CHAPTER **31**

ANALYSIS OF EXTRACORPOREAL SHOCK WAVE THERAPY

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High energy extracorporeal shock wave therapy (ESWT) is rapidly becoming the surgical treatment of choice for chronic plantar fasciitis. The use of ESWT for musculoskeletal conditions stems from the technology of the lithotripters from the 1980s. The technique first became utilized in Europe in the 1990s and was later approved in the states in October of 2000. The technique for the procedure is constantly being refined as more is known about the technology. It is a procedure that is very attractive to the patient and physician because of the lower rate of complications, it is non-invasive, has a faster recovery time, the public is more technology driven, and the overall effectiveness of the treatment.

Heel pain is a common ailment affecting millions of individuals each year. There are a number of etiologies of heel pain, though ESWT is only approved for plantar fasciitis. It is important to rule out such conditions as entrapment neuropathy, tarsal tunnel syndrome, calcaneal bursitis, infectious processes, metabolic disease, inflammatory arthropathies, calcaneal stress fractures, and soft tissue or osseous tumors. The initial evaluation for heel pain should include a thorough history and physical examination with the appropriate diagnostic studies to determine a more accurate diagnosis. The standard conservative measures for heel pain are well known and are effective in 90% of the patients.

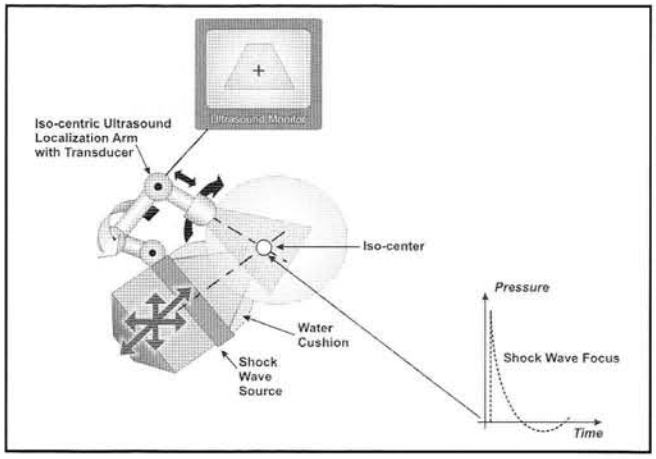

Figure 1. Epos Ultra technical information.

In the cases of resistant heel pain lasting for six months or more, extracorporeal shock wave therapy is the treatment of choice.

The generation of shock waves is by three methods, electromagnetic, electrohydraulic, and piezoelectric. This article will focus on the electromagnetic technique for producing a shock wave and specifically the Dornier's Epos Ultra (Figure 1). A pulsed electrical current passes through a coil with a thin membrane that when the membrane is repelled by the magnetic field, a shock wave is generated. The shock wave is focused by an acoustic lens at the treatment site. The effect of the shock wave on soft tissues has not been established, though it has been theorized that the cellular disruption caused by the shock wave causes neovascularization, allowing the chronicly inflamed tissues to heal.

The Epos Ultra utilizes an ultrasound unit to direct the treatment as the shocks are being delivered (Figure 2). A study by Vohra, et al used ultrasonography to evaluate symptomatic and asymptomatic plantar fascial bands. They concluded that the average thickness for a band that was symptomatic was 5.35 mm and an asymptomatic

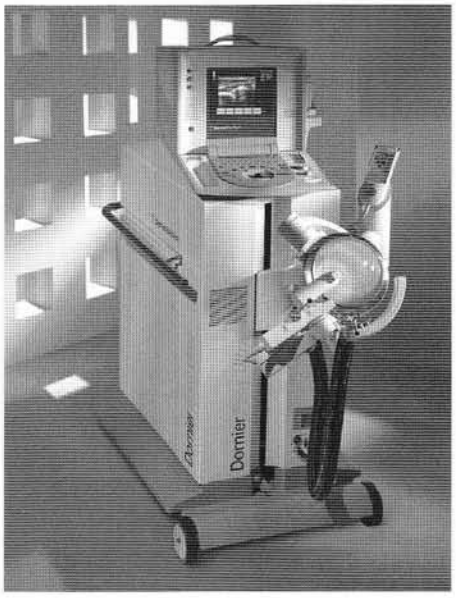

Figure 2. The Dornier Epos Ultra.

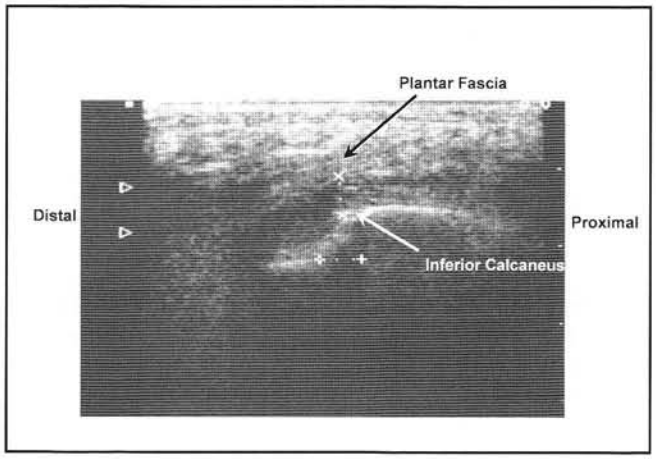

Figure 3. The ultrasound unit provides continuous visualization of the treatment area.

