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Low-Energy Extracorporeal Shock Wave Therapy as a Treatment for Greater Trochanteric Pain Syndrome

John P. Furia,^{*†} MD, Jan D. Rompe,[‡] MD, and Nicola Maffulli,[§] MD, MS, PhD, FRCS (Orth), FFSEM (UK)

From [†]SUN Orthopedics and Sports Medicine, Lewisburg, Pennsylvania, [‡]OrthoTrauma Evaluation Center, Mainz, Germany, [§]Centre for Sports and Exercise, Barts and the London School of Medicine and Dentistry, London, United Kingdom

Background: Greater trochanteric pain syndrome is often a manifestation of underlying gluteal tendinopathy. Extracorporeal shock wave therapy is effective in numerous types of tendinopathies.

Hypothesis: Shock wave therapy is an effective treatment for chronic greater trochanteric pain syndrome.

Study Design: Case control study; Level of evidence, 3.

Methods: Thirty-three patients with chronic greater trochanteric pain syndrome received low-energy shock wave therapy (2000 shocks; 4 bars of pressure, equal to 0.18 mJ/mm²; total energy flux density, 360 mJ/mm²). Thirty-three patients with chronic greater trochanteric pain syndrome were not treated with shock wave therapy but received additional forms of nonoperative therapy (control). All shock wave therapy procedures were performed without anesthesia. Evaluation was by change in visual analog score, Harris hip score, and Roles and Maudsley score.

Results: Mean pretreatment visual analog scores for the control and shock wave therapy groups were 8.5 and 8.5, respectively. One, 3, and 12 months after treatment, the mean visual analog score for the control and shock wave therapy groups were 7.6 and 5.1 ($P < .001$), 7 and 3.7 ($P < .001$), and 6.3 and 2.7 ($P < .001$), respectively. One, 3, and 12 months after treatment, mean Harris hip scores for the control and shock wave therapy groups were 54.4 and 69.8 ($P < .001$), 56.9 and 74.8 ($P < .001$), and 57.6 and 79.9 ($P < .001$), respectively. At final follow-up, the number of excellent, good, fair, and poor results for the shock wave therapy and control groups were 10 and 0 ($P < .001$), 16 and 12 ($P < .001$), 4 and 13 ($P < .001$), and 3 and 8 ($P < .001$), respectively. Chi-square analysis showed the percentage of patients with excellent (1) or good (2) Roles and Maudsley scores (ie, successful results) 12 months after treatment was statistically greater in the shock wave therapy than in the control group ($P < .001$).

Conclusion: Shock wave therapy is an effective treatment for greater trochanteric pain syndrome.

Keywords: extracorporeal shock wave therapy; hip; subgluteus bursa; bursitis

Lateral hip pain is a frustrating condition encountered regularly by primary care physicians and orthopaedists. The pathoanatomy associated with lateral hip pain is infrequently limited to the main subgluteus maximus bursa.^{6,19,21,24,25,44,46} Recent studies using advanced imaging modalities and other studies involving surgical treatment of chronic cases suggest that, in many cases, the primary pathologic changes involve injury, degeneration, and/or tearing of the gluteal tendons.^{6,7,19,21,28}

Edema of one of the numerous bursae intimately associated with the greater trochanteric bursa may be present, and when identified, the edematous bursa is almost always located juxtaposed to the injured segment of the gluteus medius or gluteus minimus tendon.^{6,21,22} For these reasons, most investigators now favor the term *greater trochanteric pain syndrome* (GTPS) to describe the clinical condition of greater trochanteric and peritrochanteric hip pain and tenderness.^{20,21,24,25,37}

Greater trochanteric pain syndrome occurs most frequently in sedentary individuals aged 40 to 60 years.^{20,21,36-38} However, GTPS has also been identified in younger age groups, particularly those involved in athletics.^{1,5,39,47}

Among athletes, GTPS is commonly identified in runners and individuals who engage in sports requiring a climbing motion such as step aerobics.^{1,39} Runners who adduct their hips beyond midline and those who undertake a significant amount of training on the sides of the road are at

*Address correspondence to John P. Furia, MD, SUN Orthopedics and Sports Medicine, 900 Buffalo Road, Lewisburg, PA 17837 (e-mail: jfuria@ptd.net).

