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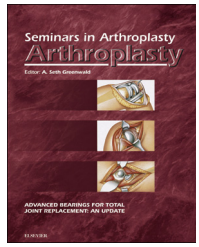

The use of platelet-rich plasma in joint replacement surgery

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ARTICLE INFO

Keywords:
platelet-rich plasma
joint replacement
arthroplasty
biologics
wound healing

ABSTRACT

The use of orthobiologics in orthopaedic surgery continues to expand. Specifically, autologous platelet-rich plasma (PRP) is seeing increased use in a variety of clinical scenarios ranging from augmenting tendon or ligament surgery to the non-operative treatment of osteoarthritis of the knee. The inherent benefits in PRP lie in the multitude of growth factors contained in platelet alpha granules that can promote tissue healing and regeneration. More recently, PRP has been used in joint replacement surgery to aid in wound healing and decreasing blood loss. These applications are more controversial and this review seeks to evaluate the basic science background and clinical evidence regarding the use of PRP in the setting of joint replacement surgery.

1. Introduction

The incorporation of biologic therapies into mainstream orthopedic surgery has experienced a tremendous upsurge over the past decade. This trend is especially noticeable with the increase in use of platelet-rich plasma or PRP. Originally described for use as a bone-graft augment in dental literature [1], the indications for the orthopedic application of PRP are continuing to evolve. Accordingly, PRP is currently either being used or researched in nearly every subspecialty within orthopedic surgery. Platelet-rich plasma has been used as an augmentation for wound hemostasis, wound sealing, and wound healing [2,3]. Other applications include use as an aid in the treatment of chronic tendinopathies [4–6], as an augmentative procedure in the repair of acute tendon injuries [7,8], and as an adjunctive treatment to primary procedures for bone defects complicated by delayed union and/or nonunion [9].

PRP is the plasma component within whole blood that has been processed to contain a supraphysiologic concentration of platelets [10]. The clinical attractiveness of PRP lies in the variety of bioactive growth factors as well as other important chemical mediators found within platelets [11,12]. Pertinent growth factors include platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-B), insulin-like growth factor (IGF), epidermal growth factor (EGF), fibroblast growth factor (FGF-2), and connective tissue growth factor (CTGF) [5,13–18]. Important chemical mediators include cytokines, histamine, fibrinogen, fibronectin, serotonin, complement c5a, and von Willebrand factor [5,13–18]. A summary of these factors is presented in Table 1.

Ideal biological augmentation options should be safe, easy to use, readily available, cost-effective, and of course, clinically effective. In many ways, PRP fulfills all of these criteria. It is autologous and has no risk of disease transmission or autoimmune response. Furthermore, it is easily obtained through simple venipuncture of a peripheral vein followed by preparation and concentration (per the instructions of the specific company) intra-operatively while the surgical procedure is

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http://dx.doi.org/10.1053/j.sart.2014.02.007
1045-4527 © 2014 Published by Elsevier Inc.

Table 1 – Growth Factors and Their Reported Use

Abbreviation	Full Name	Effects
PDGF	Platelet-derived growth factor	Macrophage activation, angiogenesis, fibroblast chemotaxis, and enhancement of collagen synthesis
PDEGF	Platelet-derived endothelial growth factor	Stimulates proliferation of keratinocytes and dermal fibroblasts to promotes wound healing
PDAF	Platelet-derived angiogenic factor	Stimulates vascular endothelial cells to promote vascularlization
TGF-B	Transforming growth factor-B	Stimulates collagen and fibronectin synthesis, enhances proliferation activity of fibroblasts, induces deposition of bone matrix, and inhibits osteoclast formation and bone resorption
IGF-1	Insulin-like growth factor-1	Attracts myoblasts and fibroblasts, stimulates protein synthesis, mediator in skeletal muscle growth/repair, and involved in proliferation and differentiation of osteoblasts
EGF	Endothelial growth factor	Involved in cellular proliferation and differentiation of epithelial cells
VEGF	Vascular endothelial growth factor	Angiogenesis, migration/mitosis of endothelial cells, and attracts macrophages and granulocytes

being performed (Figs. 1 and 2). The major remaining questions are centered around cost concerns and clinical effectiveness. There is evidence supporting the use of PRP in treating tendinopathies such as Achilles tendon injuries [18] and lateral epicondylitis [8]. Additionally, recent basic science and animal literature suggests a role for PRP in the augmentation of tendon healing with increases in the rate and duration of healing [6].

