Pressure-Pain Threshold Algometric Measurement in Patients With Greater Trochanteric Pain After Total Hip Arthroplasty

Arkan S. Sayed-Noor, MD, FEBOT,* Erling Englund, PhD,† Per Wretenberg, MD, PhD,‡§ and Göran O. Sjödén, MD, PhD*†

Background: The evaluation of tenderness associated with greater trochanteric pain (GTP) syndrome is amenable to bias and depends on the examiner’s experience. In this study, we tested whether the use of an electronic pressure algometer enhanced the reliability of this evaluation.

Patients and Methods: Pressure-pain threshold (PPT) was measured with an electronic algometer in 18 patients who developed GTP after total hip arthroplasty and in matched controls. Both groups were evaluated with visual analog scale.

Results: The PPT measurements showed large interindividual variability across patients. The correspondence of the PPT measurements in asymptomatic patients was good. We found good validity for the algometer used. The PPT ratio of 0.8 (affected vs. unaffected side) can be used as a cut-off ratio. The PPT measurements at the greater trochanter (local pain) were significantly lower than at the ilio-tibial band (radiated pain). There was no correlation between PPT measurements and visual analog scales. Despite the acceptable sensitivity and specificity of pressure algometer, because of low positive predictive value and large interindividual variability, pressure algometer has a limited value as a screening test.

Conclusions: The examination of tenderness associated with GTP is facilitated by the used algometer. It is the intraindividual body-side PPT differences that yield the most sensitive measurement for the assessment of deep pain. A cut-off value of 0.8 can be used for diagnostic purposes. Interindividual differences might be considerable and could mask pathologic diagnostic findings.

Key Words: pressure algometer, pressure-pain threshold, deep pain sensitivity, VAS

right and left body sides within asymptomatic patients; and to assess the value of pressure algometer as a screening test by measuring its sensitivity, specificity, and positive predictive value (PPV).

**MATERIALS AND METHODS**

From January to December 2002 we performed THA 172 consecutive patients (106 women and 66 men) with a mean age of 69 (30 to 91 y) for primary (n = 158) or secondary (n = 14) osteoarthritis of the hip at Sundsvall Hospital, Sweden. All patients were operated on with Lubinus SP II prosthesis using the postero-lateral (Moore) approach.

A follow-up questionnaire for evaluation of any residual hip pain was answered by these patients 11 to 23 months postoperatively. This questionnaire consisted of multiple choice questions concerning the type and severity of the pain and a pain-drawing to localize the site of the pain.

From the 172 patients, 2 groups were selected. The first group consisted of 18 patients who reported pain over the trochanteric region with or without radiation along the ilio-tibial band (ITB), tenderness on lying on the affected side, and a positive pain-drawing localizing the pain over the trochanteric area with or without radiation along the ITB. These patients manifested tenderness over the trochanteric area with or without tenderness over the ITB. Patients with lumbar/gluteal pain ± sciatica were excluded. Of these selected 18 patients there were 15 females and 3 males with mean age of 65 (45 to 82 y). The second group consisted of 18 asymptomatic patients who matched the GTP group in regard to sex and age (within 2 y marginal) and served as a control group.

The postoperative records of the patients of the 2 groups were evaluated to demonstrate any postoperative complications for example, wound infection, dislocation of the operated prosthesis, and deep vein thrombosis. Functional (on walking) VAS with 0 to 10 point scale was obtained to assess the degree of experienced lateral hip pain in GTP group and any residual hip pain in the control group. A thorough evaluation of patients of the 2 groups including physical examination were made by the same clinician (A.S.N.) at the orthopedic outpatient department.

Before performing the physical examination (including the algometric measurement), the patients were informed about the visit and a standardized information paper including details about the algometric measurement was provided.

Assessment of tenderness over the greater trochanter of the operated hip was undertaken with a hand-held electronic algometer (Somedic, Sweden). The instrument has a flat circular rubber footplate and a display unit. At least 1 trial PPT measurement on the hand was performed with the algometer to ensure that the measurement procedure was understood.

The patient was told to press the hand-held button to record the PPT at the moment when the applied pressure felt as pain. The measurement was obtained with the patient lying in the lateral decubitus position with hip joints slightly flexed. The greater trochanteric tip was identified by gentle manual palpation.

A linearly increasing perpendicular pressure was applied with the algometer (Fig. 1). The visual control of the electronic display of algometer allowed to use a ramp rate of 40 to 50 kPa/s during application of pressure.