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particularly high risk.^{1,47} The latter group typically develops GTPS in the “downside leg” (the leg nearest to the side of the road) as this is the leg that experiences the greatest amount of friction between the greater trochanter and the iliotibial tract during flexion and extension of the hip.⁵

Initial treatment of GTPS is nonoperative. Traditional methods include relative rest, anti-inflammatory medication, ice and heat, stretching and strengthening, physical therapy, ultrasound, and injection of a local corticosteroid with or without a local anesthetic.^{2,4,10,15,19,20,24,29} Although nonoperative treatment is generally effective, symptoms of GTPS can linger for many months, and relapses are relatively common.^{9,20,36,39} This is particularly frustrating for athletes and can necessitate extended periods of modified training.^{15,29}

Patients with chronic recalcitrant GTPS may undergo surgery. Numerous procedures have been described, and there is no consensus as to the optimal surgical technique. Most investigators have reported favorable outcomes.^{2,8,10,11,19,24,39,47} However, most of these studies are retrospective,^{8,10,11,19,24,39} lack a control group,^{8,10,11,19,24} and use vague outcome criteria.^{19,24} Also, many are small, at times reporting only 2 patients.^{10,19,39} For these reasons, it is difficult to determine true surgical “success rates.”

Recovery from surgery can be lengthy. In several series, patients required prolonged reduction in weightbearing for up to 6 to 8 weeks.^{19,24}

Shock wave therapy (SWT) has been used successfully since the late 1980s for the management of various musculoskeletal disorders including plantar fasciopathy, Achilles tendinopathy, shoulder calcific tendinitis, and lateral epicondylitis.¹¹ Although there are some negative trials,^{4,17,40,41} there are now many randomized, double-blinded, clinical trials that support the use of SWT for the above conditions.^{3,16,23,26,27,31-35,42}

Acknowledging the unpredictable response and frequent recurrences associated with traditional nonoperative treatment, the risks and prolonged rehabilitation associated with surgery, the recognition of gluteal tendinopathy as a potential source of pain, and the favorable results from prior studies involving SWT as a treatment for other forms of tendinopathy, the aim of this study was to determine whether low-energy SWT is a safe and effective management modality for chronic GTPS.

MATERIALS AND METHODS

From July 1, 2007, to March 31, 2008, all patients with an established diagnosis of chronic GTPS who were treated with SWT by the senior author (J.P.F.) were considered for inclusion in the study. A similar group of patients who were treated in the same time interval with additional forms of traditional nonoperative methods but did not receive SWT were enrolled in the control group. Both the SWT and control groups were derived from the clinical practice of the author. The patients in the control group were selected from a cohort of 70 patients treated by the author during the time of the study. As part of the initial

evaluation, a thorough explanation of the various options, as well as the potential risks, benefits, and outcomes associated with the various options, took place for all patients.

All SWT and control patients were offered traditional nonoperative therapy, SWT, and surgery. After making an informed decision, the control patients chose to treat their conditions with traditional nonoperative methods. After making an informed decision, the SWT patients chose to treat their conditions with SWT. The control patients were selected to match the age and gender of the patients in the SWT group. Selection of the control patients was blinded to outcome at the time the controls were selected.

Inclusion Criteria

All patients were evaluated on the basis of a history and a physical examination. The inclusion criteria included patients with an established diagnosis of chronic GTPS for at least 6 months before treatment who had failed at least 3 forms of traditional nonoperative measures for a minimum of 6 months. Traditional nonoperative therapies consisted of relative rest, anti-inflammatory medications, ice, gluteal and tensa fascia lata muscle stretching and strengthening, physical therapy modalities, iontophoresis, and a corticosteroid and local anesthetic injection.

For this study, GTPS was defined as symptoms of moderate-to-severe pain located over the greater trochanter and peritrochanteric area, pain with resisted hip abduction, and impaired function. All patients had a negative straight leg sign and painless hip rotation. All patients experienced transient improvement of symptoms after a peritrochanteric local anesthetic injection performed no sooner than 1 month before SWT treatment. All patients had anteroposterior pelvic and lateral radiographs of the affected hip to rule out end-stage hip osteoarthritis. Magnetic resonance imaging scans and additional imaging studies were performed on a case-by-case basis.

