Incisional Vacuum-Assisted Wound Closure in Morbidly Obese Patients Undergoing Acetabular Fracture Surgery

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Abstract

We studied the effect of incisional vacuum-assisted closure (IVAC) on wound complications (dehiscences, infections) associated with surgical treatment of acetabular fractures in morbidly obese patients (body mass index, >40 kg/m^2). No wound complications were found in 19 consecutive patients over 5 years of IVAC use. IVAC is an attractive treatment adjunct for minimizing postoperative wound complications in morbidly obese patients undergoing acetabular fracture surgery.

The number of obese Americans has continued to increase over recent years. Most sources estimate that at least 25% of us are obese (body mass index [BMI], ≥30 kg/m^2), and this figure is expected to rise to 40% by 2025.[1,2] Besides being associated with cancer, hypertension, coronary artery disease, and diabetes,[3] obesity is a risk factor for postoperative complications.[4] Morbidly obese patients (BMI, ≥40 kg/m^2) have also been found to be 5 times more likely to develop a deep wound infection after acetabular fracture surgery, as well as other postoperative complications.[5] In response to these problems, authors in the general surgical literature have proposed several methods, including subcutaneous fat closure and continuous fascial closure,[6-8] for minimizing postoperative wound complications in obese patients.

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Vacuum-assisted closure (V.A.C.® Therapy; Kinetic Concepts, Inc., San Antonio, Tex) has been used extensively in the treatment of open traumatic injuries, fasciotomy wounds, and other soft-tissue problems. Application of V.A.C. to challenging traumatic wounds has been widely adopted.[9-11] Using a protocol that involves V.A.C. management of high-energy war wounds, Leininger and colleagues[12] decreased their wound infection and wound complication rate to 0%. V.A.C. has also been applied in treating postoperative wound complications and infections.[13,14] Most recently, encouraging results have been reported for V.A.C. in management of primarily closed wounds—incisional V.A.C. (IVAC). In a small series, use of this technique reduced the wound infection and complication rate to 0%.[15] Other authors have applied this technique to traumatic orthopedic wounds with draining hematomas, with significant decreases in infection rates.[16] IVAC use evolved from favorable experience in treating major traumatic and surgical wounds on a surgical intensive care unit (SICU); patients with weeping wounds were spared the ordeal of frequent, painful dressing changes. Observation of prolonged periods of serous fluid drainage in obese patients compared with quick resolution of wound drainage problems in the SICU group prompted use of IVAC in the obese patient group. In 2000, given the favorable experience of nurses, patients, and surgeons as well as the theoretical advantage in keeping a surgical wound closed and sealed in an area of potential contamination with microorganisms, Dr. Webb adopted the technique as a protocol for patients undergoing acetabular fracture surgery.

In this study, we tested the hypothesis that application of IVAC to morbidly obese patients undergoing acetabular fracture surgery would significantly decrease the rate of postoperative wound complications.

Patients and Methods

This retrospective study was conducted with approval from our institutional human subjects review board. A computerized medical record search yielded 377 patients with an acetabular fracture surgically treated between August 1996 and April 2005. Of these patients, 237 had accurate height and weight data at time of injury. We identified patients who had been morbidly obese (according to World Health Organization criteria: specifically, calculated BMI higher than 40[17,18]) and undergone surgery for their injury after the inception of IVAC.

Patients' medical records were reviewed for basic demographic data (Table). Fracture classification, surgical

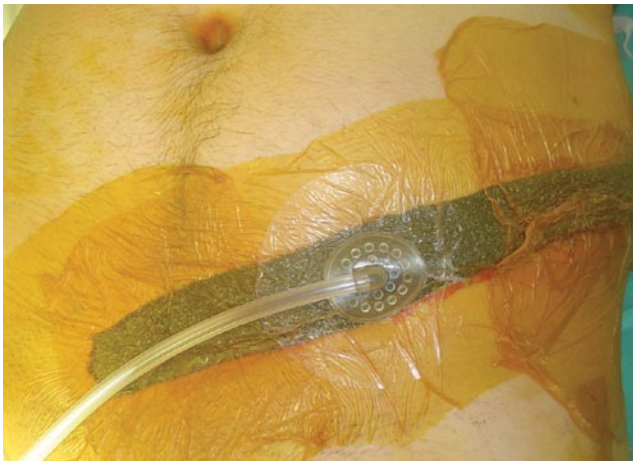

Figure. Incisional vacuum-assisted closure of surgical wound with ilioinguinal approach.

approach, and information about any surgical wound infections or wound complications were included. Fractures were classified using the system of Letournel and Judet (plain radiographs plus computed tomography scans). A wound infection was identified when the clinical appearance of the wound prompted intervention in the form of antibiotic treatment or surgical irrigation and débridement, and a wound dehiscence was identified when the clinical appearance prompted intervention in the form of reapplication of V.A.C. or surgical treatment to reapproximate the wound margins.

