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Autologous Platelet Concentrate and Vacuum-Assisted Closure Device Use in a Nonhealing Total Knee Replacement

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Abstract: Following a total knee replacement surgery, a 51-year-old insulin-dependent patient presented with complications of impaired healing and postoperative trauma to the wound site. The inability of this leg wound to heal placed this patient at risk of amputation. Vacuum-assisted closure therapy was initiated at postoperative day 53; after 100 days of protracted wound history a series of treatments with topical platelet concentrates were added to the vacuum assisted closure therapy and conventional wound care therapy. The previous nonhealing wound presented with good granulation and margination that enabled a skin graft with good take on postoperative day 150. **Keywords:** platelet concentrate, nonhealing diabetic wound, vacuum-assisted closure. *JECT. 2006;38:44–47*

The patient presented to orthopedic surgery in need of a left total knee arthroplasty (TKA). He was an insulin-dependent diabetic man taking 55–60 units Novolog mix 70/30 subcutaneously in the morning and Novolin N. 100 U/mL subcutaneously 40–50 units in the evening. The evening dose was dependent on his finger stick results. His medical history included cardiomyopathy, hypertension, hypothyroidism, hyperlipidemia, atrial fibrillation, thrombophlebitis, gout, and congestive heart failure. His history also included cervical disk displacement requiring a fusion at C_5-C_6 with a halo placement, lumbar disk displacement post-L_4-L_5, lumbosacral neuritis, chronic headaches, history of herpes zoster, chronic renal insufficiency, and obesity.

The arthroplasty of the left knee was performed without incident. Three weeks after TKA, he was evaluated for some eschar (scar scab) formation over the incision. He was started on daily wet-to-dry dressings to help debride the superficial-most aspect of this ulcer. The patient was placed in a knee immobilizer and on a week of prophylactic oral cephalexin 500 mg four times a day.

Recovery was complicated by wound dehiscence and medial collateral ligament and patella tendon rupture of the left knee resulting from a fall 27 days after TKA. On day 29, he began a second course of oral cephalexin 500 mg four times a day. Thirty-five days after TKA, he underwent open repair of the medial collateral ligament and patellar tendon. The patient was started on a 2-day course of aspirin 325 mg twice a day for prevention of deep venous thrombosis, and his dressing were maintained clean, dry, and intact. On postoperative day 39, the patient was able to ambulate with assistance and was discharged after the knee immobilizer was changed to a cylinder cast.

On post-TKA day 51, the repair was complicated by poor wound healing (Figure 1). The eschar was debrided and appeared to be superficial and covering viable tissue. Two days later, treatment with subatmospheric pressure dressings or continuous vacuum-assisted wound closure (Kenetic Concepts, San Antonio, TX) was initiated through a polyurethane foam sponge cut to fit the wound surface and a negative pressure of 125 mmHg to aide in healing. The device was removed once a week, the wound was debrided and redressed, and the continuous vacuum-assisted wound closure was reapplied approximately 4 hours after each platelet concentrate treatment. After 1 week of vacuum-assisted treatment (post-TKA day 60), granulation tissue had formed with some areas of necrotic skin and tissue. The necrotic areas were debrided to bleeding tissue. On post-TKA day 71, some decussating tissue was overlaying his patella; however, there was granulation tissue about periphery of the wound. Wound grafting was discussed and would not be an option until enough granulation bed had formed to support the graft. A necrotic patellar tendon and a 15 × 15-cm wound on post-TKA day 95 further precluded skin grafting.

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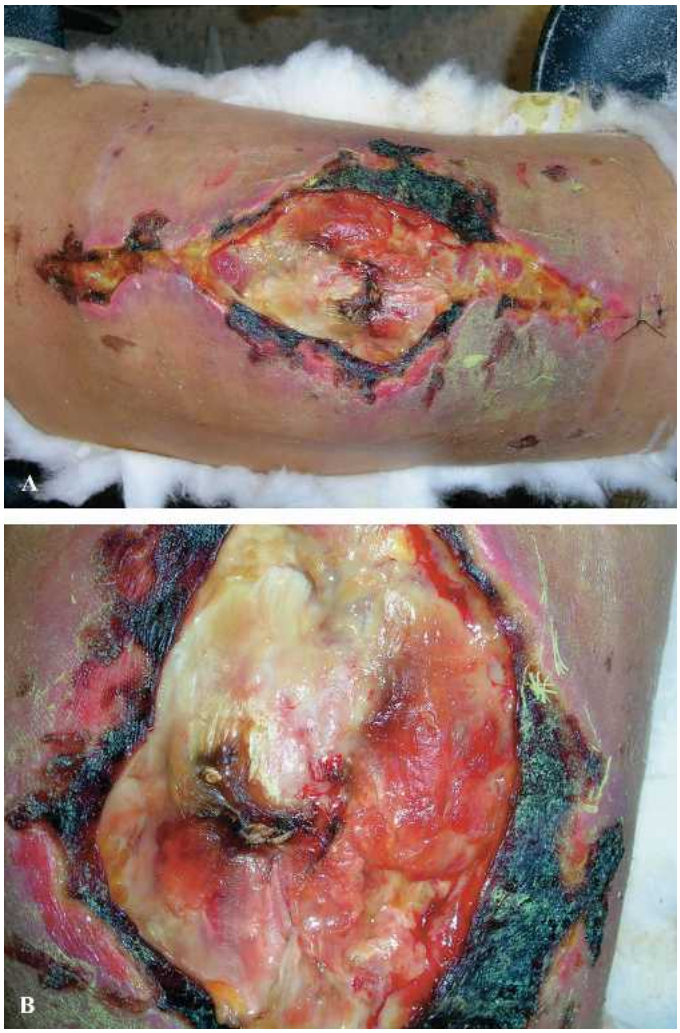

