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Home Training, Local Corticosteroid Injection, or Radial Shock Wave Therapy for Greater Trochanter Pain Syndrome

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Background: There are no controlled studies testing the efficacy of various nonoperative strategies for treatment of greater trochanter pain syndrome.

Hypothesis: The null hypothesis was that local corticosteroid injection, home training, and repetitive low-energy shock wave therapy produce equivalent outcomes 4 months from baseline.

Study Design: Randomized controlled clinical trial; Level of evidence, 2.

Methods: Two hundred twenty-nine patients with refractory unilateral greater trochanter pain syndrome were assigned sequentially to a home training program, a single local corticosteroid injection (25 mg prednisolone), or a repetitive low-energy radial shock wave treatment. Subjects underwent outcome assessments at baseline and at 1, 4, and 15 months. Primary outcome measures were degree of recovery, measured on a 6-point Likert scale (subjects with rating completely recovered or much improved were rated as treatment success), and severity of pain over the past week (0-10 points) at 4-month follow-up.

Results: One month from baseline, results after corticosteroid injection (success rate, 75%; pain rating, 2.2 points) were significantly better than those after home training (7%; 5.9 points) or shock wave therapy (13%; 5.6 points). Regarding treatment success at 4 months, radial shock wave therapy led to significantly better results (68%; 3.1 points) than did home training (41%; 5.2 points) and corticosteroid injection (51%; 4.5 points). The null hypothesis was rejected. Fifteen months from baseline, radial shock wave therapy (74%; 2.4 points) and home training (80%; 2.7 points) were significantly more successful than was corticosteroid injection (48%; 5.3 points).

Conclusion: The role of corticosteroid injection for greater trochanter pain syndrome needs to be reconsidered. Subjects should be properly informed about the advantages and disadvantages of the treatment options, including the economic burden. The significant short-term superiority of a single corticosteroid injection over home training and shock wave therapy declined after 1 month. Both corticosteroid injection and home training were significantly less successful than was shock wave therapy at 4-month follow-up. Corticosteroid injection was significantly less successful than was home training or shock wave therapy at 15-month follow-up.

Keywords: trochanteric pain; greater trochanter pain syndrome (GTPS); trochanteric bursitis; corticosteroid injection; stretching; shock wave therapy

A frequent but often overlooked painful overuse syndrome of the hip in adults engaging in recreational sports activities is commonly called trochanteric bursitis. The anatomical relationship between 3 bursae, the hip abductor-external rotator muscles, the greater trochanter, and the overlying iliotibial tract may predispose this area to biomechanical irritation. The name *trochanteric bursitis* suggests inflammation in

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1 or more of the several peritrochanteric bursae. However, beneath the area where pain is perceived, several anatomical structures lie, including muscles, tendons, and entheses, in which recent MRI studies have shown abnormalities that appear to correlate better with the syndrome than does any bursal lesion. Abnormal signal at the gluteus medius and minimus or a muscle-tendon junction tear was described, whereas swelling of the trochanteric bursae was remarkably uncommon. Given the absence of bursal lesions and the presence of gluteal tendinopathy,[1,4,10,15,27,31] it was suggested to rename the condition *greater trochanter pain syndrome* (GTPS).[8]

Greater trochanter pain syndrome is characterized by chronic intermittent or continuous pain at and around the greater trochanter, sometimes radiating to the lateral aspect of the hip or lateral thigh and increasing with physical activity. Lying on the affected side can thereby interfere with restful sleep. Physical examination reveals tenderness to palpation of the greater trochanter, reproducing the patient's pain. Single-legged stance and resisted external rotation tests have excellent sensitivity and specificity for the diagnosis of tendinous lesion and bursitis in patients with MRI-documented refractory GTPS.[17] The prevalence of GTPS is higher among women than among men (rate 4:1), and the incidence is highest between the ages 40 and 60 years.[1] A prospective study in a Dutch general practice showed an incidence of 5.6 patients per 1000 adults in 1 year.[5] In a retrospective study, Lievense et al[18] found an incidence of 1.8 per 1000 in 1 year. They described GTPS as the second most important diagnosis of hip problems seen in primary care. Segal et al[24] reported a prevalence of unilateral and bilateral GTPS of 15.0% and 8.5% in women and 6.6% and 1.9% in men, respectively. Age and race were not significantly associated with GTPS. In a multivariate model, iliotibial band tenderness, ipsilateral knee osteoarthritis, and contralateral knee osteoarthritis were positively related to GTPS, indicating that altered lower limb biomechanics may be related to GTPS.

Standard initial treatment of gluteal tendinopathy in refractory GTPS includes nonsteroidal anti-inflammatory drugs, physical therapy, and correction of training errors plus the identification and correction of suspected, albeit still unproven, predisposing factors such as repetitive overuse injury, hip trauma, bone spurs, or calcium deposits.[1,14] Recently, leg-length discrepancy was confirmed to be not associated with GTPS.[25]

Concurrently, or if the other nonoperative measures fail, a local corticosteroid injection is regarded as standard of care. There is no conclusive evidence, however, that these injections are effective, although small observational studies suggest that injections with corticosteroids are effective in the short term. In 1 open trial, a single corticosteroid injection had a response rate between 61% and 77%. Best responses were attained with the highest corticosteroid dose of 24 mg of betamethasone.[26] No controlled trials are available evaluating the benefit of injection therapy for this disorder. Likewise, we are unaware of any controlled studies of the efficacy of home training or of shock wave treatment for GTPS. After all, shock wave therapy has been found to be effective for other insertional tendinopathies, such as that of the heel (Achilles tendon, plantar fasciopathy) or the lateral elbow. Extensive information on the potential working mechanism of shock wave therapy is provided by Gerdesmeyer et al,[13] Pettrone and McCall,[20] and Rompe et al.[21,22]

This study compared the individual effectiveness of 3 treatment modalities already in use in 2 orthopaedic outpatient clinics: a single local corticosteroid injection, a standardized home training program, and a standardized shock wave treatment protocol. We wished to test the null hypothesis that a corticosteroid injection, home training, or shock wave therapy for the management of GTPS produced equivalent outcomes at 4-month follow-up evaluation.

