Dr Patrick Treacy looks back at the history of the use of ultrasound in fat reduction and examines where we are now.

Since instant fat reduction holds great appeal, liposuction has become the most common cosmetic procedure performed worldwide. According to the American Society of Plastic Surgeons (ASPS), the number of liposuction procedures performed increased by 16% in 2013 with ultrasound-assisted lipoplasty (UAL) being among the techniques used. UAL involves inserting a narrow tube (cannula) under the skin through tiny incisions and manipulating the cannula to break up and suction out fat cells. The procedure injures other local tissue, causing temporary bruising, swelling and blood loss. The areas most commonly treated are the outer thighs and abdomen in women and the flanks or “love handles” in men.

Liposuction can also remove unwanted fat from hips, buttocks, knees, upper arms, chin, cheeks, neck and other areas. The concept behind liposuction seems almost too good to be true, however, it isn’t an easy fix. The American Society of Plastic Surgeons (ASPS) warns that liposuction is a serious surgical procedure that involves a potentially painful recovery and risks of rare but serious complications. A decision as to whether to undergo liposuction, according to the American Mayo Clinic, should be considered very carefully. Nevertheless, liposuction is a popular choice. However, there are now new ultrasonic methods of removing fat from the body that involves no risk to the patient. One such treatment is UltraShape, which uses unique G-NIUSTM (Guided Non-Invasive Focused Ultrasound Selective) technology to effectively and safely break down fat cells. The use of external ultrasound means the patient does not even have to undergo any invasive surgical procedure. The UltraShape procedure has the potential to redefine aesthetic medicine by developing a non-invasive means for fat removal.
THERAPEUTIC ULTRASOUND AND THE ADVENT OF LIPOSUCTION

Therapeutic ultrasound (in contrast to diagnostic and imaging modalities) has been used as a tool in medicine for more than 50 years. The first ultrasonic machine (lithotripter) used to destroy kidney stones was produced by the German Aircraft manufacturer Dornier in Munich in 1980. In 1984, the company introduced the Dornier HM-3 (Human Model-3) and in that same year the FDA approved the use of ESWL (extracorporeal shock wave lithotripsy) in the United States for the treatment of renal calculi. Since that time, the HM-3 or the “Munich Stonebuster” as the press preferred to call it has treated over five million patients worldwide. By 1985, the technique was first applied successfully in a patient with gallbladder stones.

In the following years, many conditions suitable for the technique of ESWL were investigated. But the story of using therapeutic ultrasound in medicine did not really start there. In fact it may have inadvertently started with another aircraft manufacturer because during World War II, British ophthalmic surgeon Harold Ridley, noticed pieces of Plexiglas from the shattered canopies of Spitfire fighter planes did not cause any reaction when they became embedded in pilot’s eyes. He used this theory to use the material to implant the world’s first intraocular lens, at St. Thomas Hospital in London on November 29, 1949. The next year he encountered widespread criticism from his peers at a conference in the United States who considered the idea of replacing the eye’s natural lens with an artificial one too radical and unacceptable for the period.

Over the next 20 years the idea of lens implants for cataracts slowly became more acceptable. In 1968, American surgeon, Charles Kelman adapted the new technology of ESWL to remove cataracts. The procedure, later known as phacoemulsification, used a tiny probe with a vibrating tip to gently break up the cataract and wash it away. The techniques of phacoemulsification and plastic lens implant technology were combined and the science of cataract surgery was revolutionised. In 1981, a protégé of Ridley called Choyce gained the first FDA approval of intraocular lenses. Today, after decades of development, modern phacoemulsification is considered one of the safest surgeries performed with millions of successful procedures completed every year around the world.

Today the use of therapeutic ultrasound in the form of extracorporeal shock wave therapy has found its way into many other facets of medicine with recent advances in machines designed specifically for use on arms and legs to treat the chronic localised pain that is associated with chronic tendonitis. However, its main use may yet prove to be the most interesting as the “Tel Aviv Fat-buster”. In fact the association of ultrasound with the destruction of fat cells starts many years before. It may have started as far back as 1921, when a French surgeon called Dujarrier, decided to practice the new art of liposuction in an attempt to create a better shape on a young ballerina’s knees. Unfortunately his patient developed gangrene and required an amputation. After this initial fiasco, things remained quiet for many years until a Cologne surgeon called Josef Schruder decided to try out the technique again on someone’s ankles. The second attempt was much more successful and thankfully the patient lived to tell the tale. In 1974, an Italian gynaecologist called Giorgio Fischer further developed the technique with the invention of an electrical, rotating scalpel encapsulated by a cannula that suctioned out dislodged cells. In 1978 the technique was taken to Paris where it was refined and popularised by the French plastic surgeon Yves-Gerard Illouz. In 1982, Illouz presented a new form of lipolysis using blunt cannulas and high-vacuum suction with reproducible good results and low morbidity and a new age of liposuction arrived.

