis (FIG. 1).

TABLE 1. Summary of experimental results of mechanical tests.

	mass, g	plastic deformation energy, mJ	difference of plastic elongation, mm	maximal strain for maximum elongation, N
steel clamps (316L)	12.5± 0.19	4.8±0.22	0.0708	44.9±1.84
polymer clamps (PA66)	4.2± 0.05	7.6±014	0.218	30.6±2.56

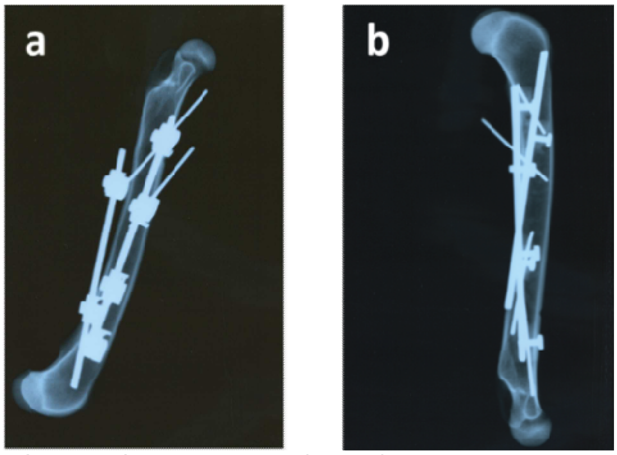

FIG. 1. RTG photography of JAM fixators with steel (a) and polymer clamps (b) fixed in rabbit bones.

Conclusions

As many fixators, which elements was made of steel, JAM fixator is heavy, particularly when is used for small animals and the radiographic assessment of bone is impaired due to metal component on radiographs. To eliminate this drawback, for clamp construction we used the Polyamide PA66, which weigh less than comparable steel clamps and is radiolucent.

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References

[1] D. Lewis *et al* J Small Anim Pract, 42 (2001) 103-109.
[2] K. Kraus *et al* Vet Surg, 27 (1998) 224-230.
[3] R. Gilley *et al* Vet Surg, 30 (2001) 341-350.