Biomechanical comparison between pins - polymethylmethacrylate to the "String of Pearls" interlocking plate system (SOP) to stabilize canine lumbosacral fracture-luxation.

Figure 1: Stabilization was performed using 3.5 mm SOP Locking plates (Orthomed UK Ltd, Halifax, UK) bilaterally, with 3.5 mm cortical screws anchored in the L6, L7, S1 and S2 vertebral bodies.

Figure 2: The pins were bent to achieve maximum overlap of caudal, lateral, right, and left pins at a level just below the dorsal spinous possesses' dorsal edge. PMMA was applied dorsally to bond all the pins, articular facets and dorsal spinous processes of L7 and S1.

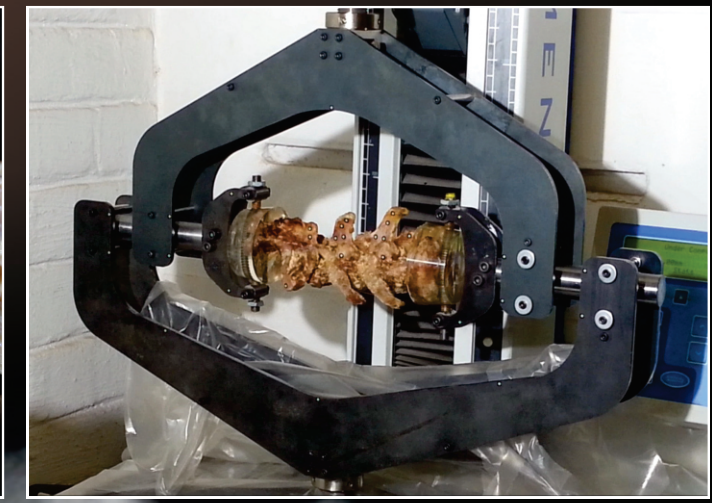

Figure 3: Free Bending Canine Spinal Loading Simulator (FBC-SLS) designed to subject the spine segment to a pure bending moment at the cranial and caudal ends, while still allowing translation along the craniocaudal and/or rotation about this axis.

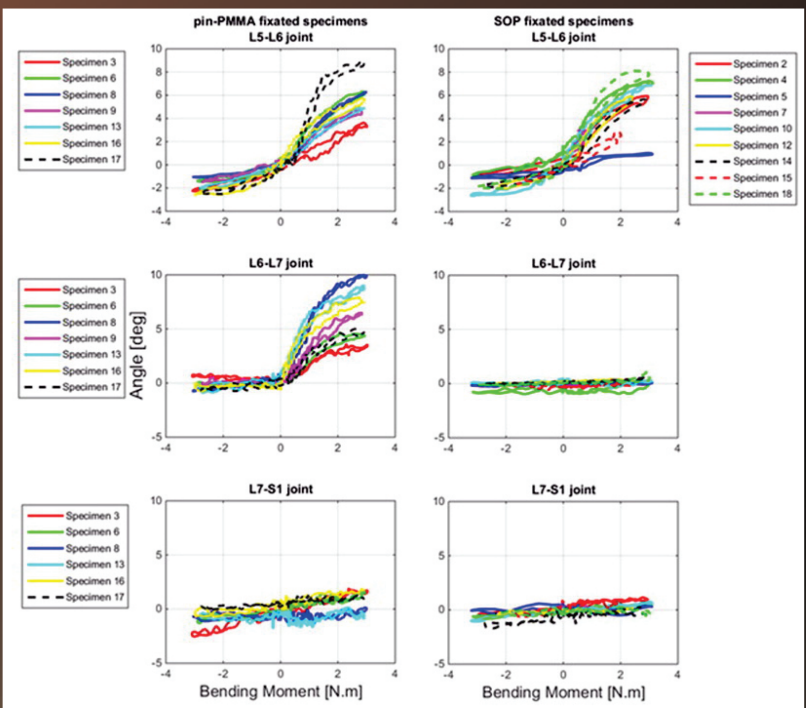

Figure 4: Bending moment – angle characteristics of the three joints of the spine segments fixated with the pin-PMMA and SOP techniques.

Table 1: Biomechanical parameters of the injured joint fixated with the two fixation techniques. p-values indicated in **Bold** is >0.05 and implies that the null hypotheses $(H_0: \mu_{pin\text{-}PMMA} = \mu_{SOP})$ cannot be rejected and is considered to be true.

