ORIGINAL ARTICLES

Using Platelet-Rich Plasma to Promote Healing and Prevent Seroma Formation in Abdominoplasty Procedures

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Introduction: *To evaluate the efficacy of platelet-rich plasma in promoting wound healing and preventing seroma formation, a 30-patient study was conducted between January 2001 and May 2003. The intent of the study was to evaluate the use of platelet-rich concentrate on patients undergoing either full abdominoplasty (4 patients) or crescent tuck abdominoplasty (miniabdominoplasty) surgery. This series of patients was contrasted with a 100-patient study with similar surgery accomplished between 1990 and 2000 and previously reported at the 17th International Congress of the French Society of Aesthetic Surgery and the 5th International Congress of the Society of Lipo-Plasty. In addition, during the 30-patient study, there were 6 patients studied who did not receive platelet-rich concentrate. Those 6 patients were also compared with the 30-patient platelet-concentrate group.*

Materials and Methods: *The platelet concentrate was prepared from 54 mL of blood drawn from the patient at the time of surgery. The anticoagulated volume of 60 mL was processed using a uniquely designed centrifuge system manufactured by Harvest Technologies (Plymouth, Mass). The separation process yielded 10 mL of platelet-rich plasma (PRP). This volume was combined with 1 mL of calcium thrombin in a spray that was applied to the surgical site. The calcium thrombin was used to activate the platelets and fibrinogen to form fibrin chains in order to achieve an immediate hemostatic seal on the tissue beds. The calcium thrombin was prepared by adding 5 mL of 10% calcium chloride to 5000 units of bovine thrombin. Only 1 mL of this mixture was used in the procedure. Prior to the application of the platelet concentrate/calcium thrombin to the tissue beds, absolute hemostasis is accomplished and both beds are blotted as dry as possible. Both the top and bottom layer are sprayed with approximately 4.5 mL of platelet concentrate/calcium thrombin. The tissue layers were approximated and the skin surface rolled to express any fluid from the location of the sutures. Sutures were then placed and the remaining PRP/calcium thrombin mixture was sprayed along the suture line. The formal abdominoplasty was done without liposuction in the upper or epigastric area of the abdomen. The crescent tuck abdominoplasty used was the same as the previous 100-patient series.*

Results: *No seromas were found in the 30 patients studied as compared with a 7% seroma rate in the previous 100-patient series and 2 out of 6 of the patients who had abdominoplasty during the same time as the 30-patient group developed seromas. Anecdotally, the wounds seemed to heal much more rapidly with more esthetically pleasing incisions.*

Discussion: *The addition of platelet-rich plasma is now easily applied at the surgical site with a very easily usable technology that does not require expensive or complicated equipment. The application of platelet-rich plasma as a natural fibrin matrix delivers growth factors to the wound and seems to promote more rapid healing.*