Figure 1. Wound pre-platelet concentrate treatment.

Written consent was obtained, and platelet concentrate treatment was initiated on postoperative day 100. Vacuum-assisted closure was reinstituted after each treatment. The concentrate was produced using 60 mL of anticoagulated patient blood drawn just before application. The platelet-rich fraction of the blood was separated and concentrated by centrifugation using a platelet acquisition kit and centrifuge device (Harvest Technologies Corp., Plymouth, MA); gelling was initiated by the addition of a calcium thrombin mixture added to the platelet-rich fraction at a ratio of 1:10 just before application. Platelet concentrate treatment was applied using either the spray tip or a dual-sided needle. At 104 days after surgery, more granulation tissue was noted after the first platelet treatment, especially over the patellar region. Platelet gel treatment was repeated on day 108. At postoperative day 118, there was sufficient granulation to consider the skin graft, and the platelet concentrate treatment was repeated. On postoperative day 126, the wound measured 8 × 6 cm and was treated with the fourth platelet concentrate; granulation was nearly complete at this time. When the wound measured 7 × 6 cm, the patient was scheduled for skin graft (Figure 2). The continuous vacuum closure device was discontinued, and no further platelet concentrate treatments were given. A split thickness graft was applied on post-TKA day 150. The patient was discharged 161 days after TKA with a successful skin graft.

DISCUSSION

According to the American Diabetes Association, the total economic cost of diabetes in 2002 was estimated to be 132 billion dollars, accounting for 1 of every 10 health care dollars spent in the United States (1). Wound healing in the diabetic patient continues to represent a challenge to patients, care practitioners, and the health care budgets. In a report by Pecoraro et al. (2), the causal factors predisposing diabetic patients to lower extremity amputations were quantified, and the following contributors were identified: ulceration, 84%; faulty wound healing, 81%; initial minor trauma, 81%; neuropathy, 61%; infection, 59%;

