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Radiographic Evaluation of Bony Healing of Rabbit Critical-Sized Calvarial Defects With Hyperbaric Oxygen Therapy

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Statement of the Problem: A critical-sized defect is the smallest osseous wound that will not heal with bony union during the lifetime of the animal. In a related experiment using histomorphometric analysis, defects larger than the critical-sized defects of the rabbit calvarial model healed with bony union when exposed to hyperbaric oxygen therapy (HBO). This study used critical-sized and supracrtical-sized defects with radiomorphometric evaluation to study the effects of HBO in promoting bony union in the rabbit critical-sized calvarial defect model.

Materials and Methods: This animal trial utilized twenty New Zealand rabbits. They were divided into 2 groups of 10 animals each. Full thickness calvarial defects were created in their parietal bones bilaterally. Defects were critical-sized (15 mm) on one side and supracritical-sized (18 mm) in the contralateral side. Group 1 received 90 minutes HBO therapy sessions at 2.4 ATA per day for 20 consecutive days. Group 2 served as a control group. Five animals in each group were sacrificed at 6 and 12 weeks postoperatively.

Method of Data Analysis: Data analysis included quantitative assessment of post sacrifice radiographs to measure the amount of radiopacities within the defects. Calvarial specimens were radiographed with a cephalostat machine standardized for 1:1 film at 9mA, 60 KVP, 0.2 seconds. A blinded investigator traced the defects and areas of radiopacities within each defect. One-way analysis of variance (ANOVA) was performed to evaluate for statistical significance between the various groups. Paired sample t-test was used to determine statistical significance between groups of interest. Statistical significance was established at ($p < .05$).

Results: HBO treated defects demonstrated more radiopacities than the control ($p < .001$). The control defects were covered with a radiolucent shadow in both defects. A statistically insignificant difference was found in areas of radiopacities within the 15 mm and 18 mm defects ($p = .688$). In the HBO group, radiographs at 12 weeks demonstrated more radiopacities than the 6 weeks group ($p = .019$).

Conclusion: HBO therapy has been demonstrated, in our other studies, to increase the critical size of the rabbit calvarial defects by 20%. This was assessed by using histomorphometric analysis, a technique involving decalcification, which reduces the investigator's capability to judge the mineralization of the defects. The current study confirms this finding using the same animal model with radiomorphometric analysis. The difference demonstrated in the 6 and 12 weeks HBO defects is physiologically consistent with the fact that radiographs may not detect bone unless it is considerably mineralized. It can also be concluded that radiomorphometrics is an effective measure to predict quantity as well as quality of bony healing in the rabbit calvarial model. However, histomorphometrics remains the gold standard for evaluation of bony union in the rabbit calvarial model.

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