Biomechanical parameter	L5-L6 PMMA (n=7) SOP (n=9)		L6-L7 (n=7) (n=9)	L7-S1 (n=6) (n=9)
NZ(+) flex [deg]	PMMA	: 0.23 ± 0.21	0.48 ± 0.37	-0.088 ± 0.53
	SOP	: 0.36 ± 0.54	-0.063 ± 0.23	0.18 ± 0.35
	p-value	: **0.5604**	0.0070	**0.3458**
NZ(-) ext [deg]	PMMA	: -0.14 ± 0.17	0.092 ± 0.35	-0.34 ± 0.43
	SOP	: -0.019 ± 0.51	-0.18 ± 0.25	0.0041 ± 0.35
	p-value	: **0.7913**	**0.1530**	**0.1255**
NZ total [deg]	PMMA	: 0.37 ± 0.2	0.39 ± 0.22	0.26 ± 0.17
	SOP	: 0.38 ± 0.22	0.12 ± 0.069	0.17 ± 0.16
	p-value	: **0.9578**	0.0129	**0.3458**
RoM(+) flex [deg]	PMMA	: 5.9 ± 1.7	6.7 ± 2.4	1.2 ± 0.82
	SOP	: 5.2 ± 2.3	0.44 ± 0.33	0.69 ± 0.37
	p-value	: **0.7913**	0.0009	**0.2386**
RoM(-) ext [deg]	PMMA	: -1.9 ± 0.57	-0.54 ± 0.39	-1.3 ± 0.84
	SOP	: -1.5 ± 0.76	-0.4 ± 0.27	-0.69 ± 0.42
	p-value	: **0.2664**	**0.4914**	**0.1255**
RoM total [deg]	PMMA	: 7.8 ± 1.9	7.3 ± 2.7	2.5 ± 1.2
	SOP	: 6.7 ± 2.8	0.84 ± 0.31	1.4 ± 0.51
	p-value	: **0.7913**	0.0009	0.0251
EZS(+) flex [N.m/deg]	PMMA	: 0.74 ± 0.49	0.39 ± 0.47	0.52 ± 0.56
	SOP	: 0.42 ± 0.85	0.21 ± 0.46	-0.34 ± 0.64
	p-value	: **0.7913**	**0.6338**	0.0184
EZS(-) ext [N.m/deg]	PMMA	: 0.36 ± 0.32	-0.072 ± 0.77	0.2 ± 0.82
	SOP	: -0.091 ± 1.4	0.033 ± 0.21	-0.21 ± 0.74
	p-value	: **0.9578**	**0.9578**	**0.4094**

Introduction

Biomechanical comparison of two internal spinal fixation techniques, applied to a surgically simulated complete spinal injury at L7-S1 was conducted. The study objective was to compare the stability provided by the two fixation techniques to the fracture-luxation.

Materials and Methods

The hypothesis was that lumbosacral fracture-luxations can be stabilised with two bilateral SOP plates, anchored in L6, L7, S1 and S2 vertebral bodies (Figure 1) and that this method of stabilisation would be as stable during flexion and extension as the conventional method of using 4 positive profile end-threaded pins and polymethylmethacrylate (PMMA) anchored in the vertebral bodies of L7 and S1 (Figure 2).

Cadaver specimens of 18 skeletally mature large-breed dogs (29.84 ±2.49 kg, mean ±1SD) with no history of spinal trauma and no signs of degenerative lumbosacral pathology were used. The lumbosacral spine specimens (L5-S3) were randomly divided into two equal groups and fixated using one of the two techniques.

The specimens were then subjected to a constant bending moment applied to the caudal and cranial end of the specimen via the Free Bending Canine Spinal Loading Simulator (FBC-SLS) (Figure 3). The FBC-SLS loads the specimen in flexion-extension with a pure bending moment in the sagittal plane without any constrain in the craniocaudal axis; allowing translation along this axis and/or rotation about this axis. The measured bending moment and angular displacement of the joints were used to obtain the bending moment-joint angle characteristic of the joints.

Biomechanical parameters (i.e. range of motion (ROM), neutral zone (NZ)) were extracted for the relevant joints and used to compare the stability of the two fixation techniques (Figure 4).

Results

The neutral zone for the injured joint was 0.26 ±0.17° and 0.17 ±0.16° for the pin-PMMA and SOP fixated groups, respectively. The range of motion for the injured joint was 2.5 ±1.2° and 1.4 ±0.51° for the pin-PMMA and SOP fixated groups, respectively. There is no significant difference between the means of the neutral zone (p=0.3565) and the range of motion (p=0.0631) of the injured joint fixated with the two fixation techniques (Table 1).

Conclusion

The stability of the two fixation techniques was evaluated in flexion/extension using the biomechanical parameters defined by Wilke et al (1998)[1]. The results showed that there was no significant difference in the means of the biomechanical parameters of the injured joint L7-S1 between the two fixation techniques and it was concluded that the stability provided by the two fixation techniques is similar.

Reference

Wilke H J, Wenger K, Claes L 1998 Testing criteria for spinal implants: recommendations for the standardization of in vitro stability testing of spinal implants. *European Spine Journal* 7: 148-154.

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