Technique

After open reduction and internal fixation, the wound is sharply débrided of nonviable muscle and adipose tissue and thoroughly irrigated. Next, a standard layered closure and a loose skin closure are performed. Before the sterile field is broken, the surrounding skin is cleaned with normal saline or alcohol. The incision is then covered with a narrow strip of nonadhering dressing (Adaptic; Johnson & Johnson Wound Management, Langhorne, Pa) cut wide enough so it is an intermediary between the skin and the V.A.C. sponge. A standard V.A.C. sponge is cut lengthwise, into a 2×2-cm strip, to conform to the wound. After the sponge strip is placed on the incision, it is secured with a sterile adhesive plastic sheet. After the suction tubing is inserted into or placed on top of the sponge, the tube is sealed with additional adhesive sheet (Figure). The sponge is placed on suction, usually with field suction, and remaining leaks are sealed off. Before the sterile field is broken, the sponge is placed on a setting of negative 75 mm Hg of continuous suction through a V.A.C. machine. This is continued after surgery until no edema fluid is evident in the collection tube for a total of 12 hours, usually corresponding to a time period of 24 to 72 hours after surgery, after which the V.A.C. is discontinued on the floor and traditional wound management techniques are used. Intravenous cefazolin, vancomycin, or clindamycin is used as preoperative antibiotic prophylaxis and is continued for 24 hours after surgery unless there are extenuating circumstances. For prophylaxis against deep venous thrombosis in all patients, enoxaparin 30 mg subcutaneously twice daily and use of an intermittent pneumatic compression device (PlexiPulse®; Kinetic Concepts, Inc.) on the foot were started the evening of surgery, unless there were medical contraindications to this treatment protocol. All patients were allowed touch-down weight-bearing for the first 6 weeks after surgery and then were gradually advanced to full weight-bearing over the next 6 weeks.

Results

Nineteen morbidly obese patients (15 women, 4 men) with BMI higher than 40 were identified for study. Mean age was 41 years (range, 20-72 years), mean weight was 274 pounds (range, 189-451 pounds), mean BMI was 48.7 (range, 42-75), and mean follow-up was 21 months (range, 3-37 months). All acetabular fractures were posterior injuries amenable to a Kocher-Langenbeck approach, but 1 required a staged, combined approach (ilioinguinal, Kocher-Langenbeck). There were no wound complications or wound infections in the perioperative period and no wound complications at final follow-up.

Discussion

Several authors have reported a link between obesity and complications after many different types of surgery or traumatic injury. Bamgbade and colleagues,[19] retrospectively reviewing postoperative complications in adults over a 4-year period, found a significantly higher incidence of myocardial infarction, wound infections, nerve injury, and urinary infection and concluded that obesity is an independent risk factor for perioperative morbidity and that morbid obesity is a risk factor for mortality. In a review of the management of obese trauma patients, Meroz and Gozal[20] found that the tendency to develop more complications after trauma was higher for obese patients than for lean patients. They also found that, across multiple reviews of the topic, more weight and higher BMI were strong predictors of 30-day mortality. Bochicchio and colleagues[21] collected data prospectively on 1167 trauma patients admitted to an ICU over a 2-year period and found that obese patients were 7.1 times more likely to die in the hospital and 2 times more likely to develop a urinary tract, bloodstream, or respiratory infection. In a retrospective study of 169 patients, Karunakar and colleagues[5] found a definite relationship between obesity and complications after surgical treatment of acetabular fractures. They measured BMI as a continuous variable and found it to have a significant relationship with estimated blood loss, prevalence of deep venous thrombosis, and wound infection. Russell and colleagues,[22] in a retrospective review of 131 patients who underwent surgical treatment of acetabular fractures, found 4 wound complications in morbidly obese patients. In addition, Russell and colleagues,[23] reporting on their 5-year experience with 39 morbidly obese patients, found 16 imperfect or poor reductions and 9 fixation failures. They also reported 9 wound complications,

Table. Patient List

Patient No.	Age at Injury (y)	Sex	Fracture Type	Follow-Up (mo)	Height (in)	Weight (lb)	Calculated BMI (kg/m^2)
1	20	F	PW/PC	3	66	260	42.3
2[a]	25	F	PW	16	67	275	43.1
3	39	F	PW/PC	18	60	231	45.1
4	29	M	PW/PC	6	59	207	42.3
5	31	F	PW/PC	24	66	268	43.6
6	40	F	Complex	21	62	275	50.3
7	48	F	TR/PW	37	68	275	42.2
8	23	F	TR/PW	29	62	244	44.6
9	42	F	TR/PW	36	70	293	42.0
10	33	M	PW/PC	30	50	189	53.1
11	31	M	PW	36	61	268	51.3
12	70	F	TR/PW	30	60	233	45.5
13	48	F	PW/PC	36	64	326	56.0
14	47	F	TR/PW	18	68	297	45.8
15	72	F	PW/PC	6	52	220	57.3
16	57	F	PW	6	65	451	75.0
17	28	F	AC/PW	6	64	249	42.7
18	56	F	PW/PC	12	63	266	47.1
19	41	M	TR/PW	24	69	385	56.8

