An Evidence-Based Approach to Liposuction

James H. Wells, M.D.
Keith A. Hurvitz, M.D.
Irvine, Calif.

The Maintenance of Certification module series is designed to help the clinician structure his or her study in specific areas appropriate to his or her clinical practice. This article is prepared to accompany practice-based assessment of preoperative assessment, anesthesia, surgical treatment plan, perioperative management, and outcomes. In this format, the clinician is invited to compare his or her methods of patient assessment and treatment, outcomes, and complications, with authoritative, information-based references.

This information base is then used for self-assessment and benchmarking in parts II and IV of the Maintenance of Certification process of the American Board of Plastic Surgery. This article is not intended to be an exhaustive treatise on the subject. Rather, it is designed to serve as a reference point for further in-depth study by review of the reference articles presented. (Plast. Reconstr. Surg 127: 949, 2011.)

CLINICAL SCENARIO

A 42-year-old woman presents with a request for liposuction. She is hypertensive and a type 2 diabetic with a body mass index of 32 (height, 5 feet 4 inches; weight, 185 lb). She smokes one pack per day and is on birth control medication. What is the best available evidence to guide you in the management of her request for liposuction?

Most surgeons practice liposuction management based on what they learned in training, altered only by anecdotal evidence with regard to complications and personal outcomes. The purpose of this article is to provide a summary of the best available evidence on liposuction that, when combined with individual clinical expertise, can assist the surgeon in the continuing evolution toward optimal outcomes.

METHODS FOR IDENTIFYING EVIDENCE

A literature search of PubMed, the Cumulative Index to Nursing and Allied Health Literature, and the Cochrane Library was performed to obtain the best available evidence on liposuction, with emphasis on preoperative assessment, antibiotic and deep vein thrombosis prophylaxis, anesthesia/analgesia, treatment, and outcomes. The following search terms were combined as appropriate, and PubMed MeSH terms were used when available: “liposuction,” “lipoplasty,” “lipectomy,” “diagnosis,” “preoperative assessment,” “risk factors,” “chronic obstructive pulmonary disease,” “coronary artery disease,” “hypertension,” “body mass index,” “diabetes mellitus,” “oral contraceptives,” “smoking,” “venous thrombosis,” “DVT,” “deep vein thrombosis,” “prevention,” “control,” “prophylaxis,” “antibiotic prophylaxis,” “anesthetics,” “premedication,” “surgical treatment plan,” “treatment,” “surgery,” “outcome,” “complications,” “postoperative complications,” “seroma,” “necrotizing fasciitis,” “toxic shock syndrome,” “contour irregularities,” “infection,” “pain management,” and “analgesia.” The initial search was limited to human studies that were published from 1999 to 2009 and indexed as meta-analyses, randomized controlled trials, clinical trials, or comparative studies; however, additional references were included if deemed necessary for discussion. Studies were excluded if the full text was inaccessible or of non-English language, as the study quality could not be evaluated. Relevant studies were appraised for quality and validity according to criteria published by the Critical Appraisal Skills Programme4 and assigned a level of evidence with the American Society of Plastic Surgeons Evidence Rating Scale for Therapy (Table 1). Levels of evidence are indicated

Disclosure: The authors have no financial interest to declare in relation to the content of this article.
EVIDENCE ON PREOPERATIVE ASSESSMENT

No articles were found in a literature search that provided consistent evidence-based information to specifically guide preoperative assessment of liposuction patients. The limited patient-selection process cited in some of the evidence-rated articles from the search was extrapolated. Currently, there is no consistent evidence about preoperative assessment.

Araco et al.,2 in their study, excluded patients with body mass indexes greater than 30 or those with inelastic or redundant skin. Patients with severe cardiovascular or respiratory disease, poor liver function, altered platelet function, thyroid disease, or Raynaud disease were also excluded as liposuction candidates.3 In other studies, surgery was restricted to patients with an American Society of Anesthesiologists class of 1 or 2.3–5 Patients with American Society of Anesthesiologists ratings of 3 or 4 were not selected for surgery. Cooter et al. limited surgery to “those in good health and close to ideal weight.”6 In a study on lipoadminoplasty, Heller et al. included smokers in two groups of patients.7 This surgery consisted of abdominoplasty with limited undermining combined with liposuction. Smoking did not appear to be an excluding factor in these patients. Khan, in contrast, asked patients to stop smoking 4 weeks before undergoing combined liposuction and abdominoplasty.5 Khan also discontinued oral contraceptives and considered diabetes a relative contraindication to surgery. Grossman et al. continued oral contraceptives but performed pregnancy tests on female patients of child-bearing age.8 González-Ortiz et al.9 wanted the patient’s weight to be stable for 3 months before surgery, whereas Butterwick et al.10 excluded patients whose weight was more than 5 percent greater than their weight at entry to the study.