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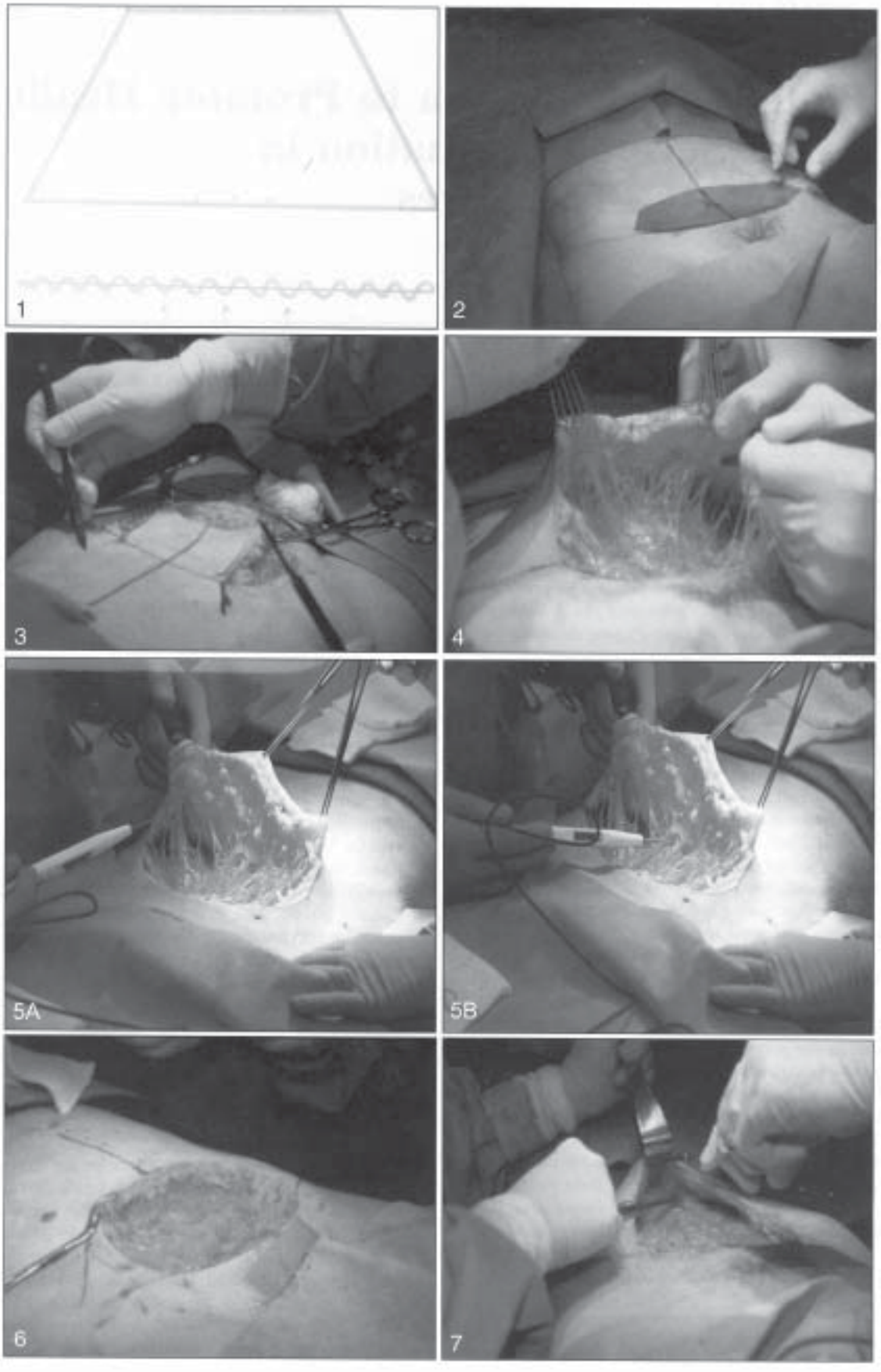
The application of platelet-rich plasma to promote wound healing and decrease seroma formation is appealing and has a good theoretical as well as scientific basis. The formation of seromas is one of the most common surgical dilemmas anytime a flap is raised. During the past 10 years, a multiplicity of techniques have been proposed to reduce the incidence of seroma formation.[1–6] A more recent approach to this problem has been the use of fibrin sealant. In both animal and clinical studies, this allogenic material has been shown to reduce drain output and reduce the incidence of postoperative seroma.[7–15] However, some clinicians have been reluctant to use this material because it has been demonstrated to be a mechanical barrier to the early cell-mediated events involved in the wound repair process due to the markedly elevated fibrinogen levels.[12]

This study was undertaken in an effort to evaluate the effect of PRP on wound healing and seroma reduction accomplished through the release of multiple growth factors. A comparison was made with 30 patients who received platelet gel during full or partial abdominoplasty and 6 who underwent the procedure with the standard protocol without PRP during the same time period and 100 patients previously reported.

There have been several techniques presented in the literature that are intended to manage this problem.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These ranged from intrawound vacuum drains,[4–5] synthetic tissue adhesives,[6] surgical technique,[3] and postoperative care.[1] All of the above have shown a positive effect on reducing seroma. The use of bovine thrombin has been reported as having no effect on seroma formation.[13,14]

Another approach to this problem has been the use of fibrin sealant or fibrin glue. In both animal and clinical studies, this allogeneic material has been shown to reduce drain output and reduce the incidence of postoperative seromas.[3,7–15] In an effort to evaluate the effect of platelet-rich plasma on wound healing and seroma reduction, this study was undertaken.

