Liposuction with 'sonic sculpture': Four years' experience in over 250 patient procedures

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RA Kloehn. Liposuction with 'sonic sculpture': Four years' experience in over 250 patient procedures. Can J Plast Surg 1994;2(2):85-89. The author has now used ultrasonic liposculpture for over four years on a large series of patients, employing first the Ultravac Series 3 and currently the Surgitron Series 2000 prototypes for this application. Use of ultrasonic energy for liquefaction of body fat has evolved from the earlier use of such energy in phacoemulsification for cataract removal. This adaptation has proven advantageous to both patient and surgeon alike, when comparing previous methods of closed liposuction with those of ultrasonic-assisted lipoaspiration. Specific patient advantages include greater comfort postoperatively due to decreased tissue trauma, more refinement possible in body sculpting, diminished blood loss during surgery, and an opportunity for the larger patient to benefit from technology heretofore reserved for only the smaller individuals. The benefits to the surgeon include greater speed of execution in liposuction surgery and reduced physical effort. Electrical energy is transformed to high frequency energy by the ultrasonic generator, which is transmitted to a piezoelectric transducer or handpiece. The handpiece changes the energy into ultrasonic mechanical vibrations which are conveyed and amplified by the hollow titanium cannula to the fatty tissues. These ultrasonic mechanical vibrations, capable of creating microcavities within fluid and fat, do not affect the more dense structures in the area such as vessels, nerves, muscle or bone, at the specific energy levels employed. Following the initial creation of micro-cavities within fatty tissue, these cavities implode with continued energy application. This leads to cavitation, with explosion of fat cells and fatty liquefaction within adipocytes. Triglycerides are released into extracellular tissues and aspirated along with damaged fat cells, connective tissue and infused fluid. Heat generated in the process is not damaging if the tumescent technique is used.

Key Words: *Adipocytes, Cavitation, Implode, Liposuction, Microcavities, Ultrasound*

Liposuction avec remodelage sonique : quatre années d'expérience et plus de 250 interventions

RÉSUMÉ : L'auteur a procédé depuis plus de quatre ans à des liposculptures ultrasoniques chez de nombreux patients, à l'aide tout d'abord de l'Ultravac Series III et actuellement, à l'aide du Surgitron Series 2000, prototypes utilisés pour cette application. L'utilisation de l'énergie ultrasonique pour la liquéfaction des graisses corporelles a évolué depuis ses débuts dans la phacoémulsification pour le traitement des cataractes. Ce progrès s'est révélé avantageux, tant pour les patients que pour les chirurgiens, si on établit une comparaison avec les méthodes précédentes de liposuction fermée avec lipoaspiration assistée par échographie. Les avantages spécifiques pour les patients comprennent un plus grand confort post-opératoire dû à un traumatisme tissulaire moindre, un remodelage possiblement plus raffiné du corps, une moins grande perte sanguine durant la chirurgie et la possibilité pour le patient plus gros de bénéficier de cette technologie à laquelle il n'avait jusqu'à présent pas accès. Les avantages pour le chirurgien sont, entre autres, une exécution plus rapide de la chirurgie pour liposuction et un effort physique moindre. L'énergie électrique est transformée en énergie de fréquence élevée par le générateur ultrasonique, puis transmise à un capteur ou pièce à main piésoélectrique. La pièce à main change l'énergie en vibrations mécaniques ultrasoniques qui sont transmises et amplifiées par la canule de titane vers les tissus graisseux. Ces vibrations mécaniques ultrasoniques, capables de créer des microcavités à l'intérieur des liquides et des graisses, n'affectent pas les structures plus denses des vaisseaux sanguins, des nerfs, des muscles ou de l'os, au degré d'énergie spécifique employé. Suite à la création initiale des microcavités à l'intérieur des tissus graisseux, ces cavités font implosion avec l'application continue d'énergie. Cela entraîne une excavation avec explosion des cellules graisseuses et liquéfaction graisseuse à l'intérieur des adipocytes. Les triglycérides sont libérés vers les tissus extracellulaires et aspirés avec les cellules graisseuses endommagées, le tissu conjonctif et le liquide perfusé. La chaleur générée par ce processus n'est pas nuisible si la technique de d'infiltration est utilisée.