During the eighties other cannulae were developed by Kesselring and Meyer while the father of aesthetic medicine Pierre Fournier developed another technique using a syringe. In this period liposuction reached the United States but quickly fell out of favour because of increased complications and several deaths. It now appears that many of the deaths related to plastic surgeons combining liposuction with abdominoplasty “tummy tucks.” In 1985 a Californian dermatologist, Jeffrey Klein, invented and pioneered a new tumescent method technique, the safest method known. He was helped in this development by a Colorado dermatologist, Patrick Lillis. In 1987, an Italian plastic surgeon from La Sapienza University in Rome called professor Nicolo Scuderi introduced the use of ultrasound as an emulsifying modality for fat tissue during liposuction and a new age of “fat busting” began. This technique was further modified when Zocchi introduced titanium ultrasonic probes and
manual remodelling of the treated areas to eliminate the fluid from the burst fat cells in 1992.

In 1998, Californian plastic surgeon, Barry Silberg elaborated on the technique using external ultrasound-assisted liposuction (XUAL). This method required traditional aspirative liposuction after the application of high frequency ultrasonic fields delivered through the skin into a wetted tissue. Silberg felt that this method led to less traumatic surgery with superior clinical outcome. There is little doubt as an invasive modality, like tumescent liposuction, the technique still had many of the drawbacks that accompany invasive procedures. Moreover, many doctors started to voice opinions that the magnitude of ultrasonic energy used to destroy the fat cells may also damage other tissue in contact with the cannula. Many felt one of the technical drawbacks of the ultrasonic liposuction technique was that the cannula had to be inside the body. It was at this stage a Tel Aviv plastic surgeon called Ami Glicksman considered the possibility of using external ultrasonic waves to selectively break down fat cells without the patient having to undergo a surgical procedure.

In 2001, while the rest of the world was getting to grips with the aftermath of an Al Qaeda terrorist attack on the World Trade Centre in New York, Dr Glicksman was in Tel Aviv researching the feasibility of using external ultrasound to break down fat cells in pigs. His experiments were successful and he noted that fat lysis was selective leaving nearby tissues intact. Further macroscopic and microscopic analyses of overlying skin noted that it also remained untouched. The researchers quickly moved from the pig models and tried the external ultrasound transducer to lyse human fat from ex vivo tissue harvested from skin flaps excised in hospital abdominoplasty procedures. These experiments also showed fat lysis only occurred in a specific region, leaving skin or fat outside of the focused beam intact. The temperature on the skin and within the focus was monitored and showed an increase of 1°C for an ultrasound treatment of one to two seconds. Further human in-vivo trials were commenced in Israel with participants being treated with the ultrasonic device prior to abdominoplasty in which the treated area was removed and analysed. The first study of twenty patients commenced in 2002 monitoring the safety and effectiveness of the treatment. Histological evaluation of all tissues excised during surgery clearly showed that the external ultrasound treatment only destroyed adipose cells, leaving blood vessels, connective tissue, nerves, and epidermis intact.

In 2003 a large multi-centre clinical trial with the external ultrasound device started in five sites in the USA, UK, and Japan, in which 137 patients underwent a single treatment. The results showed that on average a 2cm reduction in circumference was observed post-treatment. This approximates to about 0.5 litres and the rest may be removed with a further procedure performed one month later. The device obtained CE approval in Europe and more than 5,000 individuals were commercially treated with the device in the Ireland, UK, Spain and Scandinavia, demonstrating the safety and effectiveness of the treatment. In 2014 the FDA trials approved the UltraShape System as the first and only non-invasive body-shaping device for abdominal circumference reduction by mechanical disruption of fat cells. The new Ultrashape V3 uses pulsed, focused ultrasound to mechanically (non-thermally) and selectively destroy fat cells at a designated focal point in the subcutaneous fat tissue without harming the skin, blood vessels, nerves or connective tissue.

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