Exclusion Criteria

Exclusion criteria included rheumatoid arthritis, generalized polyarthritis, local infection, pregnancy, bleeding disorders, tumors, being younger than 18 years, end-stage ipsilateral hip osteoarthritis (defined as severe hip joint space narrowing, joint sclerosis, and periacetabular osteophyte), prior hip surgery, and unresolved hip, pelvis, or lumbar vertebrae fractures.

Shock Wave Therapy Group

Thirty-six patients were treated (36 hips). One patient underwent concomitant treatment of Achilles tendinopathy with low-energy SWT and was excluded. There was insufficient follow-up data on 2 patients. Thus, 33 patients with 33 hips with GTPS were available for analysis. These patients represent the SWT group.

There were 22 women and 11 men in the SWT group, with a mean patient age of 51 years (range, 18-71 years; SD, 9.9 years) (Table 1). The mean duration of the condition

¹¹References 3, 12-14, 16, 23, 26, 27, 31-35, 42, 45.

TABLE 1
Mean Age and Mean Duration of Symptoms

Group	Age, y			Symptoms, m		
	Mean	Range	SD	Mean	Range	SD
Shock wave therapy	51.0	18-71	9.9	13.7	8-23	4.1
Control	50.2	18-74	14.0	14.0	8-22	4.3
<i>P</i>		.8			.4	

TABLE 2
Sporting Activities of Shock Wave Therapy (SWT)
Group and Control Group

	SWT Group (n = 17)	Control Group (n = 15)
Basketball	1	0
Jogging	4	3
Running	4	3
Volleyball	0	1
Racquetball	1	0
Tennis	2	2
Soccer	0	2
Cycling	1	2
Golf	4	2

was 13.7 months (range, 8-23 months; SD, 4.1 months) (Table 1).

Control Group

Thirty-three patients were treated with traditional forms of nonoperative therapy. There were 22 women and 11 men in the control group, with a mean patient age of 50.2 years (range, 18-74 years; SD, 14 years) (Table 1). The mean duration of the condition was 14 months (range, 8-22 months; SD, 4.3 months) for the control group (Table 1). The patients in the control group were managed with traditional nonoperative measures for a minimum of 6 months. There was no difference in mean age ($P = .8$) or duration of symptoms ($P = .4$) between the SWT and control groups (Table 1).

Occupation and Sporting Activities

Seventeen of the patients in the SWT and 15 of the patients in the control group stated that they participated in some type of regular recreational sporting activity (ie, some form of noncompetitive exercise performed approximately 3-5 times per week) (Table 2). Eight of the SWT patients and 6 of the control patients worked as laborers (ie, factory workers or manual laborers or those in occupations that required extensive physical activity such as nursing and restaurant service) (Table 3).

TABLE 3
Patient Occupations

	Shock Wave Therapy Group (n = 33)	Control Group (n = 33)
Heavy factory worker	1	0
Manual laborer	1	2
Nurse	3	2
Restaurant server	3	2
Manager	5	3
Insurance agent	2	0
Teacher	3	4
Real estate broker	3	1
Flight attendant	0	1
Homemaker	5	6
Office worker	5	8
Student	2	3

Method of Treatment

All patients signed an informed consent form. The details of the procedure and potential risks were discussed fully before treatment.

All treatments were performed by the senior author, in the senior author's office, without anesthesia. A radial shock wave device (Swiss DolorClast, Electro Medical Systems, Munich, Germany) was used in all instances. With this device, shock waves are produced after a projectile in a hand piece is accelerated by a pressurized air source and strikes a 15-mm-diameter metal applicator. The energy generated is transmitted to the skin as a shock wave through a standard, commercially available ultrasound gel. The waves are then dispersed radially from the application site into the surrounding tissues.

Each patient received 1 low-energy treatment. Two thousand shocks were applied with a pressure of 4.0 bars (equal to an energy flux density of approximately 0.18 mJ/mm²). The treatment frequency was 10 shocks/s. The total energy flux density of the treatment session was approximately 360 mJ/mm².

The procedure was performed with the patient in the lateral decubitus position. Ultrasound gel was applied liberally to the skin overlying the greater trochanter and peritrochanteric regions. The shock waves were delivered in a lateral-to-medial direction.