PATIENTS AND METHODS

This was a pragmatic study conducted in a secondary care setting. Consecutive patients referred to 2 orthopaedic outpatient clinics for persisting lateral hip pain were checked for the following inclusion criteria:

- Local tenderness on palpation of the area of the great trochanter of patients with this symptom as the reason for the consultation. Physical examination included asking subjects "Is this tender or painful?" while applying 1.5 to 3.0 kg of pressure over the lateral and posterior aspects of the greater trochanter with the subject in the lateral decubitus position. The examiner used a Wagner Force Dial dolorimeter (Wagner Instruments, Greenwich, Connecticut).
- Pain located anterior, lateral, or posterior to the greater trochanter for more than 6 months.
- Pain while lying on the affected side.
- Positive resisted external rotation test result. Patients were asked to lie supine on a table with the hip and knee flexed at 90° and the hip in external rotation. After slightly diminishing the external rotation just enough to relieve the pain, patients were asked to return actively to neutral rotation, that is, to place the leg along the axis of the bed, against resistance. The test result was considered positive when it reproduced the spontaneous pain reported by the patient.[16]
- No radiologic evidence at imaging of hip joint disease or knee joint disease (Kellgren-Lawrence scale <2 points; 0, no radiographic finding of osteoarthritis; 1, minute osteophytes of doubtful clinical significance; 2, definite osteophytes with unimpaired joint space; 3, definite osteophytes with moderate joint space narrowing; 4, definite osteophytes with severe joint space narrowing and subchondral sclerosis).

Exclusion criteria were the following:

- History of acute trauma.
- Presence of signs and symptoms of another cause of regional hip pain, such as dysplasia, deformities, sciatica.
- Presence of hip internal rotation ≤20° in the context of pain with internal rotation.
- Presence of signs of general myofascial tenderness on palpation.[24]

- Bilateral GTPS.
- Previous injection of the trochanteric area during the preceding 6 months.
- Previous spinal surgery.
- Previous hip surgery.
- Acute low back pain.
- Local infection to the hip joint region.
- Blood coagulation disorders or use of anticoagulant medication.
- Any known kind of vascular, neurologic, or neoplastic comorbidity.

Of 611 patients referred for probable trochanteric bursitis or lateral hip pain, 229 fulfilled all 5 inclusion criteria, and gave informed consent. After diagnosis, patients were asked to contact the clinics for an appointment for treatment. As with all other outpatients, eligible individuals were then sequentially given an appointment by a secretary to 1 of 3 weekly consultation hours, indicated as A, B, and C.

The investigator himself did not know in advance to which consultation hour an individual patient was assigned. The patient did not know in advance which consultation hour represented which treatment protocol.

The study design and the information documents were approved by the institution's review board. No conflict of interest was declared.

TREATMENT PROCEDURES

Home Training Group

Patients allocated to consultation hour A were recommended a home training program. This consisted of progressive slow repetitive exercises[23] with the following instructions:

- *Piriformis stretch*. Lie on your back with both knees bent and the foot of the uninjured leg flat on the floor. Rest the ankle of your injured leg over the knee of your uninjured leg. Grasp the thigh of the uninjured leg, and pull that knee toward your chest. You will feel a stretch along the buttocks and possibly along the outside of your thigh on the injured side. Hold this stretch for 30 to 60 seconds. Repeat 3 times.
- *Iliotibial band stretch standing*. Cross your uninjured leg in front of your injured leg, and bend down and touch your toes. You can move your hands across the floor toward the uninjured side, and you will feel more stretch on the outside of your thigh on the injured side. Hold this position for 30 seconds. Return to the starting position. Repeat 3 times.
- *Straight leg raise*. Lie on the floor on your back, and tighten up the top of the thigh muscles on your injured leg. Point your toes up toward the ceiling, and lift your leg up off the floor about 10 in. Keep your knee straight. Slowly lower your leg back down to the floor. Repeat 10 times. Do 3 sets of 10.
- *Wall squat with ball*. Stand with your back, shoulders, and head against a wall, and look straight ahead. Keep your shoulders relaxed and your feet 1 ft away from the wall, shoulder-width apart. Place a rolled-up pillow or a ball between your thighs. Keeping your head against the wall, slowly squat while squeezing the pillow or ball at the same time. Squat down until your thighs are parallel to the floor. Hold this position for 10 seconds. Slowly stand back up. Make sure you are squeezing the pillow or ball throughout this exercise. Repeat 20 times.
- *Gluteal strengthening*. To strengthen your buttock muscles, lie on your stomach with your legs straight out behind you. Tighten your buttock muscles, and lift your injured leg off the floor 8 in, keeping your knee straight. Hold for 5 seconds, and then relax and return to the starting position. Repeat 10 times. Do 3 sets of 10.