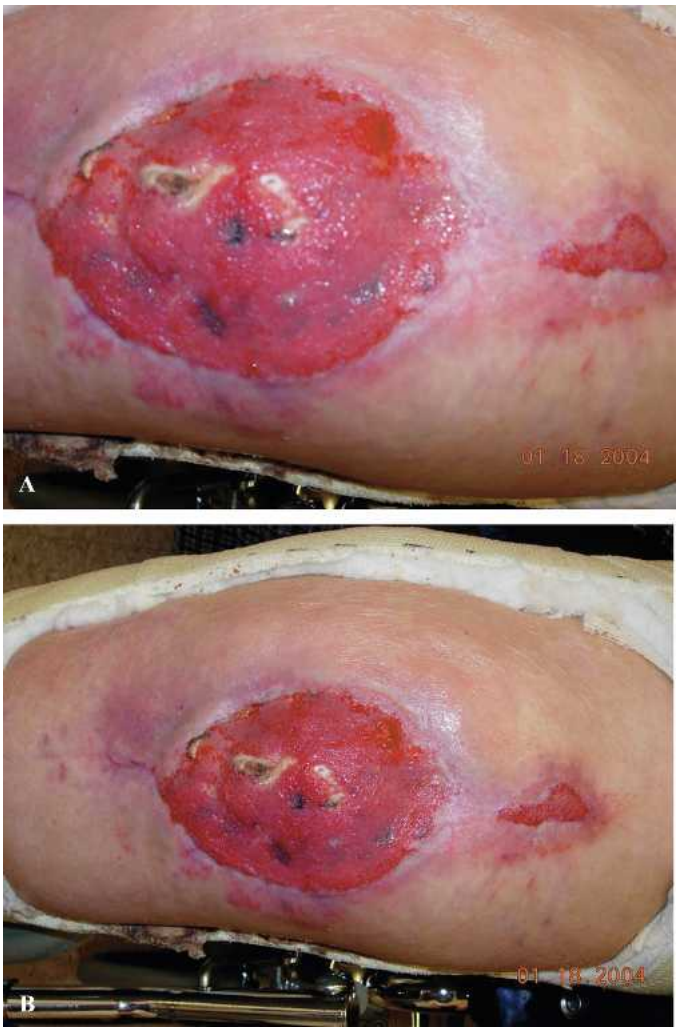

Figure 2. Wound post-platelet concentrate treatment.

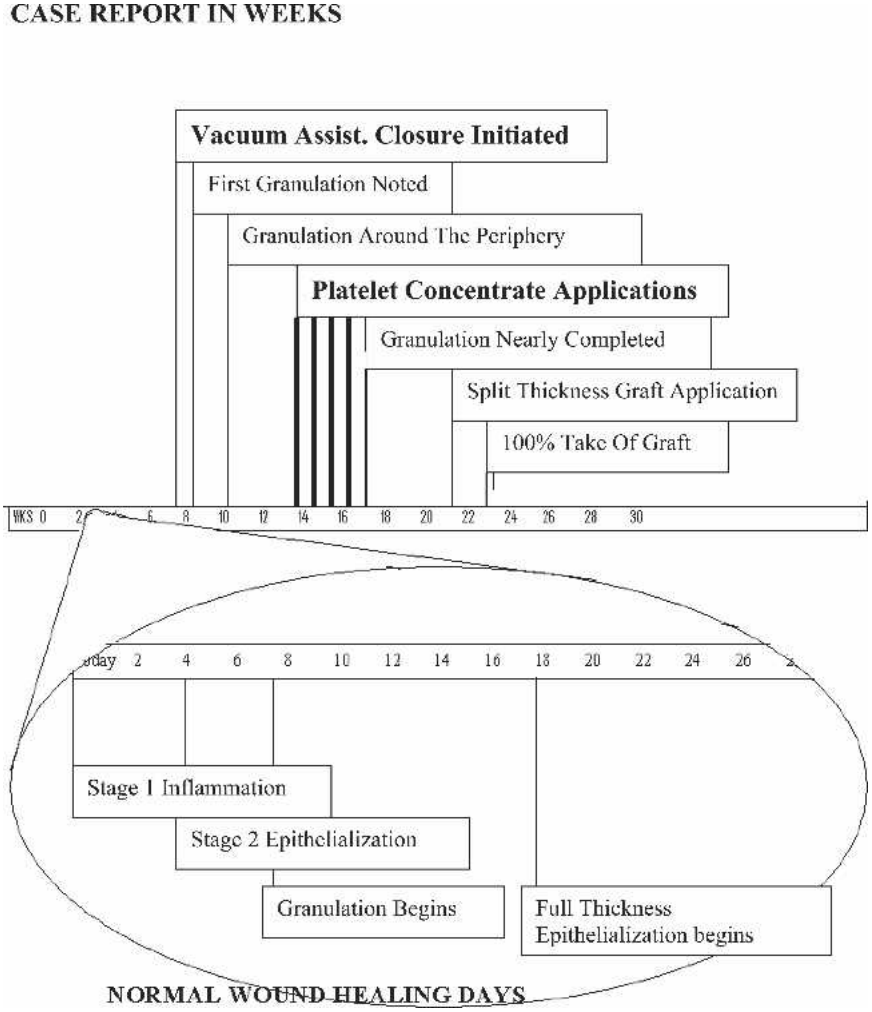

Figure 3. Comparison of the wound healing timetable in a normal subject vs. the patient presented. Normal healing is tracked in days transpired to healing landmarks exploded from the patients elongated healing timetable presented in weeks to healing landmarks.

gangrene, 55%; ischemia, 46%. More than 18 million people in the United States have diabetes, representing 6.3% of the population; 1.5 million new cases of diabetes were diagnosed in people ≥20 years of age in 2005.