Shock wave application was a dynamic process. With use of the principle of clinical focusing, the area of maximal tenderness was treated in a circumferential pattern, starting at the point of maximal pain. The mean size of the area of treatment was approximately 4 to 8 cm in width and 4 to 8 cm in length.

Postprocedure Treatment

On completion of the procedure, the treated hip was assessed for hematoma, bruising, and swelling. All concomitant interventions were discouraged for 3 months

TABLE 4
Mean VAS, HHS, and Roles and Maudsley Score^a

Group	VAS			HHS			Roles/Maudsley					
	Pretreatment	1 Month	3 Months	12 Months	Pretreatment	1 Month	3 Months	12 Months	Pretreatment	1 Month	3 Months	12 Months
SWT	8.5	5.1	3.7	2.7	49.6	69.8	74.8	79.9	4	2.5	2	2
Control	8.5	7.6	7	6.3	50.4	54.4	56.9	57.6	4	3	2.9	2.9

^aHHS, Harris hip score; SWT, shock wave therapy; VAS, visual analog score. VAS, $P < .001$ for each time point for SWT and control group compared with pretreatment. HHS, $P < .001$ for each time point for SWT group compared with pretreatment.

after the last treatment. Patients were allowed immediate weightbearing and unrestricted range of motion. No ambulatory aids were used. No immobilization or other counterintervention was used.

Activity was advanced as symptoms dissipated. Patients who worked in a sedentary occupation were allowed to immediately return to their pretreatment work status. Stationary cycling was permitted immediately after treatment. Easy running was permitted 1 week after treatment as tolerated. The time to return to competitive sports and heavy labor occupations was made on a case-by-case basis.

Outcome Measures

Outcome measures included the visual analog score (VAS), the Harris hip score (HHS),¹⁸ and the Roles and Maudsley (RM)³⁰ score. The VAS, HHS, and RM score were collected pretreatment and 1, 3, and 12 months posttreatment during the follow-up examinations. On the visual analog scale, 10 points indicated severe pain and 0 points no pain. A 2-point change was considered a clinically significant result. A 10-point change in HHS was considered a clinically relevant result.

The RM scale is a subjective 4-point patient assessment of pain and limitations of activity.³⁰ The RM score has been used extensively at centers throughout the world to assess outcome after SWT.^{3,4,12-14,23,35} On the scale, 1 point indicates an excellent result with the patient having no symptoms. Two points indicate a good result with the patient significantly improved from the pretreatment condition and satisfied with the result. Three points indicate a fair result with the patient somewhat improved from the pretreatment condition and partially satisfied with the treatment outcome. Four points indicate a poor outcome with symptoms identical or worse than the pretreatment condition and dissatisfaction with the treatment result.

Statistical Analysis

A power analysis revealed that a sample size of 23 would be required to establish the statistical significance with $\alpha = .05$ and power = .9, with calculations based on the outcomes of SWT and nonoperative treatment of chronic GTPS. Statistical analysis for the comparison of the means between groups was performed using the paired Student t test and the χ^2 analysis. The significance level was $P < .05$. All analyses were conducted with SAS, version 8.2 (SAS Institute Inc, Cary, North Carolina).

RESULTS

For all comparisons, the data met the assumptions for the statistical tests chosen. The mean age and duration of symptoms for the SWT and control groups are summarized in Table 1. There was no difference between mean age ($P = .8$) or mean duration of symptoms ($P = .4$) between the SWT and control groups.

Shock Wave Therapy Versus Control Group

Visual Analog Score. The mean pretreatment VAS for the SWT group was 8.5 ± 0.9 . One month after treatment, the mean VAS decreased to 5.1 ± 0.9 . This difference of 3.4 points was statistically significant ($P < .001$) (Table 4).

The mean baseline VAS for the control group was 8.5 ± 0.9 . One month after enrollment, the mean VAS was 7.6 ± 1 . This difference of 0.9 points was statistically significant ($P < .001$) (Table 4).

Three months after treatment, the mean VAS for the SWT group decreased further to 3.7 ± 0.8 ($P < .001$). The corresponding VAS for the control group was 7.0 ± 0.8 ($P < .001$) (Table 4).