When entering the study, all subjects were given a practical demonstration by trained physical therapists (6 instructional sessions, each 20 minutes long) and written instructions of home exercises. All exercises were to be performed twice a day, 7 days a week, for 12 weeks. All subjects were invited to see the physician after 2 and 4 weeks to check compliance with the training program by interview and to provide the same number of physician-subject contacts as in the other groups. All subjects could contact the physician during working hours if they had questions about the training program. After 6 weeks, the subjects were told to slowly return to their previous levels of sports/recreational activity.

Corticosteroid Injection Group

Subjects assigned to consultation hour B were treated by the physician following the method described by Cardone and Tallia.[6] Before the injection, the physician explained the procedure and any associated risks, and informed consent was obtained. Each subject was positioned in the lateral decubitus position with the GTPS side up. For the patient's comfort and stabilization, the hip was flexed 30° to 50° and the knee flexed 60° to 90°. The greater trochanter was identified by palpating the femur from the midshaft proximally until the trochanteric area was reached. The injection site was at the point of maximal tenderness or swelling. The physician marked the most painful point with a pen or pencil and disinfected the site. A syringe was prepared, containing 5 mL of 0.5% Mepivacain (Meaverin 0.5%, DeltaSelect GmbH, Dreieich, Germany) mixed with 1 mL of Prednisolone (25 mg, Predni 25 mg Lichtenstein N Kristallsuspension, Winthrop Arzneimittel GmbH, Fürstenfeldbruck, Germany). At the area most tender to palpation in the region of the greater trochanter, a 22- or 25-gauge needle was inserted perpendicular to the skin. In very obese subjects, a longer needle was required. The needle was inserted directly down to bone and then withdrawn 2 to 3 mm before injecting 1 mL of the substance at that point. The needle was then redirected to distribute the remainder of the medication in a fanlike pattern over additional painful areas.

All patients were invited to see the physician after 2 and 4 weeks to secure the same number of physician-subject contacts as in the other groups. Subjects were asked to avoid pain-provoking activities. After 6 weeks, the subjects were told to slowly return to their previous levels of sports/recreational activity.

Shock Wave Therapy Group

All subjects allocated to consultation hour C received 3 sessions of shock wave treatment. A radial shock wave device (Swiss Dolorclast, Electromedical Systems, Nyon, Switzerland) was used.[13,21,22] A projectile in a hand piece is accelerated by a pressurized air source and strikes the 15-mm-diameter metal applicator. The energy generated is transmitted to the subject's skin as a shock wave through a standard commercially available ultrasound gel. The wave then disperses radially from the application site into the tissue to be treated. The energy generated depends considerably on the working pressure to which the device has been set. The treatment was administered in 3 weekly sessions. At each session, 2000 pulses were applied with a pressure of 3 bar (equal to an energy flux density of 0.12 mJ/mm^2). The treatment frequency was 8 pulses/s. With use of the principle of clinical focusing, the area of maximal tenderness was treated in a circumferential pattern, starting at the point of maximum pain level over the greater trochanter. No local anesthesia was applied. After 6 weeks, the patients were told to slowly return to their previous levels of sports/recreational activity.

Details of the content of each treatment session and of any immediate adverse effects were recorded by the physician. All cointerventions until the 4-month follow-up examination were discouraged. For all groups, prescription of pain medication was allowed when requested (paracetamol, 2000-4000 mg/d).

ASSESSMENT

No disease-specific questionnaires are available for GTPS. Therefore, generic outcome measures (pain severity and recovery) were chosen as primary outcome measures. Written outcome assessments were recorded by each subject on a standardized form at baseline, 1 month, 4 months, and 15 months from baseline before seeing the physician at each visit. A nurse who was unaware of the allocated intervention collected the forms and entered the responses into a database.

The primary outcome measurements were:

- Degree of recovery at 4 months compared with baseline, measured on a 6-point Likert scale (completely recovered to much worse). Success rates were calculated by dichotomizing responses. Subjects who reported themselves completely recovered or much improved were counted as successes, and subjects who reported themselves somewhat improved, same, worse, or much worse were counted as failures.
- Severity of pain during the past week measured with a numeric rating scale (0, no pain; 10, worst conceivable pain) at 4 months from baseline.

Secondary outcome measurements were degree of recovery and severity of pain recorded in the same way as described above at 1 month and at 15 months after treatment. Use of medication, visits to the physician or physical therapist, hospital treatment, and diagnostic tests were recorded every week. Finally, the subjects were asked to report any side effects. All subjects were asked whether they had been able to return to their previous sports activities.

STATISTICAL ANALYSIS

Statistical analyses were performed using the Graphpad Instat version 3.00 for Windows (Graphpad Inc, San Diego California).[30] For the outcome measure degree of recovery, sample size was based on the ability to detect a clinically relevant difference of 25% in success rate between groups on the Likert scale at 4 months from baseline. This sample size accounted for a 10% loss to follow-up, a type I error rate of 0.05, and a power of .8. Assuming a success rate of 40% in the least successful group (home training) and a success rate of 65% in the most successful group (corticosteroid injection), the target sample size was calculated at 75 patients per group. Accordingly, patients were sequentially allocated to the 3 different consultation hours until there were 75 patients in each group.

Changes in ratings over time for every patient were calculated by subtracting the results at baseline from those at follow-up. The main analysis was performed on an intention-to-treat basis. Missing responses were imputed as the last observation carried forward. Here, last observation was defined as the last recorded value.

