The Cost-Effectiveness of Using Platelet-Rich Plasma During Rotator Cuff Repair: A Markov Model Analysis

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Purpose: To perform a cost-utility analysis to determine if the use of platelet-rich plasma (PRP) products during arthroscopic rotator cuff repair (RCR) is cost-effective. **Methods:** A cost-utility analysis was conducted using a Markov decision model. Model inputs including health utility values, retear rates, and transition probabilities were derived from the best evidence available in the literature regarding full-thickness rotator cuff tears and their repair, as well as the augmentation of their repair with PRP. Costs were determined by examining the typical patient undergoing treatment for a full-thickness rotator cuff tear in a private orthopaedic clinic and outpatient surgery center. **Results:** The cost per quality-adjusted life-year ($/QALY) of RCR with and without PRP was $6,775/QALY and $6,612/QALY, respectively. In our base case, the use of PRP to augment RCR was not cost-effective because it had exactly the same "effectiveness" as RCR without PRP augmentation while being associated with a higher cost (additional $750). Sensitivity analysis showed that to achieve a willingness-to-pay threshold of $50,000/QALY, the addition of PRP would need to be associated with a 9.1% reduction in retear rates. If the cost of PRP were increased to $1,000, the retear rate would need to be reduced by 12.1% to reach this same threshold. This compared with a necessary reduction of only 6.1% if the additional cost of PRP was $500. **Conclusions:** This cost-utility analysis shows that, currently, the use of PRP to augment RCR is not cost-effective. Sensitivity analysis showed that PRP-augmented repairs would have to show a reduced retear rate of at least 9.1% before the additional cost would be considered cost-effective. **Level of Evidence:** Level III, analysis of Level I, II, and III studies.

Pathology of the rotator cuff is one of the most common causes of shoulder pain; it results in 4.5 million patient visits and more than 75,000 rotator cuff repairs (RCRs) performed each year in the United States alone.[1-5] It is well known that there is a significant rate of recurrent rotator cuff tendon defects (11% to 94%) after RCR.[1,3,6,7] Investigative focus to try to improve the rate of rotator cuff healing after repair has largely been on maximizing the biomechanical fixation of the rotator cuff.[1,3,7,8] Despite these advances, however, the rate of recurrent defects after RCR remains a significant issue.[1,7-9]

Attention has recently turned to the biological enhancement of RCRs to reduce this significant retear rate because there seems to be a deficiency in the ability of local cellular and molecular processes to produce robust, long-lasting repair tissue.[1,3,8,10-12] These biological enhancements include the application of growth factors and cytokines, use of tissue augmentation/scaffolds, use of gene therapy, and use of tissue engineering.[1,10] One of the most studied of these biological factors has been platelet-rich products such as platelet-rich plasma (PRP).[1,3,6,8,10-17] The most basic definition of PRP is "a sample of autologous blood with concentrations of platelets above baseline values."[1] It is hypothesized that the alpha granules contained in platelets release various growth factors and cytokines in

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a "physiological balance" at supraphysiological concentrations and that, when applied to a repaired rotator cuff, result in an enhanced healing potential.[1,3,11,17,18]

Although the benefits of PRP application to musculoskeletal tissues have shown promise in basic science and animal studies, evidence of efficacy in treating orthopaedic conditions in humans has been lacking.[1,19-24] Chahal et al.,[1] in a systematic review that pooled data from 5 Level I, II, and III studies, noted that there was no significant difference in functional outcome, irrespective of the outcome scoring system used, or in overall retear rates between RCRs with PRP augmentation and those without PRP augmentation.

The application of PRP, as well as similar biological products, in an attempt to enhance the biological healing process is associated with a significant cost.[12,18] It was estimated that in 2013, the global market for PRP products was $160 million, and this amount is expected to increase to $350 million by 2020.[25] With the current concerns about escalating health care costs, physicians and providers need to be increasingly mindful of our resources to ensure that our patients are receiving the most cost-effective treatments available.[2,5,18,26]

This cost-utility analysis was performed using previously published health-related quality-of-life utility values regarding rotator cuff tears and their repair, as well as the average costs of a patient undergoing treatment for a full-thickness rotator cuff tear at a private orthopaedic clinic and outpatient surgery center. The purpose of this study was to perform a cost-utility analysis to determine if the use of PRP products during arthroscopic RCR is cost-effective. Our hypothesis was that the additional use of PRP to augment arthroscopic RCR would not be considered cost-effective.

