Gravitational platelet separation
Accelerating the body’s own healing process

In this month’s article in our blood series, Hadi Saleh and Felicia Cox explore how autologous blood products can be used to facilitate haemostasis and enhance wound healing. This article focuses on the functions of platelets and how gravitational platelet separation can be used in a wide variety of clinical settings.

**Introduction**

A number of products have been employed to act as wound sealants and enhance wound healing, including cyanoacrylates and homologous and autologous fibrin preparations. Autologous blood can be treated in the operating theatre to produce a concentrate high in both platelets and plasma. This concentrate can be applied to wounds, providing haemostasis, adhesion, and enhanced wound healing. These platelet gels are now accessible to most surgeons and have potentially wide applications in surgery, especially for the reconstruction of soft and bony tissues in facial plastic and reconstructive surgery. The use of platelet concentrates can reduce the length of surgery and amount of postoperative drainage and can provide adhesion for the consolidation of bone fracture segments.

The wound-healing process is a complex series of events that can be divided into three phases (Bhanot & Alex 2002):

- Inflammatory
- Proliferative
- Remodelling.

A multitude of cellular and humoral components interact to regenerate injured tissue. These interactions are mediated by numerous factors such as growth factors, hormones and blood components. Several growth factors released at the wound site are thought to be necessary for wound healing and are listed in Figure 1 over the page.

Growth factors are increasingly being used as a means of accelerating the healing process. Recently, the use of autologous platelets and platelet products has been identified to be useful as a less expensive source of multiple growth factors (Dugrillon et al 2002). Bhanot & Alex (2002) report that both platelet gel and fibrin glue are effective haemostatic agents. The ability to derive these from the patient’s own blood also has the advantage of reducing the risk of cross infection and disease transmission (Martinez-Gonzalez et al 2002).

**Why platelets?**

Platelets are known to form a plug at the site of a blood vessel injury by adhering to exposed subendothelial connective tissues in the vessel wall. They then change shape, become activated, and finally aggregate (Sharp 2004).
Platelets contain a variety of growth factors that, when applied to a wound site, will accelerate the healing response. Slater et al (1995) describe how platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-ß), epithelial growth factor (EGF) and vascular endothelial growth factor (VEGF), are just some of those contained within platelets. That these factors also play an important role in the regulation of the wound healing cascade, is based upon in vitro and in vivo evidence of their stimulatory effects on the proliferation and migration of various cell types, and angiogenesis (the formation of new blood vessels from pre-existing capillaries).

These developments have led to research of new healing therapies using platelets to enhance and accelerate the wound healing process. This article describes in detail one gravitational platelet separation GPS™ system (Biomet Merck, UK) that is commercially available.

Creating the platelet concentrate using the GPS™ system

A small volume of autologous blood (55–110ml) is aseptically harvested from the patient, usually in the operating theatre, using a disposable system. This sample is mixed with citrate (for anticoagulation) and transferred to the GPS™ tube (See Figure 2). This tube is placed in a centrifuge, balanced by a tube of equal fluid volume and undergoes a 12-minute spin at 3,200rpm.

After removal from the centrifuge, the volume gauge is attached and the plunger is pressed down to separate out the platelet poor plasma (PPP) which is then withdrawn using the side port (see Figure 3). The concentrated platelets, on top of the floating buoy, are re-suspended to form platelet rich plasma (PRP) and withdrawn using the central port (see Figures 3 and 4). The floating buoy (see Figure 5) enables the system to compensate for differing haematocrit levels between patients, thus ensuring high platelet counts.

AUTOLOGOUS THROMBIN

Before use, the platelet concentrate must be mixed with thrombin, a process known to induce growth factor release (Carter et al 2003). Although bovine

Growth factors

- Epidermal growth factor (EGF)
- Fibroblast growth factor (FGF)
- Insulin-like growth factor (IGF)
- Keratinocyte growth factor (KGF)
- Platelet-derived growth factor (PDGF)
- Transforming growth factor-beta (TGF-ß)
- Vascular endothelial growth factor (VEGF)

Concentrated Growth Factors
• The GPS System concentrates the growth factor rich platelets from the patient’s own blood.
• Applied as a spray, gel or mixed with bone graft/ substitute, the platelet concentrate accelerates natural healing.