Methods

Thirty (30) patients who ranged in age from 29 to 65 years underwent either formal abdominoplasty (4 patients) or a crescent tuck abdominoplasty (miniabdominoplasty) with or without rectus plication. In the crescent tuck group, most were combined with liposuction. However, in the formal abdominoplasty group, no liposuction was done in the epigastric area or zone 1/SA area 3 according to Matarasso classification.[15] Surgical technique for the crescent tuck involved excision of a trapezoid area of skin and subcutaneous tissue, followed by undermining to the umbilicus. The rectus muscles were then plicated (Figures 1 through 7) and closure was accomplished. Prior to closure, absolute hemostasis was accomplished. A thin spray of platelet-rich plasma was applied to both the superior tissue bed and inferior tissue bed (Figure 8). The author used 4.5 mL on each surface, then the remaining 1 mL was used to spray a bead along the wound just prior to placing the final subcutaneous sutures and before application of the Steri-Strips (Figure 9). Just before complete closure, the skin surface was rolled to express any fluid that might remain. The autologous platelet concentrate was prepared from 60 mL of anticoagulated whole blood using the SmartPRep system (Harvest Technologies, Plymouth, Mass). The process yields 10 mL of platelet concentrate, which is ultimately combined by spray in a 10:1 ratio with a bovine thrombin/10% calcium chloride mixture (PC BT) at a strength of 1000 u/mL (Figure 10).

The patients were followed carefully for at least 6 weeks. The results were then contrasted with a previous series 100-patient study accomplished between 1990 and 2000 (Figures 11 and 12). Six patients that were operated on during the same time frame as the 30-patient study group did not have application of platelet-rich plasma and they were also compared in this report.

Results

There were no seromas in the 30 patients in which we used the platelet concentrate. This is contrasted with a 7% seroma rate in the previous series. There were 2 seromas in the 6 patients who had similar surgery without platelet concentrate during the same time. Anecdotally, the surgical site seemed to heal much more rapidly with finer, more esthetically pleasing scars (Figures 13 through 17).

Discussion

Clinically, the effect of platelet gel application was similar to what has been previously reported for soft tissue procedures. There was no evidence of seromas or hematoma (bruising) formation, the wounds healed more rapidly than expected, and the patients experienced virtually no discomfort. This is not unexpected because platelet gel produces a bioactive matrix that not only has hemostatic properties but also carries a multiplicity of growth-factor proteins that are active in initiating and controlling the initial stages of the healing process.

The use of FS (fibrin sealant) or fibrin glue has been one approach to decrease seroma formation. In both animal and clinical studies, this allogeneic material has been shown to reduce drain output and reduce the incidence of postoperative seroma.[7–15] However, some clinicians have been reluctant to use this material because "data from studies provided evidence that FS may serve as a mechanical barrier to the early cell mediated events involved in the wound repair process."[11,12] In 2 recent studies, it has been reported that "supplementation of FS with [transforming growth factor] TGF-B2 at a concentration of 1 μg/mL, which provided a dose of TGF-B of 0.1 μg/mL, reversed the inhibitory effects of FS on the intermediate stages of wound repair process"[15], and that "delivering a combination of growth factors constituted an improvement over the delivery of individual growth factors for enhancing neovascularization."[12]

Autologous platelet concentrate activated by the addition of calcium thrombin can produce a bioactive matrix that has hemostatic properties but also carries a multiplicity of growth-factor proteins, which are ac-

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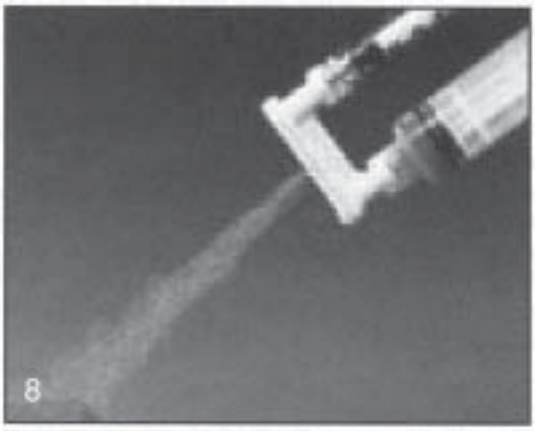
Figure 1. *Schematic of a true trapezoid and the slight wrinkling of closure.*
Figure 2. *Template designed by author for use in crescent tuck.*
Figure 3. *Excision of the trapezoid ellipse of skin and subcutaneous tissue.*
Figure 4. *Elevation of flap. Note effect of liposuction.*
Figure 5. *(A, B) Resection carried out with electrosurgical unit and Colorado needle.*
Figure 6. *The upper lateral corner brought toward the midline until no "dog ear" exists.*
Figure 7. *Rectus plication is accomplished.*