Differences (95% confidence interval [CI]) in improvement between the groups were computed. A 2-way analysis of variance with group as the between-subjects factor and time as the within-subjects factor was used to assess the presence of significant differences between the 3 groups and within each group before treatment and at the scheduled follow-ups. A Tukey post hoc comparison was used to assess significant differences between mean values when a significant main effect and interaction were found. For all analyses, the level of significance was set at $P < .05$. Significance levels for multiple comparisons were adjusted with the Bonferroni procedure.[3,19]

To test differences between the proportions of baseline characteristics, and of success and failures, groups were combined and then tested with the Fisher exact test. For all analyses (2-sided), $P < .05$ was considered significant.

RESULTS

Figure 1 diagrams the trial profile. A total of 16 patients could not be reexamined at the main follow-up at 4 months from baseline: 5 in the home training group, 6 in the corticosteroid injection group, and 5 in the shock wave treatment group. Their missing responses were imputed as the last observation carried forward.

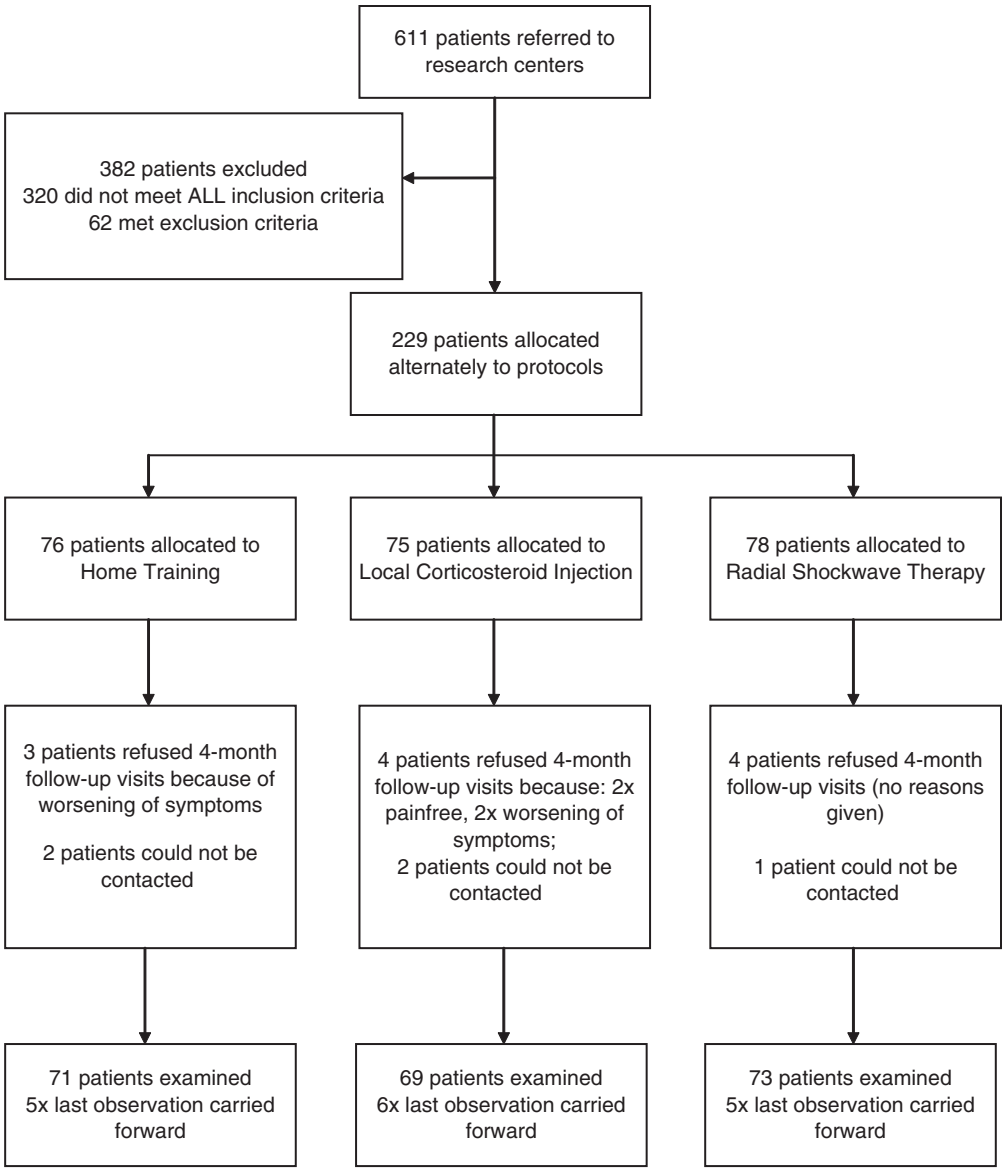

Figure 1. Trial profile.

Table 1 shows the baseline characteristics of the subjects. Although no formal randomization procedure was applied, subjects from the various groups did not differ clinically significantly regarding their baseline characteristics (all $P > .05$). Two of every 3 subjects engaged in sporting activities on a regular basis.

The mean values of the percentage of success on the Likert scale and of the numeric rating scale, related to the comparison between the 3 groups, are summarized in Table 2. The analysis of variance demonstrated a significant effect of treatment ($P < .01$) and a significant treatment-time interaction ($P < .01$) at all follow-ups.