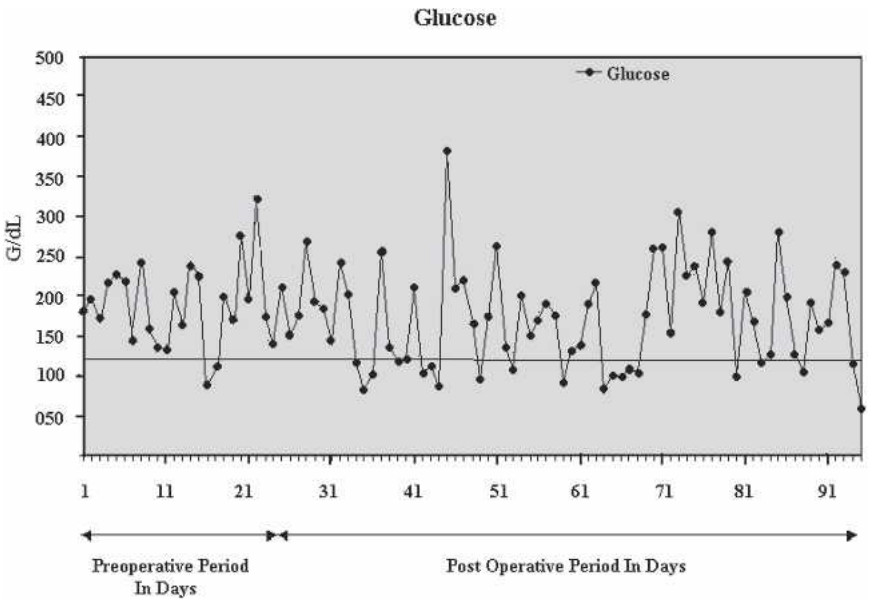

Figure 4. The patient's blood glucose levels measured in dL/ml for the period prior to surgery through skin grafting. A line is set at 120 as the upper limit of normal and the left arrow indicates the period prior to surgery, the right arrow indicates the period from surgery to skin grafting in days. Day 1 begins at the first blood glucose level measured preoperatively.

Wound healing can be divided into three phases: inflammation, tissue formation, and tissue remodeling (3). Figure 3 compares our patient's wound healing progress vs. the timeline in normal wound healing. The use of the negative pressure device theoretically increases localized blood flow, reduces wound edema, and enhances formation of granulation tissue (4).

There is evidence of improvements in wound healing with the application of recombinant and autologous platelet concentrate containing growth factors in both chronic nonhealing (5,6) and acute surgical wounds (7). Platelet α-granules release several substances on activation. More than 40 factors have been identified, including platelet-derived growth factor, transforming growth factor, vascular endothelial growth factor, endothelial growth factor, and insulin-like growth factor, in platelet concentrate. Platelet-derived growth factor is chemotactic for migration of neutrophils, monocytes, and lymphocytes, and growth factor stimulates mitogenic activity resulting in the migration from adjacent epidermis of myofibroblasts and forms the cytoskeleton that draws the wound together during granulation (6,7). The platelet concentrate seemed to have assisted in the healing process. The specific effect of the components of the α-granules of the platelet or which component is most effective in healing wounds is still not completely understood. The acceleration in the rate of granulation and wound margination by the application of platelet concentrate has been shown (8). Wound healing progressed with the addition of both vacuum and platelet concentrate therapies; however the granulation progress seemed more dramatically increased after the addition of the four platelet concentrate treatments (Figure 3). After adequate granulation, the patient returned to surgery for a skin graft.

The diabetic patient has increased circulating platelets (9). Circulating platelet degranulation seems to play a role in accelerated atherosclerotic disease (10) and could possibly result in a decrease in platelet release of the chemotactic agents in the wound itself (11). Inflammation and infection difficulties in the diabetic patient may prevent the wound from moving on to the epithelialization phase and granulation. Chronic wounds have shown the ability to degrade growth factors (12). Defects in granulocyte function have been shown in the hyperglycemic patient. A study by Nolan et al. (13) compared the granulocyte function of poorly controlled diabetes with fasting hyperglycemia with the same patients under tighter control. There is a marked difference in the granulocyte kill and engulfment function when the problem is poorly controlled. Improvement in glycemic control showed improved function, approaching that of normal subjects. Glycemic control is also believed to be beneficial to platelet function (14,15); the scope of glycemic control's effect on platelet function is a subject of great interest. Our patient had difficulty with glycemic control both preoperatively and postoperatively (Figure 4). Using 120 mg/dL as an upper limit of normal glycemia, he spent 77% of his time at hyperglycemia despite insulin therapy. Perhaps tighter controls would have made a difference in the course of healing this wound.

Diabetes is the most common metabolic disease, with a high medical care cost per year, and is often complicated by difficulty in healing wounds. Nonhealing wounds can run courses that require treatment and monitoring for months or years, the application of platelet gel may provide a concentrated quantity of growth factors to stimulate the rate of healing in difficult wounds in the diabetic patient. Platelet concentrate uses autologous blood and therefore no risk of homologous blood exposure. Either with or without vacuum-assisted closure devices, this therapy may prove valuable as an adjunct to good wound care and may shorten the amount of time to healing.

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