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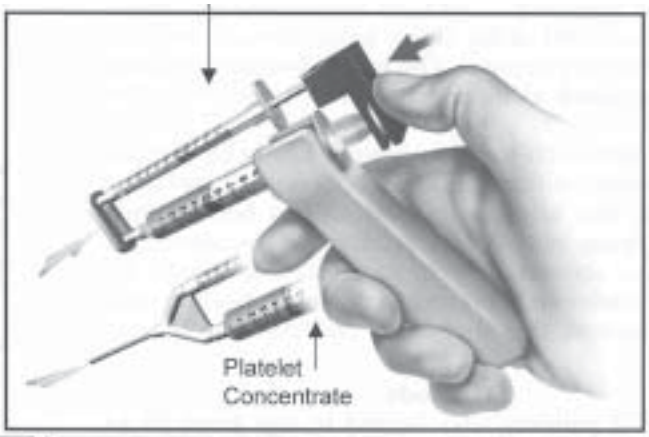

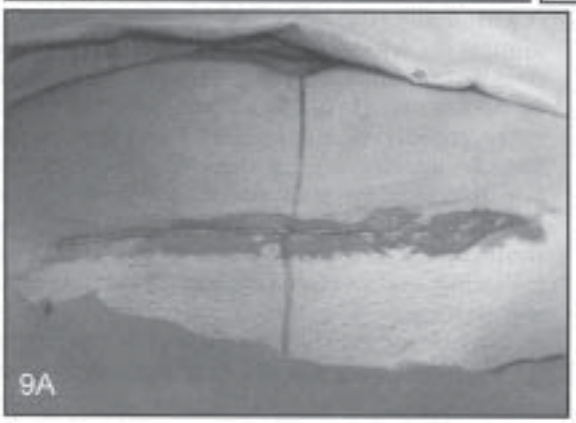

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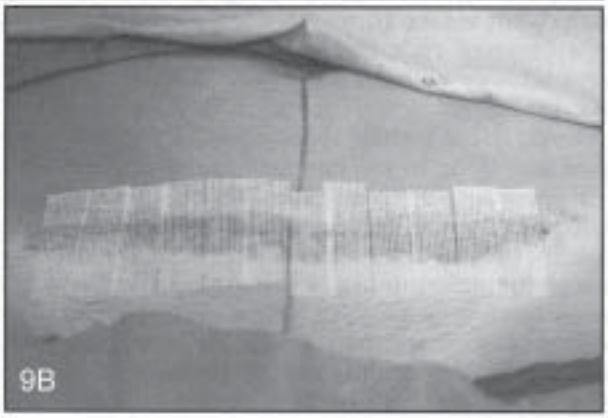

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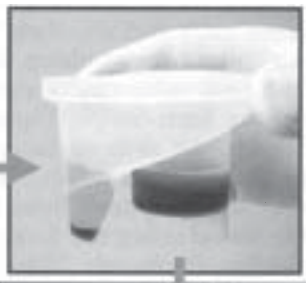

Smart PReP System:
Blood Draw and Platelet Concentrate Product

Volume of processed anticoagulated blood	Platelet concentrate yield		Platelet increase above native level	Standard deviation of increase above native level
22.5 mL (20 mL blood)	65.2 %		4.4x in 3 mL	+/-0.6
60 mL (54 mL blood)	80.2 %		4.3x in 10 mL 6.2x in 7 mL	+/-0.2