Likert Scale

At 1 month from baseline, success was reported by 7% (5/76 subjects) in the home training group, 75% (56/75 subjects) in the corticosteroid injection group, and 13% (10/78 subjects) in the shock wave therapy group. The significant initial beneficial effect of corticosteroid injection did not persist. At 4 months from baseline, success rates were 41% (31/76 subjects) for home training, 51% (38/75 subjects) for corticosteroid injection, and 68% (53/78 subjects) for shock wave treatment. At 15 months from baseline, success rates were 80% (61/76 subjects), 48% (36/75 subjects), and 74% (58/78 subjects), respectively (Table 3). Post hoc comparison showed a significant difference between the home training group and the shock wave therapy group ($P < .001$), as well as between the corticosteroid injection group and the shock wave therapy group ($P < .05$) at 4 months from baseline. At the same time point, no statistically significant difference was found between the home training group and the corticosteroid injection group ($P > .05$). Moreover, post hoc comparison showed a

TABLE 1
Baseline Characteristics[a]

Characteristic	Home Training (n = 76)	Corticosteroid Injection (n = 75)	Shock Wave Therapy (n = 78)
Age, y	46	50	47
Women	53 (69)	54 (75)	55 (71)
Duration of current episode of symptoms, months (range)	14 (8-22)	11 (6-40)	15 (6-21)
Dominant leg affected	46 (61)	43 (57)	49 (62)
Concomitant low back pain	51 (67)	53 (71)	38 (49)
Use of analgesics during past week	11 (14)	10 (13)	13 (17)
Patient's preference for treatment			
Stretch training	38 (50)	30 (40)	33 (42)
Injection	19 (25)	22 (29)	23 (30)
Shock wave	10 (13)	13 (17)	10 (13)
No preference	9 (12)	10 (14)	11 (15)
Main sports activities			
Nordic walking	23 (30)	17 (23)	17 (22)
Jogging	16 (21)	9 (12)	10 (13)
Tennis	10 (13)	14 (18)	6 (8)
Other	5 (6)	11 (15)	9 (11)
None	23 (30)	24 (32)	36 (46)
Outcome measure: pain during past week, 0-10 points (range)	6.2 (4-8)	5.8 (4-8)	6.3 (4-9)

[a]Data are number of subjects (percentage) unless otherwise indicated. For all variables, between-group analysis was $P > .05$.

TABLE 2
Improvement in Primary and Secondary Outcomes[a]

	Baseline				1 Month			
	A	B	C	*P*	A	B	C	*P*
Likert, 1 or 2				NS	6.6% (5/76)	74.7% (56/75)	12.8% (10/78)	
A vs C								NS
B vs C								<.001
A vs B								<.001
Pain, 1-10	6.2 ± 3.7	5.8 ± 3.6	6.3 ± 4.1		5.9 ± 2.8	2.2 ± 2.0	5.6 ± 3.7	
A vs C				NS				NS
B vs C				NS				<.001
A vs B				NS				<.001

	4 Months				15 Months			
	A	B	C	*P*	A	B	C	*P*
Likert, 1 or 2	40.8% (31/76)	50.6% (38/75)	67.9% (53/78)		80.2% (61/76)	48.0% (36/75)	74.3% (58/78)	
A vs C				<.001				NS
B vs C				<.05				<.01
A vs B				NS				<.001
Pain, 1-10	5.2 ± 2.9	4.5 ± 3.0	3.2 ± 2.4		2.7 ± 2.8	5.3 ± 3.4	2.4 ± 3.0	
A vs C				<.001				NS
B vs C				<.01				<.001
A vs B				NS				<.001

[a]Data are number of subjects and percentage for the Likert scale and mean ± SD for pain. A, home training group (n = 76); B, corticosteroid injection group (n = 75); C, shock wave therapy group (n = 78); Likert 1, completely recovered; Likert 2, much improved NS, not significant.

TABLE 3
Likert Scale Ratings[a]

	1 Month						4 Months						15 Months					
Group	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Home training (n = 76)	1	4	28	36	7		12	19	24	23			46	15	7	6	2	
Corticosteroid injection (n = 75)	27	29	11	8			21	17	9	27	1		21	15	24	15		
Shock wave therapy (n = 78)	1	9	30	34	3	1	22	31	22	12	1		24	34	9	21		

[a] Likert scale ratings: 1, completely recovered; 2, much improved; 3, somewhat improved; 4, same; 5, worse; 6, much worse. Data are number of subjects. One month: corticosteroid injection group versus shock wave therapy group, $P < .001$; corticosteroid injection group versus home training group, $P < .00$; home training group versus shock wave therapy group, $P > .05$. Four months: home training group versus shock wave therapy group, $P < .001$; corticosteroid injection group versus shock wave therapy group, $P < .05$; home training group versus corticosteroid injection group, $P > .05$. Fifteen months: corticosteroid injection group versus shock wave therapy group, $P < .01$; corticosteroid injection group versus home training group, $P < .001$; home training group versus shock wave therapy group, $P > .05$.

significant difference between the corticosteroid injection group and the shock wave therapy group at 1 month ($P < .001$) and 15 months ($P < .01$) from baseline, as well as between the corticosteroid injection group and the home training group at 1 month ($P < .001$) and 15 months ($P < .001$) from baseline. No statistically significant difference was found between the home training group and the shock wave therapy group (Table 2). All subjects reporting success at the various time points resumed their previously preferred sports activities.

Numeric Rating Scale

Post hoc comparison showed a significant difference between the home training group and the shock wave therapy group ($P < .001$), as well as between the corticosteroid injection group and the shock wave therapy group ($P < .01$) at 4 months from baseline. At the same time point, no statistically significant difference was found between the home training group and corticosteroid injection group.