EVIDENCE ON ANESTHESIA

The addition of lidocaine to wetting solutions is believed to provide the patient with intraoperative and postoperative analgesia at the liposuction sites. Lidocaine is well known to be toxic in high doses. However, the addition of epinephrine to the lidocaine wetting solution has been shown to delay the absorption of lidocaine, thereby decreasing the potential for toxicity (Level II Evidence).11 The safe level of lidocaine in tumescent solutions has been established by Klein and others at 35 mg/kg concentration, as referenced by Kenkel et al. (Level V Evidence).12 However, Hatef et al. recently showed that lidocaine concentrations as low as 10 mg/kg in the wetting solution provided intraoperative and postoperative analgesia equal to that provided by 30-mg/kg concentrations in their series of patients (Level II Evidence).13

To test the theory of whether lidocaine-containing wetting solution reduces postoperative pain, Perry et al. performed bilateral liposuction procedures on 10 patients (Level II Evidence).14 Lidocaine was omitted from one side of each patient; thus, each patient served as his or her own control. No significant difference in pain level was reported postoperatively between the lidocaine-wetted and non-lidocaine-wetted sides. These results indicated that lidocaine is not necessary for postoperative analgesia in liposuction.

Grossman et al. explored the use of alternative analgesics for tumescent liposuction (Level II Evidence).8 They used articaine hydrochloride instead of lidocaine and found it to be rapidly metabolized in the periphery to inactive byproducts. No signs of nervous system toxicity were encountered despite concentration levels up to 32.8 mg/kg. Its lower toxicity rating and rapid breakdown has an appeal particularly if liposuction is performed under local anesthesia.

EVIDENCE ON SURGICAL TREATMENT PLAN

Traditional suction-assisted lipoplasty, ultrasound-assisted lipoplasty, and power-assisted lipoplasty are all widely used, based mainly on individual physician preference. However, advances in...
traditional suction-assisted lipoplasty instrumentation have been shown to produce benefits for both patient and surgeon. Compared with suction-assisted lipoplasty, power-assisted liposuction has been shown to reduce procedure time, intraoperative pain, and surgeon fatigue, and to produce higher fat aspirate volumes per area (Level II Evidence). Internal ultrasound-assisted liposuction patients have quicker recoveries from pain and significantly less blood in the lipoaspirate (Level II, III Evidence). Garcia and Nathan compared suction-assisted lipoplasty with ultrasound-assisted lipoplasty and noted three times more aspirate with ultrasound-assisted lipoplasty than with suction-assisted lipoplasty (Level III Evidence). The hematocrit value of suction-assisted lipoplasty aspirate was 6.5 times higher than that of the ultrasound-assisted lipoplasty aspirate. Patient satisfaction was found to be higher in the ultrasound-assisted lipoplasty group, with an 80 percent improvement in skin laxity in 2 months. Cooter et al. studied the efficacy and safety of ultrasound-assisted lipoplasty and found it beneficial in fibrous anatomical areas and secondary liposuction (Level IV Evidence). The power water-assisted technique has shown promising results with respect to significant reduction in postoperative pain and bruising compared with traditional suction-assisted lipoplasty (Level I Evidence).

Scuderi et al. compared three liposuction techniques: ultrasound-assisted lipoplasty, suction-assisted lipoplasty, and power-assisted liposuction (Level II Evidence). Suction-assisted lipoplasty aspirate was found to be bloodier. Ultrasound-assisted lipoplasty resulted in higher triglyceride levels in the lipoaspirate, higher cost, and a longer learning curve, with slightly larger incisions. Power-assisted liposuction had the highest surgeon discomfort because of vibration, but this was contrasted with reduced surgeon fatigue. It was less traumatic to the patient, with easier tunneling and faster fat removal. Power-assisted liposuction operating times were 50 percent less compared with ultrasound-assisted lipoplasty and 25 percent less compared with suction-assisted lipoplasty. All three techniques, however, produced good aesthetic results and the technique choice was surgeon dependent.