Using the same technique, the PPT was also measured at the upper-third of ITB at a point between the upper and middle-third of the distance between greater trochanter and lateral femoral condyle. These 2 measurements (trochanteric and ilio-tibial) were then repeated on the contralateral side. The patients were blinded to the algometer readings. We registered 1 measurement of PPT on each of the 4 examined sites. For statistical analyses the students paired sample t test and Pearson correlation coefficient were used with a P < 0.05 considered as statistical significant. The study was approved by the regional ethical committee.

**RESULTS**

The evaluation of postoperative records revealed no postoperative complications except 1 superficial wound infection without residual scarring.

We found large interindividual variability of PPT algometric measurements across patients (Fig. 2). The PPT algometric measurements over the affected greater trochanter (mean 382 kPa, SD 195 kPa) and ITB (mean 563 kPa, SD 286 kPa) in the GTP group were significantly lower than the equivalent values over the contralateral side (greater trochanter mean 624 kPa, SD 305 kPa, and ITB mean 680 kPa, SD 350 kPa) (r = 0.68, P = 0.002 and r = 0.90, P = 0.0001, respectively). Such a difference

![FIGURE 1. The method used to perform the PPT algometric measurements. The algometer is held perpendicular to the examined trochanteric region and a linearly pressure is applied under direct visual control of the pressure ramp shown at the electronic display of the device.](image-url)
could not be found in the control group when comparing the measurements over the greater trochanter (mean 750 kPa, SD 176 kPa) and ITB (mean 693 kPa, SD 211 kPa) of operated side with the contralateral side (greater trochanter mean 775 kPa, SD 135 kPa and ITB mean 685 kPa, SD 192 kPa) (P = 0.453 and P = 0.760, respectively), that is, good “predictive” validity. Furthermore, the PPT measurements over the greater trochanter (site of local pain) on the affected side in GTP group were significantly lower than the measurements obtained over the ITB (site of radiated pain) on the same side (r = 0.60, P = 0.01).

There was good correspondence of PPT measurements when comparing data for right and left body sides of the control group both over the trochanteric region and the ITB (r = 0.63, P = 0.006 and r = 0.87, P = 0.001, respectively) (Fig. 3 shows the good correspondence over the ITB).

The mean ratio of algometric PPT measurements over the trochanteric region (affected/unaffected side) was 0.65 (SD ± 0.23). This was significantly different from the mean ratio of 0.97 (SD ± 0.17) obtained over the trochanteric region in the control group, P < 0.001 (Fig. 4).

The proper intraindividual cut-off value differentiating normal from pathologic tenderness that is, the ratio of PPT measurements of the affected to the unaffected side was found to be 0.8 (Fig. 4). Despite the fact that VAS index was significantly higher (P = 0.0001) in the GTP group (mean 3.9, range: 1 to 7) than in the control group (mean 0.74, range: 0 to 2), there was no correlation between VAS index and PPT algometric measurements.

To assess the value of pressure algometer as a screening test, the algometer sensitivity, specificity, and PPV were measured.

An 89% specificity and a 78% sensitivity values were used to determine PPT cut-off values over the trochanteric region in the GTP group. These values corresponded to a cut-off value of 6365 kPa. In the present study, there were 16/18 GTP patients who showed PPT values of less than the given cut-off value, versus 4/18 in controls.

The prevalence of GTP after THA operation is variable and can be affected by the surgical approach used.7 We found a prevalence of 12% in our material.16 Others have found a prevalence ranging from approximately 5% to 15%.7

The PPV is directly affected by the prevalence of the condition.

We chose the prevalence of 12% as it reflects the outcome of the present group of patients. According to the above-mentioned values of specificity, sensitivity, and prevalence, a PPV of 50% was estimated.

We found no practical difficulties in obtaining PPT algometric measurements. Patients of both sexes understood and accepted the procedure easily. One of the GTP patients developed bruises at the greater trochanteric site of measurement. No other complications were reported.