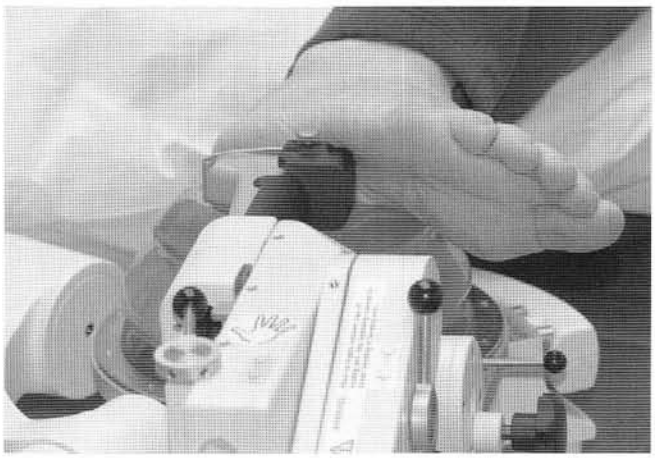

Figure 4. Patient positioning for the procedure.

band was 2.70 mm. It may be beneficial to determine the average thickness of the band in patients that respond to conservative measures versus those who undergo ESWT. Another study utilized ultrasound before treatment with ESWT and six months after treatment. The study concluded that there was no significant difference in thickness of the plantar fascial band between the opposite extremity and the treated one. The ability to visualize the area of treatment allows the user to constantly control the delivery of the shock waves (Figure 3).

A number of studies have been performed to better determine the effectiveness of extracorporeal shock wave therapy in chronic plantar fasciitis. The literature reports success rates of 56-94% with significant improvement in heel pain from 3-12 months after the procedure. There are fewer complications encountered with ESWT as compared with traditional plantar fascial surgery. The post-operative care is drastically different in ESWT versus traditional plantar fascial surgery. The ability of patients undergoing ESWT to return to work and activities within a few days or weeks is far less debilitating than the traditional four to six weeks of inactivity with traditional surgery. Following the procedure, each patient is instructed to use their orthoses and to perform stretching exercises. The ideal post-operative plan has to be adjusted to each patient because of the severity of symptoms, heel structure, and type of work.

The procedure is performed in an office setting, ambulatory surgical facility or hospital. All of the procedures that will be discussed in this article were performed under local anesthesia in the office. An oral sedating agent, such as valium or mepergan fortis, is administered to help relax the patient in the office. An equal mixture of 1% lidocaine and 0.25% bupivicaine is infiltrated about the ankle, to include the posterior tibial and sural nerves. After the foot is anesthetized, the patient is placed in a lateral position on a treatment table or chair (Figure 4). The treatment is then administered with a sequential increase in energy and number of shocks, which produces a TENS effect (Table 1). The treatment protocol may be changed in the future once more data is collected. The total amount of energy that is delivered is 1301 mJ/mm2, which is twice the energy delivered by the Ossatron (Table 2). The treatment time averages from 15-20 minutes.

Following the procedure, the patient is placed in an air cast walker for two weeks and then may

Table 1

SHOCK WAVE PROTOCOL

Level	Energy	Number of Shocks	Frequency
1	0.03 mJ/mm2	50 (+/- 10)	60 shocks/min
2	0.06 mJ/mm2	50 (+/- 10)	90 shocks/min
3	0.08 mJ/mm2	50 (+/- 10)	120 shocks/min
4	0.15 mJ/mm2	50 (+/- 10)	150 shocks/min
5	0.21 mJ/mm2	50 (+/- 10)	180 shocks/min
6	0.29 mJ/mm2	50 (+/- 10)	210 shocks/min
7	0.36 mJ/mm2	3500 (+/- 10)	240 shocks/min

Table 2

ENERGY COMPARISON

Manufacturer	Minimum (mJ/mm2)	Median (mJ/mm2)	Maximum (mJ/mm2)	Total Energy Per Treatment
Dornier Epos Ultra™	0.03	0.21	0.57	1301 mj/mm2
Health Tronics Ossatron™	0.09	0.24	0.34	680 mj/mm2
Siemens Sonocur™	0.03	0.21	0.50	360 mj/mm2

return to his/her athletic shoes. The use of orthotics to control hind foot motion is important to lessen the chance of reoccurrence of the heel pain symptoms. An aggressive stretching regiment is continued for eight weeks following the procedure. Some patients may develop mild pain or ecchymosis, during the initial postoperative period. These side effects are usually mild and transient. No patients encountered paresthesias as occur with the Ossatron device. The patient is evaluated in four weeks, eight weeks, and twelve weeks following the procedure.

The preliminary results of 165 patients that had 186 treatments revealed a modest success rate. The average length of heel pain for each patient was 2.1 years, which quickly dispels the myth that some physicians feel that all heel pain will resolve. The average level of pain before the procedure, on a scale of 0-10, was 9.1. After the procedure, the level of pain was 3.5. This data collection represents a follow up time of 185.7 days. There have been no re-treatments of this initial group of patients. The side effects that were encountered were minimal with 19 out of 186 treatments having injection soreness or bruising. No neurological symptoms were noted in any of the patients. The preliminary results show that 82.8% of the patients showed a significant or moderate improvement in their symptoms. The survey found that 170 out of 186 patients would recommend the procedure to a friend or family member.

Extracorporeal shock wave therapy is a technology that has a lot of potential uses. The ultrasound imaging system on the Dornier unit provides precise localization and excellent imaging quality, allowing the user to continuously observe and control the therapy. The Epos Ultra delivers a high energy shock wave to produce a therapeutic effect. The low energy studies have failed to show that ESWT is effective in treating plantar fasciitis, which may be a result of the inability to generate enough power to penetrate the thicker heel structures. ESWT is not effective in all patients, though early results of the procedure are very promising with significantly less complications than traditional heel surgery. High energy ESWT is a technology that has shown great success in treating chronic heel pain and will drastically reduce the number of traditional heel surgeries being performed.

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