Twelve months after treatment, the mean VAS for the SWT group decreased further to 2.7 ± 0.9 ($P < .001$). The corresponding VAS for the control group was 6.3 ± 1.2 ($P < .001$) (Table 4).

The mean 1-, 3-, and 12-month SWT and control VAS scores were also compared. The mean 1-, 3-, and 12-month VAS scores for the SWT group were each significantly less than the corresponding VAS scores for the control group ($P < .001$ for each time point).

The mean differences between baseline VAS and 1-month (3.4 and 0.9), 3-month (4.8 and 1.5), and 12-month (5.8 and 2.2) VAS scores were also compared for the SWT and control group, respectively. For each time point, the magnitude of the change in VAS was significantly greater for the SWT group than the control group ($P < .001$ for each time point).

Harris Hip Score. The mean pretreatment HHS for the SWT group was 49.6 ± 4.9 . One month after treatment, the mean HHS increased to 69.8 ± 7.3 . This difference of 20.2 points was statistically significant ($P < .001$) (Table 4).

The mean baseline HHS for the control group was 50.4 ± 4.4 . One month after enrollment, the mean HHS was 54.4 ± 5 . This difference of 4 points was statistically significant ($P < .001$) (Table 4).

TABLE 5
Summary of Roles and Maudsley Scores for Shock Wave Therapy (SWT) and Control Groups

	1 Month				3 Months				12 Months			
	SWT (n = 33)		Control (n = 33)		SWT (n = 33)		Control (n = 33)		SWT (n = 33)		Control (n = 33)	
	n	%	n	%	n	%	n	%	n	%	n	%
1 (excellent)	3	9	0	0	8	24	0	0	10	30	0	0
2 (good)	14	42	8	24	18	55	9	27	16	49	12	36
3 (fair)	13	40	16	49	4	12	19	58	4	12	13	40
4 (poor)	3	9	9	27	3	9	5	15	3	9	8	24

Three months after treatment, the mean HSS for the SWT group increased further to 74.8 ± 5.9 ($P < .001$). The corresponding HSS for the control group was 56.9 ± 5.2 ($P < .001$) (Table 4).

Twelve months after treatment, the mean HSS for the SWT group increased further to 79.9 ± 6.2 ($P < .001$). The corresponding HSS for the control group was 57.6 ± 5.8 ($P < .001$) (Table 4).

The mean 1-, 3-, and 12-month SWT and control HSS were also compared. The mean 1-, 3-, and 12-month HSS for the SWT group were each significantly greater than the corresponding HSS for the control group ($P < .001$ for each time point).

The mean differences between baseline HHS and 1-month (20.2 and 4), 3-month (25.2 and 6.5), and 12-month (30 and 7.2) HHS were also compared for the SWT and control groups, respectively. For each time point, the magnitude of the change in HHS was significantly greater for the SWT group than the control group ($P < .001$ for each time point).

Roles and Maudsley Score. The 1-, 3-, and 12-month RM scores for the SWT and control groups are summarized in Tables 4 and 5. At the onset of the study, all SWT and control patients rated the condition of the affected hip as 4 (poor). Chi-square analysis revealed that the percentage of patients with excellent or good RM scores (ie, successful results) 1, 3, and 12 months after treatment was statistically greater in the SWT group than in the control group ($P < .001$ for each time point).

In both the SWT group and control group, no patient reported a worsening of symptoms compared with before treatment.

Occupation and Sporting Activities. Thirteen of the 17 patients in the SWT group who participated in regular sporting activities were able to return to their preferred sports. Ten of the 15 control patients who participated in regular sporting activity were able to return to their preferred sports. All SWT and control patients who were able to return to their preferred sports did so at their preinjury levels. Of the 4 SWT patients who did not return to their desired sports, 2 were runners, 1 played racquetball, and 1 played tennis. Of the 5 control patients who did not return to their preferred sports, 2 were joggers, 1 played tennis, 1 played soccer, and 1 played golf. Time to return to sport was variable and ranged from 1 week for some golfers to 3 months for some runners. Seven of

the 8 SWT patients and 5 of the 6 control patients who worked as laborers or in occupations that required extensive physical activity were able to return to their preinjury occupations.