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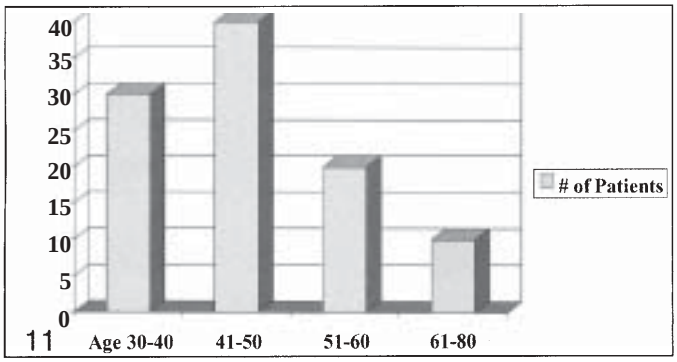

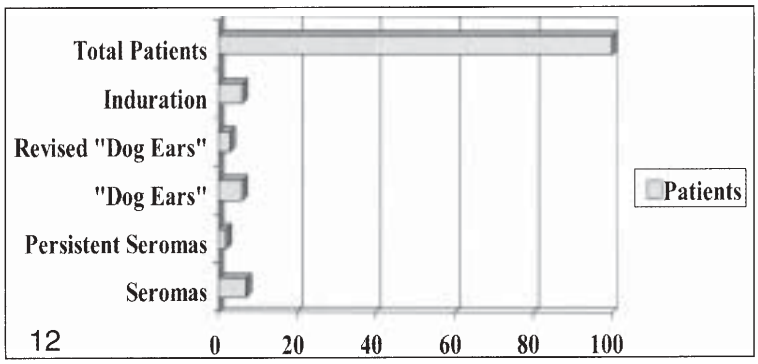

Figure 11. *Ages of patients in a randomized sample of 100; 70% fall between the ages of 30 and 50 years.*
Figure 12. *Complications found in a randomized sample of 100 patients.*
Figure 13. *Scar healing in a 42-year-old female, postcrescent tuck, rectus plication, and miniabdominoplasty with use of platelet-rich plasma (PRP). (A, B) One week postoperative. (C) Two weeks postoperative.*

tive in initiating and controlling the initial stages of the healing process (Figure 18).

The normal reparative process following tissue damage resulting from a surgical procedure can be viewed as a well-described series of four steps referred to as the "healing cascade." Because healing is sequential in nature, the quality of the early steps will have an effect on the following steps. Therefore, it is quite important that the initial 3 steps are effective in order for the final tissue remodeling to occur quickly and completely.

These sequential steps have been described as clot formation and wound sealing, inflammation, cell proliferation, and cell remodeling.[16] These steps can be best understood by viewing them at the cellular level and by understanding that fundamentally the restoration of damaged tissue is a protein story (Figures 19 and 20).

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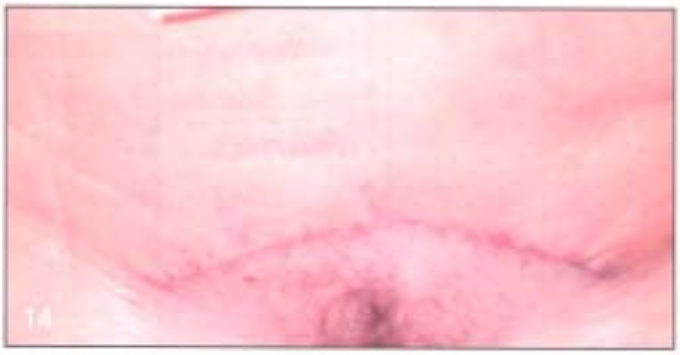
Figure 8. *Delivery of platelet concentrate and platelet-poor plasma. A surgeon can combine platelet concentrate or platelet-poor plasma with calcium/thrombin to achieve hemostatic and sealing properties. Figure courtesy of Harvest Technologies, Inc (modified by author).*
Figure 9. *Final closure. (A) Example of platelet-rich plasma (PRP) applied to wound; patient called it "bloody glue." (B) Application of steri-strips.*
Figure 10. *System used in present study. Figure courtesy of Harvest Technologies, Inc (modified by author).*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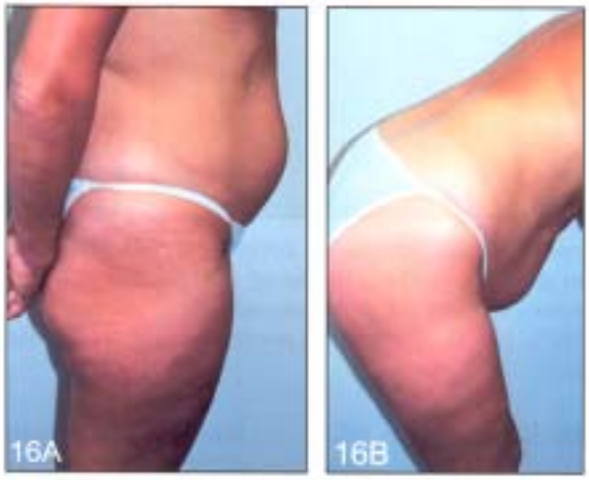
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Figure 17. *Abdominoplasty using platelet-rich plasma (PRP) of a 40-year-old male following a 265-pound weight loss. (A) Preoperative lateral view. (B) Preoperative frontal view. (C through E) One week postoperative. Note the fine-line scar.*

