

Freeze-dried chitosan-PRP in a rabbit model of rotator cuff repair

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INTRODUCTION: Rotator cuff tears are among the most common injuries occurring in the shoulder and are often seen in older athletes of overhead sports, like tennis [1]. Following rotator cuff repair, failure to heal occurs in 20-95% of cases and has been shown to correlate with tear size [2], time from injury [3], tendon quality [4], muscle quality [5], and surgical repair technique [6]. The purpose of the study was to examine the feasibility of applying chitosan-PRP implants in conjunction with transosseous suturing to improve rotator cuff repair compared to suturing only at 1 day, 2 weeks and 8 weeks post-surgery in a rabbit model.

METHODS: Bilateral full-thickness tears were created in the supraspinatus tendons (SSP) of the rotator cuff of NZW rabbits (n = 4 female retired breeders). The tears were immediately repaired via a transosseous suturing technique. On the treated side, a chitosan-PRP hybrid mixture was additionally injected at the repair site. Freeze-dried chitosan cakes were prepared using 1% w/v chitosan (80% DDA and M_n 40kDa), 1% w/v trehalose as lyoprotectant and 42.2mM calcium chloride ($CaCl_2$) as clot activator, and solubilised with autologous PRP immediately prior to injection.

RESULTS: As expected, chitosan-PRP implants induced recruitment of polymorphonuclear cells (PMNs) to the tendon and to the muscle endomysial space from 1 day (Fig 1 E-H) to 2 weeks post-surgery. Integration of the supraspinatus tendon into the humeral head at the attachment site was also visible at two weeks. Endochondral ossification and new bone formation were apparent at 2 weeks in the control shoulder only, close to the insertion site (data not shown). At 2 months post-surgery, the superior part of the SSP enthesis in the treated shoulder had a structure that was similar to the intact normal shoulder (Fig 1 A-D), with a calcified interface between the tendon and the bone (Fig 1 I-L). In contrast, the SSP tendon insertion site in the control shoulder showed abnormal integration, with significant bone overgrowth into the tendon itself (Fig 1 M-P). Both control and treated shoulders showed hypertrophy and altered structure of the SSP tendons at 2 and 8 weeks post-surgery (Fig 1). The humeral head articular cartilage had normal appearance and showed no signs of degeneration in both control and treated shoulders (Fig 1). In addition, no adverse events were recorded during the study.

DISCUSSION: Chitosan-PRP implants in conjunction with transosseous suturing showed promising histological findings at the SSP insertion site compared to suturing alone in this pilot feasibility study. These findings are expected to translate into superior SSP repaired in an ongoing powered pivotal study.

SIGNIFICANCE: Our findings provide evidence that chitosan-PRP implants are a safe and effective way to improve rotator cuff tear repair in a small animal model, that could potentially be translated to a larger animal model and then to a clinical setting.

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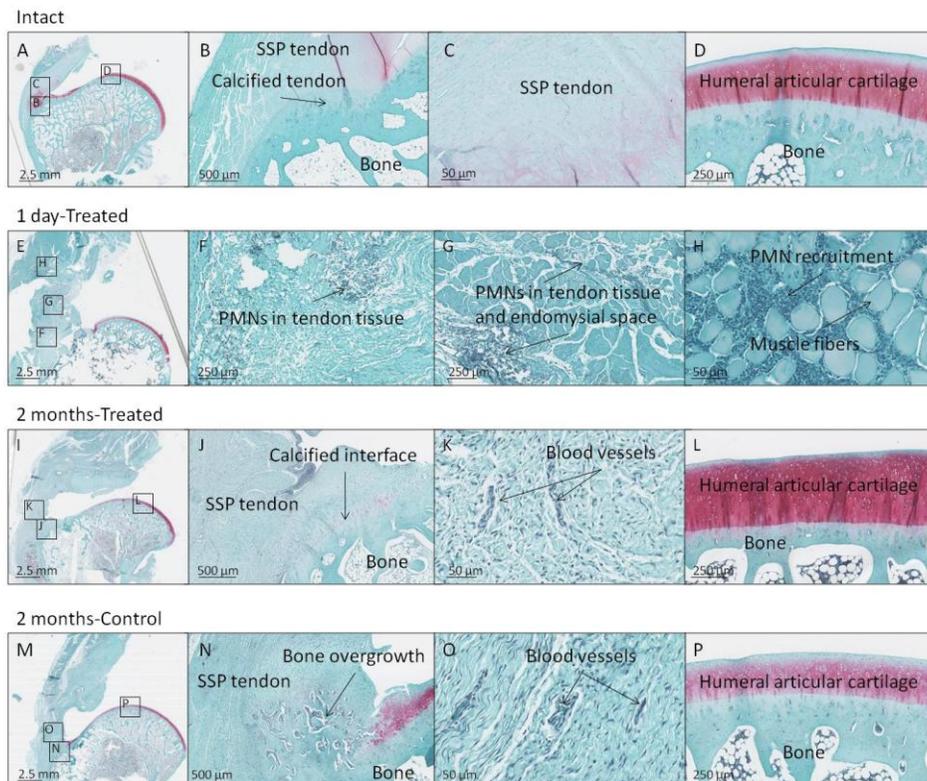


Figure 1. Safranin O/Fast Green-stained paraffin sections of an intact normal shoulder (A to D), and of shoulders treated with transosseous suturing + chitosan-PRP after 1 day (E to H) and 2 months (I to L) or suturing only as control (M to P). Chitosan-PRP implants induced recruitment of polymorphonuclear cells (PMNs) to the tendon and to the muscle endomysial space (E to H). The superior part of the supraspinatus enthesis on the suturing + chitosan-PRP treated side had a calcified interface between the tendon and the bone (J), that was structurally similar to that of the intact normal shoulder (B). The tendon insertion site on the suturing-only control site was abnormal with significant bone overgrowth into the tendon tissue itself (N). The supraspinatus tendons on both treated and control sides were hypertrophic, hypercellular and more vascularized (G, K & O) than the intact normal shoulder (C). Humeral head articular cartilage on both sides showed no signs of degeneration (L&P) and appeared normal (D). Outlines in A, E I & M show where higher magnification images were acquired.