Moreover, the same post hoc comparison showed significant differences between the corticosteroid injection group and the shock wave therapy group at 1 month ($P < .001$) and 15 months ($P < .001$) from baseline, as well as between the corticosteroid injection group and the home training group at 1 month ($P < .001$) and 15 months ($P < .001$) from baseline. No statistically significant difference was found between the home training group and shock wave therapy group at the same times (Table 2).

Differences of change between the 3 groups were calculated. Between baseline and 1-month follow-up, the between-group analysis showed a significantly higher difference of change for corticosteroid injection. Mean difference of change between corticosteroid injection and home training was 3.3 points (95% CI, 2.6-3.9 points; $P < .001$) and between corticosteroid injection and shock wave therapy was 2.9 points (95% CI, 2.2-3.6 points; $P < .001$).

In contrast, between 1-month follow-up and 4-month follow-up, significant differences of change were seen in favor of radial shock wave therapy compared with injection and with home training. Mean difference of change between corticosteroid injection and home training was –3.0 points (95% CI, –3.7 to –2.3 points; $P < .001$) and between injection and shock wave therapy was –4.7 points (95% CI, –5.4 to –3.9 points; $P < .001$).

Between 4-month follow-up and 15-month follow-up, home training showed the highest change. Mean difference of change between corticosteroid injection and home training was –3.3 points (95% CI, –4.1 to –2.6 points; $P < .001$) and between corticosteroid injection and shock wave therapy was –1.6 points (95% CI, –2.4 to –0.8 points; $P < .001$).

Return to Previous Level of Sports/Recreational Activity

At 4 months from baseline, 26 of 76 subjects (34%) of the home training group, 37 of 75 subjects (49%) of the corticosteroid injection group, and 50 of 78 subjects of the shock wave therapy group (64%) had been able to return to their previous levels of sports/recreational activity (corticosteroid injection vs home training, not significant; corticosteroid injection vs shock wave therapy, $P < .05$; home training vs shock wave therapy, $P < .001$).

Additional Treatment

Until the 4-month follow-up from baseline, 23 of 76 subjects (30%) in the home training group, 15 of 75 subjects (20%) in the corticosteroid injection group, and 12 of 78 subjects (15%) in the shock wave therapy group used the allowed pain medication.

Between 4 and 15 months from baseline, 30 of 76 subjects (39%) in the home training group, 31 of 75 subjects (41%) in the corticosteroid injection group, and 48 of 78 subjects (62%) in the shock wave therapy group received no additional treatment (Table 4).

Sixty-one of 76 subjects (81%) in the home training group reported having continued with home training on their own.

Side Effects

Overall, 111 subjects reported adverse reactions, and all were mild (Table 5). Increased pain after treatment was reported more often for home training and injection subjects. However, skin bruising was most often reported for shock wave therapy.

TABLE 4
Additional Treatments During Follow-up 4 Months to 15 Months From Baseline[a]

	Home Training (n = 76)		Corticosteroid Injection (n = 75)		Radial Shock Wave Therapy (n = 78)	
	n	%	n	%	n	%
No additional treatment	30	39	31	41	48	62
Physical therapy	24	32	13	18	3	4
Corticosteroid injection	6	8	17	23	10	13
Pain medication	16	21	14	18	17	22

[a]Corticosteroid injection group versus shock wave therapy group, $P > .05$; corticosteroid injection group versus home training group, $P < .01$; home training group versus shock wave therapy group, $P < .01$.

TABLE 5
Adverse Reactions Until 1-Month Follow-Up[a]

	Home Training (n = 76)		Corticosteroid Injection (n = 75)		Radial Shock Wave Therapy (n = 78)	
	n	%	n	%	n	%
Number of patients reporting no adverse effects	49	65	33	44	36	47
Increased pain for 1 day	7	9	8	10	8	10
Increased pain >1 day	15	20	18	25	2	2
Radiating pain	5	6	7	9	3	4
Skin irritation	0		2	3	26	33
Swelling	0		7	9	2	3
Other minor or temporary adverse reactions	0		0		1	1

[a] Corticosteroid injection group versus shock wave therapy group, $P > .05$; corticosteroid injection group versus home training group, $P < .05$; home training group versus shock wave therapy group, $P < .05$.

DISCUSSION

The best way to diagnose GTPS remains unclear; imaging procedures such as MRI do not correlate well with clinical symptoms.[4,10,31] The optimal management for GTPS remains unclear. Traditional nonoperative therapies, such as supervised stretching and strengthening, physical therapy modalities, and corticosteroid and local anesthetic injections to the trochanteric area, are reported to be helpful. However, we are aware of no reports detailing controlled results of those treatment procedures. Therefore, scientific evidence supporting these therapies is low. Most recently, Stephens et al[29] called corticosteroid injection the preferred and definitive treatment for trochanteric pain syndrome.

Symptom recurrence and incomplete symptom relief are not uncommon after corticosteroid injection. In 1 trial, 33% of subjects treated with a minimum of 2 corticosteroid injections had improvement but not resolution of symptoms. Of those subjects who did improve, 25% experienced a recurrence.[11]

Many surgical procedures are available, but all reports are small, retrospective case series. For this reason, success rates of surgical treatment are difficult to compare and interpret.[9,12,16]

The present study aimed to evaluate 3 treatment procedures already in everyday use for years in 2 orthopaedic outpatient clinics. Clearly, the major weakness of the trial is that a formal randomization procedure was not feasible. However, the procedure chosen to allocate subjects to the 3 groups fulfils the definition of a quasi-randomized trial. Accordingly, subjects from the various groups did not differ clinically significantly regarding their baseline characteristics. As the 3 groups possessed similar characteristics at baseline, differences found at follow-ups most likely can be attributed to the effect of treatment rather than to any other factor.