Recent research has shown that the natural fibrin matrix of a clot not only supports migration of fibroblasts but also promotes angiogenesis.[17–20] Fibrin has been shown to stimulate the secretion of vascular endothelial growth-factor (VEGF) protein from vascular endothelial cells.[21] This is important because "VEGF accelerates the accumulation and proliferation of vascular endothelial cells"[22] and the addition of VEGF after abdominoplasty has been shown "to improve the percentage of TRAM flap viability."[22]

In our work, we believe that an autologous platelet concentrate offers an advantageous alternative to fibrin glue. The most obvious advantage is safety from disease transmission. Because the product comes from the patient and is not allogeneic, it offers complete safety from disease transmission. It also offers a multiplicity of growth-factor proteins within the product and does not require the addition of these proteins as studies indicate are important for fibrin glue.

There is no definitive published data that would support a specific percentage increase in platelet count over baseline as necessary to effect an enhancement of the healing cascade. The current biological research does, however, support the role of platelets, their growth factors, and other proteins in the healing cascade. Based on this well-documented understanding of the biological activity involved in clot formation, inflammation, and tissue regeneration, it is reasonable to speculate that, by increasing the number of these protein signals within the scaffold of the clot and by dispersing these proteins uniformly throughout the clot, an environment may be created that could improve the speed of the healing process.

There are studies in the literature relating to bone graft procedures that document the effect of increase in platelet number on clinical outcome. One is an 88-patient clinical study of platelet concentrate added to bone graft in mandibular reconstruction surgery after cancer surgery. A significant effect was seen on the rate of bone growth and density of bone formation within the first 6 months postprocedure. The average increase in platelet count was 3.38 times baseline.[23]

These results have been confirmed in other published studies.[24–26] In a cell-culture study conducted at Case Western Reserve University, a platelet concentrate with fivefold increase above baseline platelet

