

Cook SD, Salkeld SL, Patron LP, Doughty ES, Jones DG. The Effect of Low-Intensity Pulsed Ultrasound on Autologous Osteochondral Plugs in a Canine Model. *Am J Sports Med.* 2008;36:1733-1741.

Articular cartilage damage is common among young athletes but has poor healing capabilities. Osteochondral plug transfer is an option for some patients with damage to a high contact surface, but this treatment has several risks, such as improper alignment and abnormal stress-strain ratios on the graft. Accelerated healing of the plug is the obvious goal to avoid many of these complications; however, it is a difficult task to achieve. Low-intensity pulsed ultrasound (LIPUS) has been demonstrated to improve enchondral fracture healing in rats. The purpose of this study was to observe the effects of LIPUS on autologous osteochondral plugs in canines.

Eighteen male dogs between 20 and 25 kg were used for this study. All dogs received 2 osteochondral plugs in medial femoral condyles which were placed 1.5 mm apart and extended into subchondral bone. Subjects recovered in cages until they were conscious and weightbearing, at which time they were allowed unrestricted motion. Each dog received 20 minutes of LIPUS on the right knee 6 days per week and no treatment on the left. US frequency was set at 1.5 MHz and intensity of 30mW/cm<sup>2</sup> and began on day 3 post-op. Six dogs were sacrificed at week 6 and 12 dogs were sacrificed at week 12 for evaluation. A blinded examiner evaluated the harvested femurs in 4 categories: intra-articular adhesions; restoration of interface articular surface; erosion of cartilage; and appearance of the plug and adjacent cartilage. The plug site received a score from 0 to 2 for each of these categories, with 2 being the best quality.

Next histologic exams of graft samples were performed. Three sections were taken from each graft and labeled 1-3: level 1 was closest to the center and level 3 was closest to the perimeter of the plug. The graft samples were also given a numeric value in 6 categories: cell morphologic characteristics; reconstruction of subchondral bone; matrix staining; filling of the defect; surface regularity; and bonding. Again, higher values were assigned for normal findings.

On gross examination, the investigators found that the experimental plugs had significantly improved scores than the control plugs at 6 weeks. The LIPUS plugs had decreased cartilage erosion and a more normal appearance than the control plugs. At 12 weeks, there were no statistical differences found on the gross evaluation between experimental and control plugs. The histologic exams demonstrated significantly higher scores on the experimental plugs compared to the control plugs at both 6 and 12 weeks. At the 6 week exam, LIPUS treated plugs showed greater defect filling and subchondral bone regeneration than the control group. At 12 weeks the LIPUS treated plugs had a greater amount of hyaline cartilage, whereas the control group had mostly fibrocartilage. The experimental sites also had increased bonding at 12 weeks.

This study is a prospective, controlled, cohort study. The level of evidence for this study according to the AAOS scale is level V since it is an animal study. The strength of recommendation according to SORT is grade C, as this is a low evidence level study which does not allow for strong clinical implications.

While this study does not demonstrate direct clinical effectiveness, it does demonstrate the proposed value of low-intensity pulsed ultrasound. LIPUS was shown to improve the quality of bone plugs at both 6 and 12 weeks post-op. This is a critical time frame for athletes' rehab and return to play. While this study must be performed on humans to validate its effectiveness clinically, LIPUS has been demonstrated to improve osteochondral healing in mammals. The frequency of treatment is of value for clinicians in emphasizing the importance of patient compliance. This is especially important in the high school and community college setting when athletes are less likely to follow up daily.

## Critical Appraisal Checklist

### *Evaluation Criteria:*

*(Score from 0 -2 on all questions using guidelines on pages 2-9)*

#### **Study Question**

1. Was the relevant background work cited to establish a foundation for the research question?  
2

#### **Study Design**

2. Was a comparison group used? 2
3. Was patient status at more than one time point considered? 2
4. Was data collection performed prospectively? 1
5. Were patients randomized to groups? 1
6. Were patients blinded to extent possible? 2
7. Were treatment providers blinded to the extent possible? 1
8. Was an independent evaluator used to administer outcome measures? 2

#### **Subjects**

9. Did sampling procedures minimize sample / selection biases? 1
10. Were inclusion / exclusion criteria defined? 1
11. Was an appropriate enrollment obtained? 0
12. Was appropriate retention / follow up obtained? 2

#### **Intervention**

13. Was the intervention applied according to established principles? 2
14. Were biases due to treatment provider minimized (i.e., attention, training)? 1
15. Was the intervention compared with the appropriate comparator? 1

#### **Outcomes**

16. Was an appropriate primary outcome defined? 2
17. Were appropriate secondary outcomes considered? 1
18. Was an appropriate follow-up period incorporated? 1

#### **Analysis**

19. Was an appropriate statistical test(s) performed to indicate differences related to the intervention? 2
20. Was it established that the study had significant power to identify treatment effects? 1
21. Was the size and significance of the effects reported? 2
22. Were missing data accounted for and considered in analyses? 2
23. Were clinical and practical significance considered in interpreting results? 1

#### **Recommendations**

24. Were the conclusions/clinical recommendations supported by the study objectives, analysis, and results? 1

**Total Quality Score (Sum of above / 48) = 34/48 = 71%**