Liposuction with the standard techniques used by most plastic surgeons remains one of the most popular and frequently performed cosmetic surgeries in the United States and other developed countries. Despite this, reluctance exists on both the part of patients and plastic surgeons to proceed with the operation in many instances. This is because of undesirable blood loss, possible postoperative contour deformity and prolonged bruising and discomfort for the patient. Surgeons often prefer to exclude all but the most minor

of cases for these reasons and also because of the amount of physical work required when operating on large patients. The use of a general suction aspirator, which is ultrasonic-assisted, has made liposculpture safer, with improved aesthetic results. Furthermore, operating time is significantly reduced with much less physical work for the surgeon.

For the initial three years beginning in February 1990, during which the ultrasonic liposculpture technique was employed, the Series Three Ultravac machine was the prototype used, followed by a more efficient system, the Surgitron Series 2000 System (Surgitron International Inc, Escondido, California).

With the first prototype, there was significantly less blood

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loss and more refinement possible in body contouring than with conventional methods of liposuction, although operating time was essentially unchanged even though surgical workout was less. With the Surgitron Series 2000, which is capable of delivering greater amounts of ultrasonic energy at the cannula tip for fatty emulsification, the benefits of the technology have been greatly increased in all parameters, including a reduction in operating time of approximately 60%.

This series, involving over 250 patient procedures and more than 150 patients, has required no blood transfusions.

All patients were treated on an outpatient basis with a complication rate below 8%, comprising mainly minor surface irregularities or asymmetries. Noticeable improvement in contour and balance was seen within weeks rather than months, with a high degree of patient satisfaction and comfort. Other modalities, such as superficial liposuction with fat reinjection and cellulite reduction techniques, have been integrated with this technology for the best combinations of methods known to produce good results.

DEFINITION

The Surgitron Series 2000 System consists of a general suction system with ultrasonic assisted aspiration. A controllable amount of ultrasonic energy is applied to the tip of the aspirating cannula which is mechanically resonant at an applied ultrasonic frequency causing vibrations in the cannula tip. These vibrations, in turn, emulsify the fatty tissues at least partially, prior to aspiration. Applied ultrasonic energy amplitude is manually controlled by the operator during the surgical procedure but will automatically modify depending upon tissue density.

The Surgitron Series 2000 includes a computerized ultrasonic generator, a piezoelectric hand piece, and three hollow titanium cannulae, which are moved longitudinally in the ultrasonic spectrum for aspiration. Removal of the emulsified fatty tissue, triglycerides and connective tissue is facilitated through the hollow cannula, which has a 5 mm outer diameter.

Procedure of 'sonic sculpture'

Aspiration is carried out through 1 cm incisions in strategic areas using the typical cross hatching pattern of cannula movement with standard liposuction techniques, though this is not as important as it is with the older techniques because of the emulsification. The speed of the cannula movement is approximately one half the rate normally used in standard liposuction techniques. Cannulae in stainless steel or cold rolled steel are available but are not as effective as the titanium variety, and can fracture more easily. Aspiration with these titanium cannulae can be done at all levels, including subdermal and deep subcutaneous, with the option of collection of aspirate for reinjection being done simultaneously, with an in-tube collecting device.

In cases of unusual skin laxity, or cellulite formation, fat is occasionally reinjected at the subdermal level, leading to improved results generally (1-3).

Over the past few months, in keeping with other reported

experiences (4), patients with skin laxity problems have been treated by means of more prolonged application of the ultrasonic cannula to the subdermal layer of skin, without simultaneous suction application. Special care must be taken to avoid overheating the skin in these instances by means of variable timing of ultrasonic contact from one area to another, thus preventing undesirable healing problems (5). The inducement of skin contracture by these methods appears promising, and may lead to improved postoperative skin quality without fat reinjection in select individuals.