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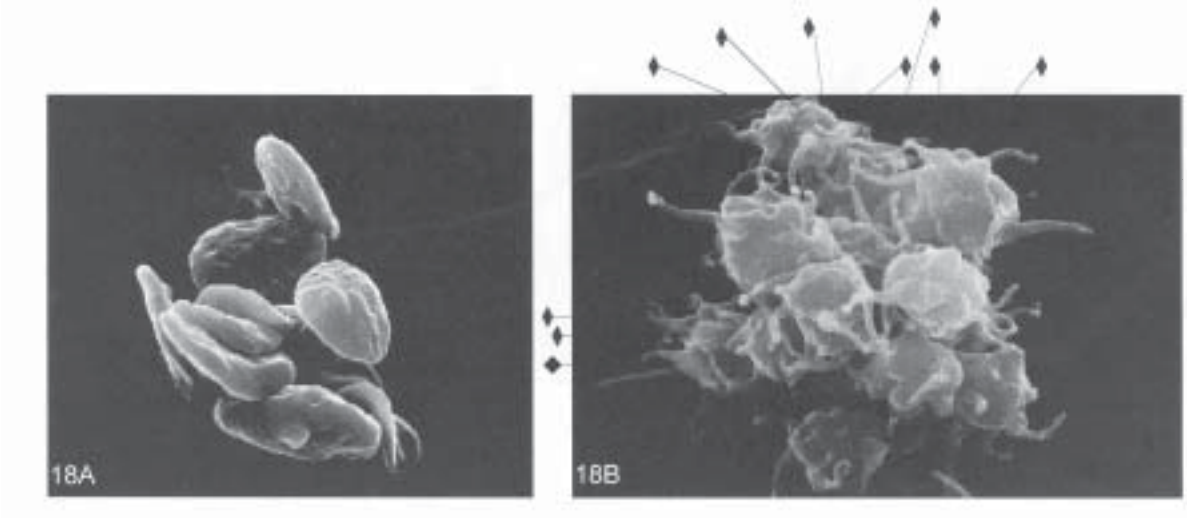
Figure 14. *One week postoperative crescent tuck abdominoplasty with use of platelet-rich plasma (PRP). Note the maturity of the wound.*
Figure 15. *Crescent tuck abdominoplasty of a 31-year-old female. (A) Preoperative. (B) Three weeks postoperative, lateral view. (C) Three weeks postoperative, frontal view. Note lack of seroma and hairline scar.*
Figure 16. *Abdominoplasty using platelet-rich plasma (PRP). Note the lack of seromas or hematomas as well as the flat scaphoid abdomen.*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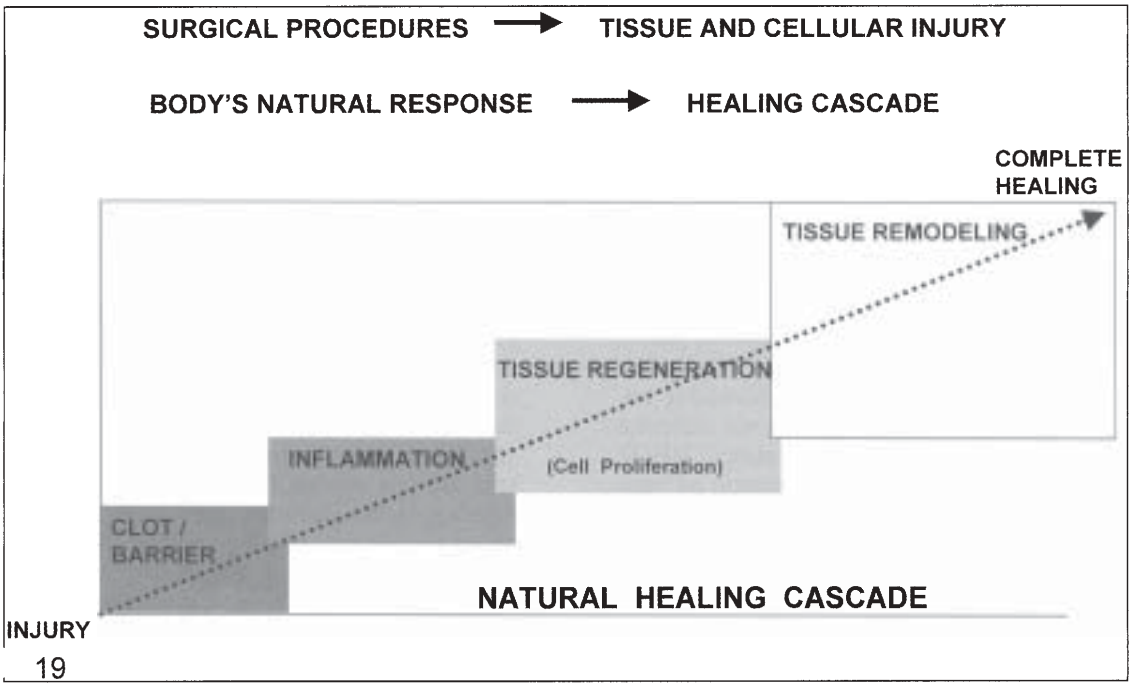
SURGICAL PROCEDURES
TISSUE AND CELLULAR INJURY
BODY'S NATURAL RESPONSE
HEALING CASCADE
COMPLETE HEALING
TISSUE REMODELING
TISSUE REGENERATION
(Cell Proliferation)
INFLAMMATION
CLOT / BARRIER
NATURAL HEALING CASCADE
INJURY
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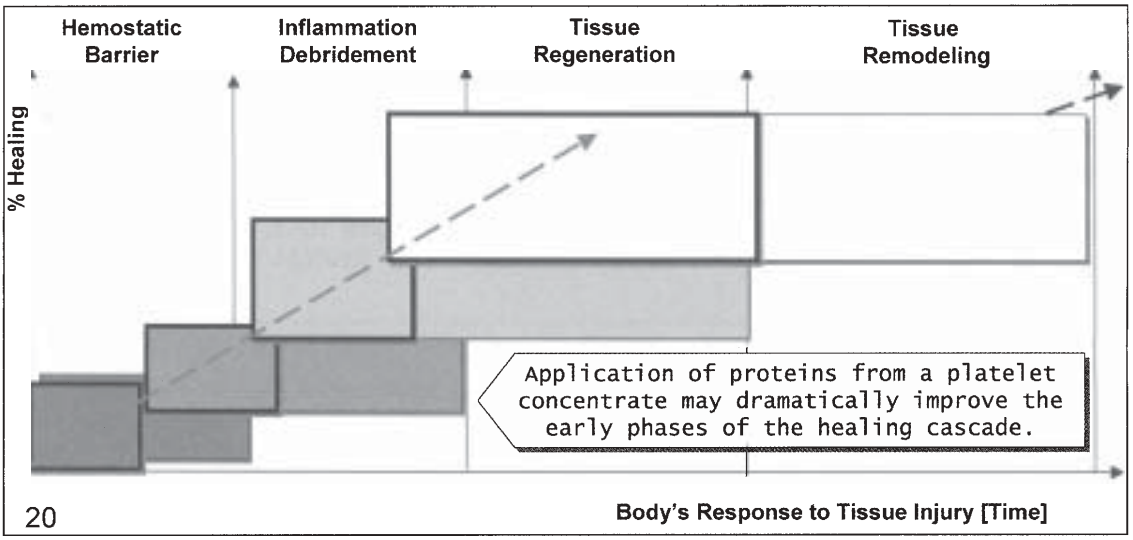
Hemostatic Barrier
Inflammation Debridement
Tissue Regeneration
Tissue Remodeling
% Healing
Application of proteins from a platelet concentrate may dramatically improve the early phases of the healing cascade.
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Body's Response to Tissue Injury [Time]

