Determination of the Platelet Capture Rate of Human Fibrin Blood Clot

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Introduction

Enhancing tissue healing through the application of bioactive factors, especially for tissue that may be biologically compromised, is an appealing concept for orthopedic surgeons. Recent attention has focused on using platelet rich plasma [PRP] as a way of delivering increased concentrations of autologous growth factors in an effort to biologically augment tissue healing [1]. PRP, however, has several shortcomings including cost and variable production methods. Additionally, liquid PRP disseminates upon surgical application and is an inefficient short-term delivery mechanism not allowing long-term contact with the surgery site.

An alternative method to standard PRP is to create an exogenous fibrin blood clot scaffold containing platelets as well as platelet derived and other bioactive components [2]. Immuno-histochemical staining of these types of fibrin networks has demonstrated “nests” of platelets that become trapped within the fibrin scaffold [3]. Furthermore, cytokines bind to fibrin such that the fibrin scaffold becomes a growth factor reservoir that may allow growth factor release slowly over many days [4]. This exogenous fibrin blood clot can act as a stable mechanism for long-term direct delivery of growth factors and as a three dimensional native scaffold for cell adhesion and proliferation.

The purpose of this study was to determine the fibrin blood clot platelet capture rate using human blood.
Methods

Thirty five cc of whole blood was obtained via venipuncture from 10 healthy volunteers with no history of clotting abnormalities and no recent use of nonsteroidal anti-inflammatory medication. Five cc of this whole blood was placed in a standard blood collection tube for pre-clot cell count evaluation. The remaining 30 cc of whole blood was placed into a sterile fibrin clot-forming container with a sintered glass cylinder supported by the lid (ClotMaster Hula Cup, Pierce Surgical Corp., Vermont). With the lid secured, the whole blood in the container was gently swirled around the sintered glass rod for 10 minutes. The lid was then removed and a dense fibrin clot had formed around and adhered to the glass cylinder in all specimens, Figure 1. The dense fibrin clot was removed and 5 cc of the post-clot serum that remained in the cup was sent for post-clot formation cell count evaluation. The cell counts for pre-clot whole blood and post-clot serum samples were then compared.
Figure 1. Formation of dense fibrin clot on sintered glass rod. Post-clot serum visible in container.
RESULTS

The mean values for the pre-clot whole blood samples were: platelets 187.80, white blood cells (WBC) 5.52, red blood cells (RBC) 4.47, neutrophils (NE) 57.10, lymphocytes (LY) 32.4. The mean values for the post-clot serum samples were: platelets 4.40, WBC 4.79, RBC 4.59, NE 53.4, LY 37.64. Compared to the pre-clot whole blood, the post-clot serum sample had a significant decrease in platelets \( (p < .01, \text{2 tail T-test}) \). Compared to the pre-clot whole blood there was no significant change in the post clot serum sample for WBC, RBC, NE and LY. Using this technique, the platelet capture rate of a fibrin blood clot was 92%.
WBC

4.4

WHOLE BLOOD

5.6

POST-CLOT SERUM
DISCUSSION

This study determined the fibrin clot platelet capture rate to be 92%. This capture rate compares favorably to prior studies that have demonstrated platelet capture rates of traditional PRP ranging from 17-80% [5]. These findings indicate that this fibrin clot formation technique creates a platelet rich fibrin scaffold [PRFS]. Recent work has also demonstrated that, similar to PRP, clots formed using this device have bioactive components (VEGF, TGF-β1, FGF and PDGF-β) capable of enhancing tissue healing [6].

Platelet rich fibrin scaffolds formed using this technique have potential advantages compared to traditional centrifuged PRP. These clots can be formed quickly, inexpensively and consistently. They provide a fibrin scaffold allowing for cell attachment and migration. Nests of platelets become trapped within the fibrin scaffold and the fibrin binds and concentrates growth factors released by the platelets. These growth factors are then released as the fibrin scaffold breaks down over many days. Finally, the dense nature of the PRFS provides a structural integrity allowing for arthroscopic suturing over a repair site [7].

Future studies may demonstrate PRFS formed using this technique to be a superior tissue healing adjuvant compared to traditional PRP.
REFERENCES


DISCLOSURES

• Dr. Proctor is a stockholder of Pierce Surgical Corp.