A placebo-controlled trial was denied by the institutional review board as patients had already suffered for more than 6 months. So this study does not provide any data on the spontaneous course of GTPS.

Another weakness was that subjects could not be blinded to their individual treatments. In this regard, the current study would have been scientifically more sound if subjects had not been told that they would have to expect "no immediate effect" (training, shock wave) or a "quick effect" (corticosteroid injection group) and what kind of side effects could occur. Thorough patient information in writing, however, was the institutional review board's condition sine qua non to consent to the study design.

When attending for assessment, subjects filled in the assessment forms by themselves and handed them over to a nurse before they were seen by a physician, so as to avoid any influence of the physician on the subject's individual rating. Nevertheless, the subject who served as the assessor of the outcome measures was aware of the treatment received.

When informed about the investigation, subjects were told that the usual standard treatment for chronic GTPS was polypragmatic, invariably including a corticosteroid injection to the greater trochanter area as current standard of care. All subjects were thoroughly informed in advance about potential complications arising from stretching and strengthening (temporary increase of pain, no immediate effect), shock wave therapy (temporary increase of pain, skin bruise, no immediate effect), and corticosteroid injection[7] (quick effect; temporary increase of pain; local infection; local reactions at the injection site with swelling, tenderness, and warmth; postinjection flare; soft tissue (fat) atrophy; local depigmentation; periarticular calcifications; tendon rupture; systemic effects; alterations in taste; hyperglycemia in subjects who have diabetes; direct needle injury to local nerves; perilymphatic depigmentation; adrenal suppression; abnormal uterine bleeding).

The 2:1 chance for subjects to avoid injection of a corticosteroid was an incentive when it came to consenting or to not taking part in the current study. No local infection or any other severe side effect occurred in the subjects who received an injection, and a single corticosteroid injection showed a convincing positive effect at 1 month from baseline, with a success rate of 75%. In subject-based assessment, this effect subsided with time, being 51% at 4 months and 48% at 15 months. Not unexpectedly, the corticosteroid, as a potent anti-inflammatory medication, had a declining effectiveness when used for GTPS—a problem usually not associated with acute inflammation. The same is observed in, for example, lateral elbow tendinopathy (epicondylitis).[2,28]

Repetitive low-energy radial shock wave therapy without local anesthesia did not lead to early pain relief.[13,20-22] Its beneficial effect increased over months, with a success rate of 68% at 4 months and 74% at 15 months, as has been reported with regard to tendinopathies of the heel and elbow.[13,20-22]

Home training was initially ineffective. Its effects started to become evident at the 4-month follow-up with a 41% success rate and improved to 80% at 15 months. Our subjects were quite satisfied with this slow but steady improvement, as at the 15-month follow-up 81% reported to have continued with home training on their own. This is the first controlled report of the efficacy of a standardized home training program for GTPS in a pragmatic setting. The current subject information delivered by the American Academy of Orthopaedic Surgeons (http://orthoinfo.aaos.org/topic.cfm?topic=a00409) still does not support the use of physical therapy or stretch exercises as effective procedures.[14]

Keeping in mind that we compared injection therapy as a passive procedure (tolerated by the subject) with home training as an active therapy that gave the subject therapeutic responsibility, it was interesting to observe that the active therapy was more effective in the long term. Further investigation should focus on subjects with acute injuries to ascertain whether a wait-and-see policy leads to results comparable to the home training.

CONCLUSION

The corticosteroid injection protocol was significantly more successful than were home training and shock wave therapy at 1 month from baseline only, but it showed a decreasing efficiency over time with treatment failures of 49% and 52% at 4 and 15 months from baseline, respectively.

With regard to treatment success at 4-month follow-up, home training, corticosteroid injection, and shock wave therapy for treatment of GTPS did not produce equivalent outcomes at 4-month follow-up. Radial shock wave therapy had significantly better results. The null hypothesis was rejected.

Fifteen months from baseline, radial shock wave therapy and home training were equally successful with treatment failures of only 26% and 20%, respectively. Both radial shock wave therapy and home training were significantly more effective than was the single corticosteroid injection protocol. Home training had the lowest proportion of reported adverse effects and the highest rate of longer term success.

This study demonstrates that all procedures were safe. Maintenance of satisfactory improvement was observed after home training and after shock wave treatment but not after corticosteroid injection. Better results were achieved earlier after shock wave therapy than with the home training.

The role of corticosteroid injection for GTPS needs to be reconsidered. Subjects should be properly informed about the advantages and disadvantages of the treatment options for GTPS. The significant short-term benefits of corticosteroid injection are reversed after 1 month, with high recurrence rates, implying that this treatment should be used with caution in the management of GTPS. The decision to recommend home training or to use radial shock wave therapy might depend on available resources because the relative difference was not significant in the long term, and the home training is less resource intensive.

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REFERENCES

1. Alvarez-Nemegyei J, Canoso JJ. Evidence-based soft tissue rheumatology, III: trochanteric bursitis. *J Clin Rheumatol*. 2004;10:123-124.
2. Bisset L, Beller E, Jull G, Brooks P, Barnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ*. 2006;333:939.