count resulted in a 227% increase in hMSC proliferation when compared with baseline platelet count.[26]

The system used to produce the platelet concentrate used in the cases presented in this article has reported an average increase in platelet count of 4.8 times (±0.2) the baseline. This is data generated at the Center for Blood Research in Boston. The average 10 mL of platelet-derived growth factor (PDGF) concentrate prepared using the Harvest System has approximately 800 000 platelets per milliliter and has also been documented as containing 1.5 μg TGF-B, 1.0 μg PDGF-AB, and 0.007 μg VEGF.

The author has seen a decrease in length of drain time necessary from latissimus dorsi donor sites. The use of PRP has been instrumental in the healing of nonhealing wounds, eg, venous stasis ulcers. Platelet-rich plasma has also been used in breast reductions by the author and was felt to increase wound healing with fewer problems at the inverted T-junction since instituting the protocol.

Conclusion

In this study, the use of platelet-rich plasma in abdominoplasty procedures resulted in fewer seromas. Anecdotally, the wounds healed more rapidly and with a more esthetic result. Prevention of/or decrease in frequency of seromas make this a worthwhile addition to abdominoplasty procedures. The relative ease of preparation at the surgical site and patient acceptance make this an exciting modality to add to our armamentarium. In the author's opinion, surgeons are at the tip of the iceberg with the use of autologous platelets in esthetic surgery. The increase in healing and improved patient recovery time makes this a technique that needs further study and increased application to determine efficacy in other cosmetic surgical procedures.

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Figure 18. *Activated platelets release growth-factor proteins into the surrounding tissue. These proteins are responsible for undifferentiated cells migrating to the site of injury and also for these cells dividing in the site of injury to replace damaged and destroyed cells. Figure courtesy of Harvest Technologies, Inc (modified by author).*

Figure 19. *The proteins that control the first 3 stages of the healing cascade are found in specific blood components: plasma, white blood cells, and platelets. Figure courtesy of Harvest Technologies, Inc (modified by author).*

Figure 20. *Delivering a concentration of autologous proteins to the surgical site may improve the healing rate. Figure courtesy of Harvest Technologies, Inc (modified by author).*

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