Autologous Fibrin Seal
• Mixing the platelet poor plasma with autologous thrombin produces a fibrin seal to address capillary bed bleeding.

Convenient
• A single spin of the centrifuge produces both Platelet Rich and Platelet Poor Plasma from the small amount of patient’s blood.

GPS - Accelerating the Body’s Natural Healing Process
derived thrombin may be used, autologous thrombin is preferred by most surgeons. By harvesting an additional amount of blood from the patient and performing a second spin cycle in the centrifuge, autologous thrombin can be produced in less than ten minutes.

APPLICATION

The PRP and the thrombin are transferred to the sterile field and then drawn up into the syringes supplied with the spray applicator kit (see Figure 6). They are then fitted into the ‘two syringe assembly component’, so that the syringes can be depressed simultaneously, ensuring that the PRP and thrombin are mixed in the correct ratio. This mixture, rich in growth factors to promote wound healing, can now be sprayed directly into the wound, inserted via a cannula, or allowed to become a gel before being applied. It is also possible to mix the gel with bone chips or synthetic bone granules.

FIBRIN SEALANT

The PRP and the thrombin can be combined to produce a fibrin sealant. Using the spray applicator kit, they are mixed in the correct proportions as they are sprayed into the wound just before final closure to address capillary bed bleeding.

Clinical results

These approaches have been applied successfully in a variety of clinical areas, including:

- plastic surgery (Welsh 2000)
- oral and maxillofacial surgery (Anitua 1999)
- spinal and orthopaedic surgery
- chronic wounds such as diabetic or decubitus ulcers (Glover et al 1997).

In dermal wound healing studies, an acceleration of granulation tissue formation and healing was observed, when platelet concentrate was applied in an animal model (Carter et al 2003). Dugrillon et al (2002) reported that platelet concentrate increased the rate of bone formation and improved trabecular density after bone grafting. Successful results from a limited number of small prospective evaluative studies have stimulated the development of commercially available platelet-concentrating devices.

Areas that are the focus of current research for the use of platelet concentrate include:

- bone regeneration
- skin donor sites
- facial plastic and reconstructive surgery
- chronic and non-healing diabetic ulcers
- decubitus ulcers.

Conclusion

Autologous blood can be quickly and easily treated in the operating theatre to produce a concentrate high in platelets and plasma. Platelets contain a
A variety of growth factors that, when applied to a wound, contribute to the wound healing cascade through their stimulatory effects on the proliferation and migration of various cell types and the formation of new blood vessels. The concentrate also acts as a wound sealant. These platelet gels (see Figure 7) may be especially useful in facial plastic and reconstructive surgery. Platelet concentrates have the potential to reduce the length of surgery and post-operative drainage, and can provide adhesion for the consolidation of bone fracture segments. The results from published clinical studies are promising.

Acknowledgment

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### Platelet gel

<table>
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<th>Product</th>
<th>Adhesion potential</th>
<th>Haemostasis</th>
<th>Contamination</th>
<th>Ease of procurement</th>
<th>Available produce</th>
<th>Cost</th>
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Adapted from Welsh (2000)

**Key**

+ slight  ++ mild  +++ moderate  ++++ strong

### References


Bhanot S, Alex JC 2002 Current Applications of Platelet Gels in Facial Plastic Surgery. _Facial Plastic Surgery_ 18 (1) 27–33

Carter CA, Jolly DG, Worden CE et al. 2003 Platelet-Rich Plasma Gel Promotes Differentiation and Regeneration During Equine Wound Healing. _Experimental & Molecular Pathology_ 74 (3) 244–255


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