The ease of movement of the ultrasonically vibrating cannula is remarkable, comparisons having been done in many cases with both standard and ultrasonic cannulae on the same patient. This allows for easier penetration of tissues, less intraoperative patient discomfort and less surgeon fatigue, enabling the surgeon to concentrate on aesthetics.

Feathering of edge areas is also facilitated because of the partial 'melting' or emulsification of fat which makes the tissues smooth out more completely during the healing process.

Blood loss with the 'sonic sculpture' technique is reduced by approximately one half to two-thirds of that seen using standard liposuction techniques. The visual hematocrit in the tubing is consistently and significantly less than with standard techniques and the volume of aspirate is also less by comparison, because of partial liquefaction of the aspirated fat. The tumescent technique is now standard in my cases (6), but large volume injections are not necessary, making contour symmetry much easier to obtain postoperatively. (The formula for injection used in the tumescent technique is: 1000 mL lactated Ringer's; 120 mL 0.75% bupivacaine hydrochloride; 2 mL adrenaline chloride 1:1000; 6 mL 3% bicarbonate solution). The use of the tumescent technique normally minimizes blood loss, without the use of the ultrasonic method. Even with only the use of the tumescent technique, autotransfusion had been required in many of our earlier cases but is now no longer needed.

PATIENT PREPARATION

Patients undergoing liposuction are treated with oral iron therapy for approximately 10 days preoperatively and continue with this for approximately three or more weeks postoperatively depending upon the amount of adipose tissue removed. Patient selection includes those with minimal or moderate disproportion with an occasional large patient who wishes a 'jump start' on general body fat reduction by diet and exercise.

Patients avoid preoperative ingestion of any substance which may cause increased bleeding and each has a complete blood count and HIV screening. Local anaesthesia with the modified tumescent technique and intravenous sedation with monitoring is the method most currently used for all cases. Betamethasone (6 to 9 mg) and prophylactic intravenous cephalixin are given preoperatively to all patients.

POSTOPERATIVE EXPECTATIONS

Patients are uniformly noted to be more comfortable in-

Figure 1) Front and side views of a 50-year-old patient before ultrasonic liposuction of abdomen and hip rolls

Figure 2) Front and side views of 50-year-old patient shown in Figure 1, two months postoperatively

Figure 3) Upper arm ultrasonic liposuction without skin removal – preoperatively and one year five months postoperatively

traoperatively as well as immediately postoperatively following liposuction with the 'sonic sculpture' system as compared with standard equipment.

There is also less bruising and surface irregularity immediately after the procedure. This is because this method is less traumatic and avoids the avulsion of capillaries and the repeated rapid passage of the cannula commonly required with the standard techniques.

Dressing removal is done approximately four days postoperatively; standard dressing including compression tape with a thick foam, self sticking Reston sponge (3M Corp, St Paul, Minnesota) is applied in areas of major reduction. The compression garment is worn for approximately 40 days with the removal of incisional staples one week postoperatively.

Most patients are able to resume activity at a modest exertional level by the third or fourth day with minimal postoperative discomfort experienced at any time.

PATIENT EXPERIENCE

In my clinical experience involving over 250 patient procedures with the ultrasonic technique over a 4-year period, the majority of these individuals have had major body area liposuction. Most have had contouring of the trunk (Figures 1 and 2) and lower extremities including the calves, but many cases have involved the neck area, the upper arm (Figure 3) and breast regions (Figure 4). Breast reductions are enhanced with ultrasonic contouring for the production of the best symmetry. Approximately 12 gynecomastia cases have been performed; the most satisfying results were achieved using the most recent prototype of the Surgitron 2000 Series which produces a higher ultrasonic energy output, making cannula passage simpler. Patients' ages ranged from 14 to 64 years, with several patients having more than 3000 mL of lipoaspirate removed per single procedure.

Due to the unnecessary risk associated with removing large volumes, we generally do not remove more than 2400 mL during a single sitting.

