THE EFFICACY OF DC STIMULATION ON LUMBAR INTERTRANSVERSE FUSION

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INTRODUCTION

A variety of studies have been done regarding direct current electrical stimulation and its effect on bone healing. Kahanovitz et al. (1990) have been able to demonstrate significant efficacy in facet fusions using a canine model. Additionally, a variety of clinical studies are available supporting its use in human intertransverse process fusions, but many of these lack adequate controls. Human in vivo studies limit the ability to perform adequate biomechanical and histological investigation regarding adequacy of the fusion mass. All of these studies have been done utilizing the standard lower amperage stimulator with 20 microamps. The purpose of this study was to better understand and assess the effect of direct current stimulation on a more commonly utilized intertransverse process fusion utilizing a rabbit model. In addition, we compared the low amperage (20 microamps) to a newly developed higher amperage (60 microamps) stimulator.

PROCEDURE

Thirty-one mature New Zealand white rabbits were randomly divided into three groups and the investigators remained blinded throughout the study. All rabbits underwent a L5-6 intertransverse process fusion using a standard muscle splitting approach and autologous bone graft as outlined by Boden et al. (1995). All rabbits were harvested at five weeks for testing. Group I was done with a sham (inactive) implanted stimulator battery; Group II utilized the currently available 20 microamp stimulator and Group III was implanted with a 60 microamp stimulator. Lastly, an additional unfused adjacent segment was harvested at the time of the testing to act as a control group for the biomechanical testing. Following harvesting, all rabbits underwent radiographic evaluation for assessment of fusion. This was done by assigning a grade of one to three. Four rabbits were sent for histological evaluation and the remainder of the rabbits underwent additional testing using a gross palpation analysis and biomechanical testing for stiffness and load to failure.

RESULTS AND DISCUSSION

The mean radiographic grade for Group I (sham) was 1.91, Group II (20 microamp active battery) was 2.22 and Group III (60 microamp active battery) was 2.58. The difference between the higher amperage battery and the sham group was statistically significant (p < 0.04). A trend towards stronger fusion on manual palpation was also noted in the higher amperage battery group, though this did not quite reach statistical significance. On biomechanical testing, the higher amperage group was found to be significantly stiffer (p < 0.05) (Fig. 1) and had a significantly higher load to failure (p < 0.02) (Fig. 2) than the unfused control segments. In each mode of analysis, it appeared that there was a consistent trend in that the lower amperage stimulated models had a better fusion mass than the sham group and the higher amperage group had even better overall testing results than the lower amperage battery. We did not
identify any complications that could be attributed to the difference in the electrical stimulator amperage strength.

The results of this study offer strong evidence that direct current electrical stimulation enhances intertransverse process fusions at least in the early phases of healing. One criticism of the Kahanovitz study in canine facet fusions has been that the more current and common anatomic location for lumbar fusion is the intertransverse region. Our study utilized a model more accurately simulating this technique and has been widely utilized by others to evaluate efficacy of methods to enhance fusion.

The maximal amount of amperage distributed by DC batteries has not been accurately determined. Studies to date have all used 20 microamp stimulators. The efficacy of such stimulators is again demonstrated in this study, but by increasing amperage to 60 microamps, the beneficial effect was enhanced in all tested parameters. Thus, the newly developed higher amperage (60 microamps) battery appears to have an enhanced effect even above and beyond the previously utilized lower amperage (20 microamps) batteries. Further investigation on the effect of stimulation in a more compromised model such as smoking chamber or the longer term effect on the strength of fusion mass may be warranted.

**SUMMARY**

The effect of direct current stimulation on an intertransverse process fusion rabbit model was assessed using low and a new higher amperage stimulator. Results offered strong evidence that direct current stimulation enhances intertransverse process fusion, and that the healing effect was enhanced by increasing the amperage to 60 microamps.

**REFERENCES**


**ACKNOWLEDGEMENTS**

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![Graph 1](image1.png)

**Figure 1:** The higher amperage group had significantly greater stiffness than the control group (p < 0.05).

![Graph 2](image2.png)

**Figure 2:** The higher amperage group had significantly greater failure load than the control group (p < 0.02).