Disadvantages with the newer techniques over traditional suction-assisted lipoplasty include increased tissue damage with the ultrasound-assisted technique (Level II Evidence) and higher surgeon distress while using power-assisted liposuction devices (Level II Evidence). Cárdenas-Camarena et al. compared ultrasound-assisted lipoplasty with classic tumescent suction-assisted lipoplasty and found more tissue damage and bleeding in ultrasound-assisted lipoplasty patients. Other negative findings with ultrasound-assisted lipoplasty included increased operating times, thermal injury at entry sites, temporary neurapraxia, and seromas. Cooter et al. reviewed ultrasound-assisted lipoplasty compared with suction-assisted lipoplasty, with no conclusive evidence of ultrasound-assisted lipoplasty safety benefits (Level IV Evidence). Adverse effects included fat necrosis, sensory changes, skin necrosis, skin pigmentation, surface irregularities, and thermal burns at incision sites before the use of skin protectors. There was inadequate information regarding possible DNA damage from ultrasound-assisted lipoplasty. A recommendation was made for the need for specific surgeon training in ultrasound-assisted lipoplasty techniques and risks. Roustaei et al. noted a relatively high rate of seroma formation within their series of patients; however, their overall complication rate was low (1.36 percent) and within the range of other liposuction modalities (Level IV Evidence). In another study, Scuderi et al. compared power-assisted liposuction and suction-assisted lipoplasty and noted a 17.5 percent higher output level with power-assisted liposuction over suction-assisted lipoplasty except for the inner thigh area (Level II Evidence). Katz et al., in a series of power-assisted liposuction tumescent cases, showed the efficiency of power-assisted liposuction in reduced operative time and reduced surgeon fatigue (Level IV Evidence). No systemic patient complications were noted. The few postprocedure seromas encountered were treated with aspiration and compression.

New technology in liposuction, however, does not necessarily mean an advancement in technique. This appears to be the case for laser-assisted lipoplasty and external ultrasound-assisted liposuction. Prado et al. examined laser-assisted lipoplasty versus traditional suction-assisted lipoplasty but failed to find any true benefit from using one technique over the other (Level II Evidence). In contrast, higher levels of free fatty acids following laser-assisted liposuction caused some concern over the potential for hepatic or renal toxicity. External ultrasound-assisted liposuction has not been shown to produce any benefit over traditional suction-assisted lipoplasty (Level II Evidence).

Maintenance of patient normothermia during liposuction significantly reduces bleeding times and activated partial thromboplastin levels compared with hypothermic patients (Level II Evidence).
Evidence). Temperature measures include warming infused fluids and forced-air skin warming. Robles-Cervantes et al. heated infiltrating solutions for 2 minutes in a microwave oven and found that it improved patient comfort in recovery by reducing chills (Level II Evidence). There were no other intraoperative hemodynamic changes noted and, overall, it did not appear to have any significant effect on patient outcome.

The combination of abdominoplasty and liposuction is a topic of concern and debate. Heller et al., in a study demonstrating the safety and efficacy of modified transverse abdominoplasty with limited paramedian supraumbilical dissection, successfully performed liposuction using a superwet technique in combination with their abdominoplasties (Level III Evidence). An important key was limited undermining of the supraumbilical abdominal flap only 7.5 cm from the midline in both lateral directions. Khan demonstrated safety in combined abdominoplasty and limited flank liposuction (700 to 800 cc) and also added tension suture closure of the abdominal flap (Level III Evidence).

Wojnikow et al. specifically evaluated liposuction to reduce lymphedema of the arms (Level III Evidence). The benefit of adding tourniquets and epinephrine to the therapy was examined. They were able to show that blood loss can be significantly reduced if liposuction is performed with a tourniquet and further reduced if epinephrine tumescent is also used.