Abbreviations: PW, posterior wall; PC, posterior column; TR, transverse; AC, anterior column; BMI, body mass index.
[a]For patient 2, a staged, combined approach (ilioinguinal, Kocher-Langenbeck) was used. For all other patients, only the Kocher-Langenbeck approach was used.

including 8 deep wound infections. In a comparison with patients with BMI lower than 40, they found a significant increase in estimated blood loss, surgical time, and length of hospital stay. Their recommendation is to "heavily" weigh the risk for complications before operating on these patients. Sems and colleagues[24] compared obese (BMI, ≥30) and nonobese patients in a retrospective analysis of 182 consecutive pelvic ring injuries. They found that the 56.3% complication rate for the 48 obese patients included 16 deep wound infections and concluded that BMI correlates with an increased rate of complications and need for reoperation after surgical treatment of pelvic ring injuries. In our series of 19 morbidly obese patients, including 1 patient with BMI of 75, there was not a single postoperative wound complication after institution of IVAC.

Several authors have written about microcirculation and its role in wound healing as well as the effect of V.A.C. on microcirculation.[25-27] Application of a controlled vacuum to tissue facilitates removal of excess interstitial fluid because of increased pressure gradients, which decrease interstitial pressure. When interstitial pressure level drops below capillary pressure level, capillaries reopen and blood flow at the microcirculatory level is restored.[25] Factors that impair cell adhesion and migration—such as collagenases and elastase—are removed along with excess fluid.[25] This mechanism creates an environment less favorable for bacterial proliferation and increases the speed of early healing. Early V.A.C. research demonstrated that mechanical stress to the wound tissue deforms the extracellular matrix and cell cytoskeleton, enhancing tissue growth and expansion to further enhance early healing.[25] This has been shown to result from release of intracellular second messengers and upregulation of early oncogenes associated with cell growth, proliferation, and differentiation.[14,20-23,26-28] In their discussion of managing the high-energy contaminated wound, Webb and colleagues[29] described *inflammatory mediator storm–induced soft-tissue compartment syndrome*, in which initial tissue trauma causes a release of inflammatory mediators, which cause capillaries to leak. The net result is a flow of fluid from the vascular space to the extravascular space, resulting in tissue swelling and edema. As the venular side of the capillary loop is the most thinly walled area of the blood vessel circuit, it is the area most susceptible to the increased pressure; thus, it collapses partially, and capillary flow is decreased. This results in tissue compromise and in the decreased ability of cellular defensive mechanisms to access the zone of injury. When this cycle is not broken early enough, tissue compromise in the zone of injury can continue, facilitating creation of an environment favorable for bacterial growth and tissue necrosis. For surgically treated acetabular fractures, the incisional bed endures 2 insults: (1) an insult from the injury that created the fracture itself and (2) an iatrogenic injury in the form of surgical treatment. IVAC application after these insults is thought to actively remove the local edema (and associated inflammatory mediators) from the tissue and, analogous to the situation in the high-velocity wound, thereby improve microcirculation.

Our retrospective study had all the potential weaknesses of this design. The wound complication diagnosis short of fulminant deep wound infection was derived from interpretation of the wound condition by the physicians who were caring for the patient at that precise point, so there is room for potential error in the understanding of their descriptions in the medical record. In addition, as the studied groups encompassed a span of several years, we cannot be sure that institution of the IVAC protocol was the only factor affecting our infection rate. In addition, confirmatory height and weight data were not captured in the medical record for 140 patients with acetabu-

lar fractures in our series of 377 fractures. However, for all patients who developed a wound complication in the form of infection or dehiscence, height and weight data were captured during their follow-up care regardless of BMI both before and after institution of the IVAC protocol. A strength of this study is that it was a single-surgeon, single-institution study, so there is some inherent consistency in the technique outside of the wound care protocol. A separate analysis of the patients treated between August 1996 and June 2001—corresponding to the 5-year period immediately before adoption of IVAC as a regular part of a postoperative protocol for acetabular fracture surgery at Dr. Webb's institution—can be used as a basis for comparison. Sixty consecutive patients available in the 5 years immediately preceding IVAC use had 4 (6.7%) deep wound infections and 2 (3.3%) wound dehiscences. All wound dehiscences occurred in patients with surgical wound infections. After institution of IVAC as part of a standard protocol for postoperative management of acetabular fracture patients, 212 patients had 3 (1.4%) deep wound infections and 1 (0.5%) had a wound dehiscence. No superficial wound infections were documented.

Our retrospective study demonstrated that IVAC prevented wound complications or infections in a challenging group of patients, the morbidly obese. We believe that application of this soft-tissue management tool decreases the incidence of perioperative wound complications in morbidly obese patients.

Authors' Disclosure Statement

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