Complications. There were only 4 minor complications. Two patients had pain during the treatment. The pain resolved after completion of the procedure. Two patients had transitory reddening of the skin that resolved without intervention. There were no other complications detected during the postprocedure examination or telephone survey.

DISCUSSION

Although GTPS is common, the exact prevalence in the general population is unknown. In 1 recent study, GTPS was identified in 17.6% of 3026 community-dwelling adults aged 50 to 79 years.³⁷ The condition was more common in women (24%) than men (9%), was usually unilateral, and was shown to be associated with ipsilateral knee osteoarthritis.³⁷

Clinically, patients with GTPS report lateral hip pain, typically described as dull, achy, or burning. Onset may be acute but typically is insidious and chronic.^{19,25,32,37,38,44} The pain is felt over the greater trochanter and frequently radiates to the posterolateral aspect of the thigh and buttock.^{2,19,25,32,37,38} Lying on the affected side, stair climbing, prolonged standing, and running typically accentuate symptoms.^{8,25}

Physical examination reveals tenderness over the greater trochanter, usually posteriorly,^{20,24,37,44} and pain with resisted hip abduction. Crepitation, although uncommon, can sometimes be detected over the greater trochanteric bursa.^{20,38} Passive hip and spine motion may be full or limited and typically does not produce symptoms.^{7,24,38}

Greater trochanteric pain syndrome can mimic other musculoskeletal conditions, particularly spine and hip disorders and, for that reason, can be surprisingly difficult to diagnose.^{10,28,43} Several studies have demonstrated that underrecognition, misdiagnosis, and delayed treatment are common.^{7,19,28,36,39,43} Indeed, 20% of patients referred for lower back pain and to a tertiary care surgical spine specialist for consideration of surgery were ultimately diagnosed with GTPS.⁴³

Imaging studies, although not necessary, can be helpful for defining the pathoanatomy and to rule out other conditions. Roentgenograms are usually normal except for occasional calcifications seen in the peritrochanteric areas.^{6,10,32} Magnetic resonance imaging findings include gluteus medius and minimus tendon thickening, surrounding soft tissue edema, intrasubstance signal abnormalities, and, in advanced cases, focal discontinuity of some tendon fibers.^{6,23} Other findings include subgluteus minimus or subgluteus medius effusion in bursal tissues and enthesopathic changes along the greater trochanteric insertion.^{21,22} Bursal involvement, when present, is usually noted in the region of the tendon insertion.^{6,21,22}

The optimal management for GTPS remains unclear. Traditional nonoperative therapies such as stretching and strengthening, physical therapy modalities, and peritrochanteric corticosteroid and local anesthetic injections are generally helpful. However, symptom recurrence and incomplete symptom relief are common.^{9,10,24} In 1 trial, 33% of patients treated with a minimum of 2 corticosteroid injections experienced improvement but not resolution of symptoms.⁹ Of those patients who did improve, 25% reported a recurrence.⁹

Surgical options include open bursectomy with an unsutured iliotibial band incision,³⁹ excision of a portion of the iliotibial band overlying the greater trochanter and removal of the bursa,⁴⁷ debridement and repair of damaged gluteal tendons with resection of the bursa,^{19,25} iliotibial band Z-lengthening and removal of the bursa with tendon repair,⁸ arthroscopic bursectomy,¹⁰ arthroscopic bursectomy with debridement of damaged gluteal tendons,² and arthroscopic bursectomy with concomitant iliotibial band release.¹⁰ Arthroscopic techniques have yielded particularly favorable results.^{2,10,11} Unfortunately, most of these studies are small, retrospective case series,^{10-12,19,25,39,47} and for this reason, reports of surgical management can be difficult to compare and interpret.

Zoltan et al⁴⁷ reported their experience with partial iliotibial band and trochanteric bursa resection in 7 athletes with refractory trochanteric bursitis. Six of the 7 were either varsity collegiate runners or competitive, recreational runners, and 1 was a crew athlete. The results were only fair. At mean follow-up of 55 months, 4 were improved, but only 1 was asymptomatic. Three continued to experience at least some pain with athletic activities. One had operative failure with complete recurrence, and 2 were lost to follow-up.