**EVIDENCE ON PAIN MANAGEMENT**

The use of lidocaine and anesthetics for pain relief during liposuction is discussed in the Evidence on Anesthesia section. However, there is little evidence on postoperative pain management in liposuction patients. Kenkel et al. demonstrated that lidocaine used during the liposuction process drops to subtherapeutic levels within 4 to 8 hours after surgery (Level V Evidence). Despite these continued lesser levels, which may result in lowered anesthesia needs, patient-controlled opiates were administered after large-volume liposuction. Specific dosages are not indicated. Araco et al., in discussing power water-assisted liposuction, found 87 percent of patients free of pain after 4 days (Level I Evidence). No comment regarding postoperative pain management was made. Comparison was made to traditional liposuction in which 51.8 percent of patient required pain relief during the first postoperative hours, with 29 percent requiring pain relief during the first postoperative day. Higher narcotic dosages were required to alleviate the pain.

**EVIDENCE ON POSTOPERATIVE OUTCOMES**

Obese patients who have undergone large-volume liposuction have been shown to have a significant improvement in insulin sensitivity and decreased peripheral plasma concentrations of glucose and uric acid (Level II Evidence). Ybarra et al., in a case series on obese women, noted a decrease in weight, body mass index, and waist circumference after abdominal liposuction (Level IV Evidence). Improvement in the major lipoprotein components of obesity-associated atherogenic dyslipidemia was also noted. However, removal of subcutaneous fat without loss of visceral fat produced no effect on insulin resistance in this study, in contrast to the study by González-Ortiz et al.

Gravante et al. conducted a prospective comparative study on patients with combined abdominoplasty and liposuction (Level II Evidence). Treatment with low-molecular-weight heparin was instituted both preoperatively and postoperatively. Patients received 4000 units 2 hours preoperatively. Preoperative antibiotics were also administered. Patients were not on hormones or oral contraceptives. Pulmonary embolism occurred in patients who were nonsmokers and had a resection weight greater than 1500 g. Surgical time greater than 140 minutes was also a factor. Wound infections occurred in smokers only. A correlation between embolism formation and longer operating room time could be inferred from these data.

In 2001, Cárdenas-Camarena et al. studied tumescent liposuction in conjunction with external ultrasound and its impact on skin retraction (Level II Evidence). There appeared to be no added benefit to using external ultrasound in conjunction with tumescent liposuction. No evidence of increased skin retraction was seen after 6 months. In 2002, Cárdenas-Camarena evaluated the internal ultrasound modality (Level II Evidence). Aspirate was collected and evaluated in the laboratory. The results showed a statistically greater degree of tissue damage when using internal ultrasound compared with traditional tumescent liposuction.

**SUGGESTED TREATMENT FOR CLINICAL SCENARIO**

When practicing evidence-based medicine, the surgeon should consider the strength of the available evidence and integrate the evidence with
his or her clinical expertise and the patient’s values and preferences to develop an appropriate treatment plan. The treatment plan below is an example of how the surgeon might use the evidence to care for this particular patient.

Without clear evidence-based literature on preoperative assessment of liposuction patients, an unequivocal evidence-based recommendation on this particular patient as a candidate for liposuction cannot be made. She has multiple systemic illnesses (diabetes, hypertension, obesity), is taking oral contraceptives, and is currently smoking, which places her in the American Society of Anesthesiologists class 3 range. An American Society of Anesthesiologists rating in the range of 1 and 2 is used to qualify patients for liposuction or liposuction in combination with abdominoplasty in various studies3–5,13; however, there is no evidence to directly support this practice.

With respect to liposuction technique options, however, power-assisted liposuction or the power water-assisted technique under general anesthesia with dilute epinephrine superwet technique on an outpatient basis is the preferred evidence-based technique (Level I, II Evidence).2,15,16 The fluids infused should be warmed to room temperature and the patient maintained at normothermic temperatures (Level II Evidence).3,4 No lidocaine would be necessary if the procedure were performed under general anesthesia (Level II Evidence).14 Operating room time should be minimized to reduce the risk of pulmonary embolism (Level II Evidence).27

James H. Wells, M.D.
2880 Atlantic, Suite 290
Long Beach, Calif. 90806
jhwells1@me.com

ACKNOWLEDGMENTS
The authors thank the following individuals for their assistance with this project: American Society of Plastic Surgeons staff member Jennifer Swanson, B.S., M.Ed., for project management and editorial support; American Society of Plastic Surgeons staff member Karie Rosolowski, M.P.H., for literature searches; and Victoria Briones Chiongbian, Ph.D., for critical appraisal of studies included in this review.

REFERENCES
22. Katz BE, Bruck MC, Felsenfeld L, Frew KE. Power liposuc-
927; discussion 927.