Methods

Model Structure

Publicly available software (TreeAge Pro; TreeAge Software, Williamstown, MA) was used to construct the Markov decision tree model for this study. The base-case scenario is a 60-year-old individual with a full-thickness rotator cuff tear that meets the indications for arthroscopic RCR. There are 2 primary treatment arms in the model: RCR with PRP augmentation and RCR without PRP augmentation (Fig 1). In both treatment arms there are 3 possible postoperative outcome health states: intact repair, asymptomatic retear, and symptomatic retear (Fig 1). Patients who had an intact repair after the initial surgical intervention could continue to have an intact repair or sustain a retear of the repaired rotator cuff (Fig 1). Previous literature has suggested that the majority (85% to 100%) of rotator cuff retears occur within the first 6 months postoperatively.[7,27] For this reason, we chose a cycle length of 3 months to capture this early failure in healing and its potential negative effect on quality of life. Patients who entered the asymptomatic retear arm of the model could either remain asymptomatic or subsequently become symptomatic (Fig 1). Patients in the symptomatic retear state could remain in the symptomatic state or undergo revision RCR (Fig 1). In the model, patients could only undergo 1 revision arthroscopic RCR. Complications other than rotator cuff retear, such as stiffness and infection, were assumed to be identical between patients treated with PRP and those treated without PRP and were not specifically included in the model. This Markov decision tree model was developed, and subsequent analysis was performed, by 2 of the authors (E.M.S. and S.M.O.).

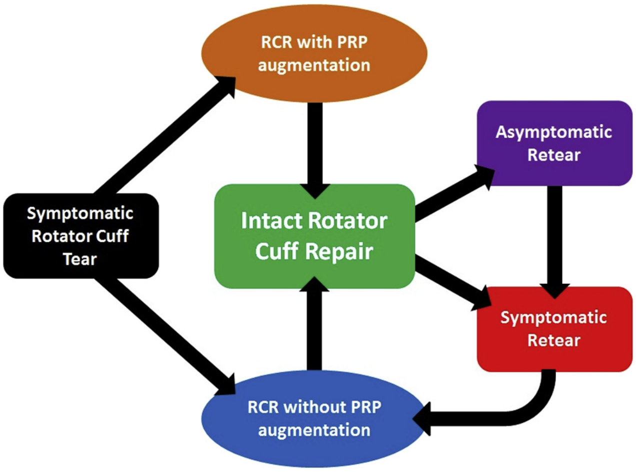

Fig 1. Markov model diagram showing flow of patients within Markov decision model. (PRP, platelet-rich plasma; RCR, rotator cuff repair.)

Transition Probabilities

As noted earlier, patients in each treatment arm could have an intact repair, asymptomatic retear, or symptomatic retear after arthroscopic repair. It is well known that there is a significant rate of rotator cuff retears after attempted repair (11% to 94%).[1,3,6,7] In a systematic review including Level I, II, and III evidence regarding PRP-augmented RCR, Chahal et al.[1] reported that there was no statistically significant difference in overall retear rate between patients treated with PRP augmentation and those treated without it. They also reported an overall pooled retear rate of 31% from the 5 included studies, with no significant difference in retear rates between the 2 groups. Therefore, in the model's base-case scenario, it was assumed that there was an overall retear rate of 31%, with no difference in retear rates between the PRP-augmented and non−PRP-augmented groups (Table 1). Again, all of the retears in the model occurred in the first 6 months after arthroscopic repair, as suggested in follow-up imaging studies by Kluger et al.[27] and Miller et al.[7] The patients in the model who sustained an asymptomatic retear