Several unpublished, uncontrolled pilot studies suggest that SWT may be an effective treatment for "hip bursitis." In 1 such trial, Meyer (unpublished data, 2002) reported the results of 18 women aged 40 to 86 years with a 1-year history of chronic trochanteric bursitis refractory to nonoperative therapy treated with 1500 to 3000 shocks at various energy levels ranging from .03 to .2 mJ/mm². Fifteen of 18 patients were satisfied with their results and reported clinically relevant improvement in their VAS (M. Meyer, unpublished data, 2002). Souza et al (unpublished data, 2006) performed an uncontrolled clinical trial of 46 patients with chronic hip bursitis. Patients were treated with 1 (42 patients) or 2

(4 patients) sessions of high-energy SWT (1200 impulses, total energy flux density ranged from 3.35 to 3.6 mJ/mm²). At 6 months after treatment, 91% of patients were reported to have had a good or excellent result. Most recently, Morral and Fernandez-Fairen (unpublished data, 2008) treated 81 patients with chronic GTPS with low-energy SWT (3 sessions at intervals of 1-2 weeks; 3000 impulses; total energy flux density of 0.12-0.16 mJ/mm²). One year after treatment, 72% of patients reported good or excellent results based on the RM scale.

The present study evaluated the effects of SWT on a consecutive series of patients with GTPS who had not responded to nonoperative management. The outcome for the entire population was evaluated and compared with a well-matched control group. The mean VAS and HHS for the SWT group were statistically improved at 1, 3, and 12 months after treatment compared with the control group. The percentages of excellent or good results 12 months after treatment for the SWT and control groups were 79% and 36%, respectively. There were no significant complications, and no patient required additional SWT.

Prior published studies evaluating SWT have used a change of 2 points on the visual analog scale as an indication of clinical relevance.¹² Using this criteria, we evaluated the magnitude of the improvement in mean VAS from baseline for both groups. For each time point for the SWT group, the magnitude of the change in mean VAS (3.4, 4.8, and 5.8, respectively) was clinically relevant. Neither the 1-month nor the 3-month magnitude of change in mean VAS (0.9 and 1.5, respectively) for the control group, however, was clinically relevant. The 12-month magnitude of change in mean VAS (2.2) for the control group did achieve clinical relevance.

We arbitrarily defined a change of 10 points in the HHS as an indication of clinical relevance. We chose 10 points because a 10-point change is often used clinically as an indicator of a different level of function. Specifically, for hip arthroplasty, an HHS between 90 and 100 indicates an excellent score, whereas an HHS between 80 and 89 indicates a good score. Using this criteria, for the SWT group, at each time point, the magnitude of the change in mean HHS (20.2, 25.2, and 30, respectively) was clinically relevant. However, for the control group, at each time point, the magnitude of the changes in mean HHS (4, 6.5, and 7.2, respectively) was not clinically relevant.

All SWT procedures were performed in the office without anesthesia. Prior studies involving patients with chronic plantar fasciitis, Achilles tendinopathy, and lateral epicondylitis have demonstrated that local anesthesia application in the area of shock wave delivery compromises the positive treatment effects of SWT.^{13,33} Local anesthesia might interfere with clinical focusing of the shock waves or, more likely, alter the neurogenic inflammatory response and antinociceptive effects associated with SWT.

This study is a retrospective cohort study and, as such, has some inherent limitations that require consideration. There was no randomization, and there was no placebo arm to the investigation. The length of follow-up was only 12 months. However, a positive treatment effect was already evident at this time. Finally, MRI scans were not

performed for each patient. However, the symptoms used to define GTPS, moderate-to-severe pain located over the greater trochanter and peritrochanteric area, pain with resisted hip abduction, and impaired function, are generally accepted and considered to be appropriate diagnostic descriptors of this condition.^{20,21,25,37}

Acknowledging these weaknesses, this series contributes valuable information. The results from this study add to the growing number of favorable reports that substantiate the efficacy of SWT as a treatment for chronic tendinopathies.

CONCLUSION

Traditional treatment of GTPS is generally lengthy, associated with frequent recurrences, and, in many cases, has an unacceptable degree of improvement. This study demonstrates that low-energy SWT is safe and effective, that it can be used to treat patients with chronic GTPS, and that satisfactory improvement is maintained for at least 1 year. Further randomized, prospective studies are needed to confirm this finding.

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