Because it is my clinical impression that blood loss with the use of the 'sonic sculpture' technique is approximately 30

to 50% less than with conventional techniques, we do not plan for intraoperative or postoperative transfusions. A transfusion has been required only once during the four years I have used this technique. It was required by the anaesthetist because the operation was combined with another procedure. In two other patients, pre- and postoperative hemoglobin measurements were taken. In one case, where 3400 mL of lipoaspirate was removed, the patient's preoperative hemoglobin level was 12.9 g/L and the postoperative hemoglobin, 18 days later, was 10.3 g/L. In the second patient who had 2400 mL removed, the preoperative hemoglobin level was 11.4 g/L and the postoperative hemoglobin five days later was 10.8 g/L. These patients were aged 59 and 39 years, respectively. No other similar hemoglobin measures were performed because the patients had satisfactory clinical courses.

The tumescent technique is used in all individuals with moderate volume tissue injection until the point where skin blanching occurs, the amount of fluid injected being approximately one half the planned amount of lipoaspirate. Intravenous fluid replacement is generally one to one, equalling the amount of lipoaspirate with intravenous fluid resuscitation, using 5% dextrose in lactated Ringer's solution.

Only in cases of significant fat reinjection, which is rarely practiced now, do patients experience noticeable bruising of concern. Because there is less blood loss due to less tissue trauma, there is less bruising and more rapid healing. We therefore have a more comfortable patient who returns to work and daily activities more quickly, with an associated high degree of satisfaction.

POSSIBLE COMPLICATIONS

As with conventional liposuction, the most common complication following surgery with the ultrasonic technique has been minor asymmetry or surface irregularity of contour which is usually correctable with a second procedure under local anaesthesia. In our case series of over 150 patients, less than 8% had such revisional work. This does not include the larger patients who understand that they will require a second

Figure 4) Male gynecomastia corrected with ultrasonic liposuction – preoperatively and two months postoperatively

or even third procedure to accomplish their goal. The patients in this series requiring such staged operations because of volume have been fewer than 8%.

Localized first and second degree skin burns at incisional sites due to repeated contact with the ultrasonic cannula have occurred, but heal uneventfully with topical antibiotic creams. Skin protection during surgery with a moist lap and larger incisions (1 cm) have been useful in prevention.

We have been successful with the techniques of fat reinjection described originally by Toledo (2) and others (7) and of superficial liposuction as discussed by Gasparotti (7,8) for the correction of unusual skin laxity or cellulite problems. Superficial liposuction can be done with the titanium ultrasonic cannula or with conventional narrow cannulae as in standard liposuction (9). Emulsified fat seems to work almost as well as fat extracted in the conventional manner for fat grafting experience. The incorporation of these techniques has allowed us to take on more difficult patients with skin quality problems along with the other patients with less need for body balancing.

There have been several patients with persistent skin laxity following use of these techniques, who have not agreed to reoperation. It is likely that with the use of more intense dermal stimulation via the ultrasonic cannula, such problems can be minimized in future.

DISCUSSION

The use of this technology, which evolved from the use of ultrasonic energy in phacoemulsification for cataract re-

moval during the 1970s, has proven very beneficial in liposuction surgery. It has yielded a high degree of satisfaction for both patient and surgeon. In particular, surgeon fatigue is minimized so that the physician can pay greater attention to outcome, which is also more easily controlled with this refinement. Since operating time is cut roughly in half or less, there is greater flexibility in scheduling, thus allowing the surgeon to use his or her time more effectively.

Others have attempted to use systems similar to the Series 2000, with occasional complications due to the pooling of liquefied fat which was not removed following the use of solid cannulae. Operating time is prolonged with the use of ultrasonic technology involving solid titanium cannulae and manual expression of liquid triglycerides through small incisions.

Small diameter hollow titanium cannulae will be useful for subdermal application in cases where maximal skin retraction is essential, and are currently under development.

Manufacturing of the 'sonic sculpture' technology will be ongoing under international patents by Mentor/Sonique Surgical Systems, which is a joint alliance between Mentor Corporation of Santa Barbara, California, and Sonique Surgical System, Inc (formerly Surgitron International, Inc) of Escondido, California, the latter of which is the developing company.

The author of this paper has financial interest in this product.

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