3. Bland A, Altman DG. Statistics notes. Multiple significance tests: the Bonferroni method. *BMJ*. 1995;310:170.
4. Blankenbaker DG, Ullrick SR, Davis KW, De Smet AA, Haaland B, Fine JP. Correlation of MRI findings with clinical findings of trochanteric pain syndrome. *Skeletal Radiol*. 2008;37:903-909.
5. Brinks A, van Rijn RM, Bohnen AM, et al. Effect of corticosteroid injection for trochanter pain syndrome: design of a randomised clinical trial in general practice. *BMC Musculoskelet Disord*. 2007;8:95.
6. Cardone DA, Tallia AF. Diagnostic and therapeutic injection of the hip and knee. *Am Fam Physician*. 2003;67:2147-2152.
7. Cardone DA, Tallia AF. Joint and soft tissue injection. *Am Fam Physician*. 2002;66:283-288.
8. Collee G, Dijkmans BA, Vandenbroucke JP, Rozing PM, Cats A. A clinical epidemiological study in low back pain: description of two clinical syndromes. *Br J Rheumatol*. 1990;29:354-357.
9. Craig RA, Jones DP, Oakley AP, Dunbar JD. Iliotibial band Z-lengthening for refractory trochanteric bursitis (greater trochanteric pain syndrome). *ANZ J Surg*. 2007;77:996-998.
10. De Maeseneer M, Gosselin R, De Ridder F, Shahabpour M, Vanderdood K. MR imaging changes in the trochanteric area of asymptomatic individuals: a potential for misdiagnosis of pain in the trochanteric region. *Eur J Radiol*. In press.
11. Ege Rasmussen KJ, Fano N. Trochanteric bursitis treatment by corticosteroid injection. *Scand J Rheumatol*. 1985;14:417-420.
12. Farr D, Selesnick H, Janecki C, Cordas D. Arthroscopic bursectomy with concomitant iliotibial band release for the treatment of recalcitrant trochanteric bursitis. *Arthroscopy*. 2007;23:905, e1-e5.
13. Gerdesmeyer L, Frey C, Vester J, et al. Radial extracorporeal shock wave therapy is safe and effective in the treatment of chronic recalcitrant plantar fasciitis: results of a confirmatory randomized placebo-controlled multicenter study. *Am J Sports Med*. 2008;36(11):2100-2109.
14. Green WB, ed. *Essentials of Musculoskeletal Care*. 2nd ed. Rosemont, Ill: American Academy of Orthopaedic Surgeons; 2001.
15. Kong A, Van der Vliet A, Zadow S. MRI and US of gluteal tendinopathy in greater trochanteric pain syndrome. *Eur Radiol*. 2007;17:1772-1783.
16. Lequesne M, Djian P, Vuillemin V, Mathieu P. Prospective study of refractory greater trochanter pain syndrome: MRI findings of gluteal tendon tears seen at surgery. Clinical and MRI results of tendon repair. *Joint Bone Spine*. 2008;75:458-464.
17. Lequesne M, Mathieu P, Vuillemin-Bodaghi V, Bard H, Djian P. Gluteal tendinopathy in refractory greater trochanter pain syndrome: diagnostic value of two clinical tests. *Arthritis Rheum*. 2008;59:241-246.
18. Lievense A, Bierma-Zeinstra S, Schouten B, Bohnen A, Verhaar J, Koes B. Prognosis of trochanteric pain in primary care. *Br J Gen Pract*. 2005;55:199-204.
19. Petrie A. Statistics in orthopaedic papers. *J Bone Joint Surg Br*. 2006;88:1121-1136.
20. Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. *J Bone Joint Surg Am*. 2005;87:1297-1304.
21. Rompe JD, Furia J, Maffulli N. Eccentric loading compared with shock wave treatment for chronic insertional Achilles tendinopathy: a randomized, controlled trial. *J Bone Joint Surg Am*. 2008;90:52-61.
22. Rompe JD, Nafe B, Furia JP, Maffulli N. Eccentric loading, shockwave treatment, or a wait-and-see policy for tendinopathy of the main body of tendo Achillis: a randomized controlled trial. *Am J Sports Med*. 2007;35:374-383.
23. Rouzier P. *The Sports Medicine Patient Advisor*. Amherst, Mass: SportsMed Press; 1999.
24. Segal NA, Felson DT, Torner JC, et al. Greater trochanteric pain syndrome: epidemiology and associated factors. *Arch Phys Med Rehabil*. 2007;88:988-992.
25. Segal NA, Harvey W, Felson DT, et al. Leg-length inequality is not associated with greater trochanteric pain syndrome. *Arthritis Res Ther*. 2008;10:R62.
26. Shbeeb MI, O'Duffy JD, Michet CJ Jr, O'Fallon WM, Matteson EL. Evaluation of glucocorticosteroid injection for the treatment of trochanteric bursitis. *J Rheumatol*. 1996;23:2104-2106.
27. Silva F, Adams T, Feinstein J, Arroyo RA. Trochanteric bursitis: refuting the myth of inflammation. *J Clin Rheumatol*. 2008;14:82-86.
28. Smidt N, van der Windt DA, Assendelft WJ, Deville WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. *Lancet*. 2002;359:657-662.
29. Stephens MB, Beutler AI, O'Connor FG. Musculoskeletal injections: a review of the evidence. *Am Fam Physician*. 2008;78:971-976.
30. Wass J. Statistics: fast and easy. *Science*. 1998;282:1652.
31. Woodley SJ, Nicholson HD, Livingstone V, et al. Lateral hip pain: findings from magnetic resonance imaging and clinical examination. *J Orthop Sports Phys Ther*. 2008;38:313-328.

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