The evidence of the clinical effectiveness of PRP has been less readily available in the arthroplasty literature, but this appears to be changing with a recent exponential increase in publications regarding PRP use specific to arthroplasty in the past 5 years. When considering the use of PRP in joint replacement surgery, there are 30 articles [4,19–47] available (from those indexed in PUBMED) from the last 5 years while there are only five articles [2,3,48–50] from 5 years previous to that. Despite this increase in research, it is unclear if such increases in research and education have translated into improved outcomes for the use of PRP in orthopedics.

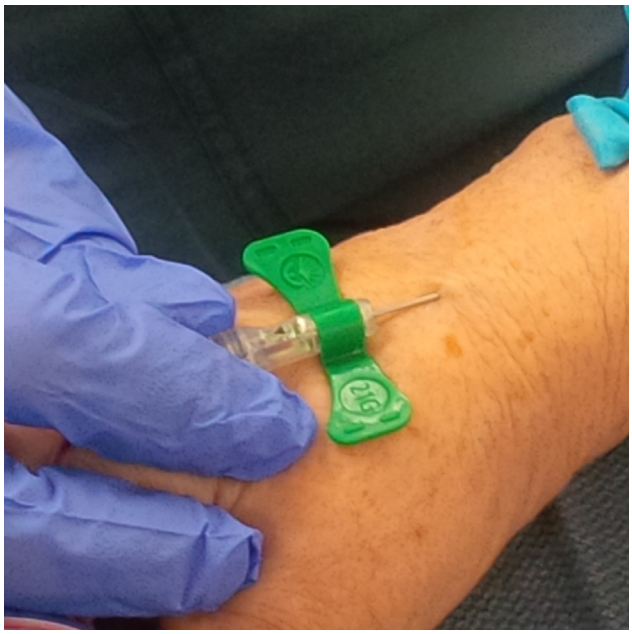

Figure 1 – Peripheral venipuncture can be performed either pre-operatively or intra-operatively. (Color illustration of figure appears online.)

Limited reports discussing the utilization of PRP in knee [2,3,19,20,23,49,51–54], shoulder [50], and ankle [55] arthroplasty are available. The vast majority of these studies analyzes the impact of PRP on wound healing, post-operative pain, post-operative range of motion, and need for post-operative blood transfusions. Given the variability of methodology in the available studies as well as the variability in outcomes reporting, comparisons between different studies are not possible. Nevertheless, analyzing these studies as a whole does allow for an overall interpretation of both current use and future directions for PRP in the setting of total joint arthroplasty. This review discusses the basic science elements of PRP relevant to arthroplasty, the specific applications of PRP in arthroplasty, and the available reported outcomes of patients undergoing PRP therapy in conjunction with total joint arthroplasty.

2. Basic science

Following injury, the general healing process consists of hemostasis (day 0), inflammation (days 0–2), cellular and matrix proliferation/repair (days 2–14), and wound remodeling (days 14+). The proliferative phase is perhaps the most important phase of the cascade and typically starts within days following injury. The remodeling phase is the longest, and may mostly be associated with scar tissue formation [56,57]. Growth factors are thought to play their most important role during days 5–14 when the wound is undergoing repair during the proliferative/repair phase [58].

As described above, PRP is the plasma component within whole blood that has been processed to contain a supra-physiologic concentration of platelets [10]. There is no actual consensus on the exact definition of PRP, with some authors defining “platelet-rich plasma” as the autologous plasma fraction that has a concentration of platelets above the baseline (200,000 platelets/μL), the plasma fraction with a concentration of at least 1,000,000 platelets/μL, or the autologous concentration of platelets in a small volume of plasma [59,60]. In general, platelets contain three types of granules