**DISCUSSION**

The pathogenesis of GTP is poorly understood. One explanation points out the development of an inflammatory reaction about the trochanteric bursa(e) in response to direct injury leading to increased tissue pressure in and around the bursa(e). THA and internal fixation of proximal femoral fractures might give rise to such a
Another explanation in nonoperated GTP patients considers degenerative changes affecting the gluteal muscle attachment to the greater trochanter with tear and tendinosis as the main finding. These 2 explanations give rise to one common pathway of increased local tissue sensitization to noxious stimuli and disturbance in pain modulation with subsequent tenderness on palpation. This tenderness represents the mainstay of the clinical diagnosis of GTP. When eliciting tenderness, at least 2 aspects are involved. A decreased PPT and an increased response to the given stimulus. These 2 aspects can vary giving rise to a variable severity. Owing to this variability the method used for evaluation of tenderness should be reliable. Finger palpation (which is considered as the gold standard) exerting an excessive pressure over a given area can give a false-positive result in a healthy individual and vice versa. Furthermore, different observers using various palpation techniques can evaluate the degree of tenderness (and subsequently the severity of the given condition) in different ways. The follow-up of such a tenderness with finger palpation is another problem.

Many studies have shown good to excellent validity and intraobserver and interobserver reliability of pressure algometer in assessment of tenderness associated with variable painful conditions. Furthermore, these studies showed that the algometer was useful to measure PPT in both symptomatic and symptom-free individuals for diagnostic purposes and for evaluation of efficacy of different treatment strategies, mainly in orofacial practice. The instrument allows the patient to self-actuate the cut-off point through a hand-held button. The latter character is thought to reduce a potential operator error factor.

In our study, we chose not to exclude the GTP patient who had superficial wound infection postoperatively. The superficial wound infection was limited to the upper-third of the operative wound and was successfully treated with 10 days course of antibiotics, with no subsequent complaint or disturbance of the postoperative rehabilitation.

We chose to make all PPT measurements by the same examiner and the rate of algometric pressure application was kept constant (40 to 50 kPa/s) to ensure good reliability with the algometer.

The algometric measurements were performed with the patient in the lateral decubitus position. The localization of the tip of greater trochanter and the control of the applied algometric pressure was easier with the patient lying on the side than in supine position, especially in the obese patient. The positioning of the patients on a soft examination table and the application of pressure on a so localized contact area made the subsequent algometric measurement of the contralateral side unaffected. We examined the painful side first because we believed that lying on the painful side first might evoke pain with subsequent local and central sensitization leading to a possible bias in measuring the PPT on this side later on.

The detection of increased PPT over ITB (site of radiated pain) in relation to the greater trochanter itself (site of local pain) is an issue of interest. Similar phenomenon was found by other researcher who studied PPT in orofacial myogenic painful conditions. It is still unclear whether sensitization of this region is centrally mediated.

The phenomenon described above provides some explanation for the interexaminer variability in assessing the degree of tenderness on palpating different points of an (diseased) area. One explanation of why the PPT is higher at the site of radiated pain than the site of local pain itself is what is called diffuse noxious inhibitory control. In muscle pain patients, it is believed that a pathologically disturbed inhibitory mechanism may result in widespread deep hypoalgesia of the surrounding tissues.

The absence of significant correlation between PPT algometric measurements and VAS in the present study indicates the complexity of using VAS as a simple pain evaluator. Poor correlation was also found by Walco et al., whereas others, for example, List et al. and
Hogeweg et al.\textsuperscript{21} found a significant correlation between PPT and VAS. This discrepancy could be due to the differences of sites where PPT was measured and the pathology of the condition investigated in different studies.

The large interindividual variability of PPT measurements across patients found in the present study was previously documented by other investigators.\textsuperscript{12,22–25} These findings together with the relatively low PPV found in this study and by other authors suggest that pressure algometer might have a limited value as a screening instrument when used to compare PPT measurements among patients in case of GTP screening after THA. On the other hand, the present study shows good validity and correspondence of the algometer in measuring PPT within-muscle, within-patient and between-patients.

Indeed, these findings reflect the importance of intraindividual side-to-side comparisons of PPT measurements when assessing the deep pain sensitivity. This was discussed in depth by Rolke et al.\textsuperscript{22}

The 0.8 ratio of PPT algometric measurements of the affected to the unaffected side found in the present study can be used for diagnostic purposes to differentiate the normal from the pathologic tenderness in patients with suspected GTP. This value was very close to the value of 84.1\% found by Fisher.\textsuperscript{13} There were 4 GTP patients with PPT ratio >0.8 overlapping the PPT ratio of the control group. Three of these patients had a mild degree of GTP with good response to nonsteroidal anti-inflammatory drugs. One patient had a bilateral GTP complaint with decreased PPT on both sides.

The selection of a cut-off value corresponding to 78\% sensitivity and 89\% specificity is recommended by different studies.\textsuperscript{26,27} According to Widmer et al.\textsuperscript{26} when the condition investigated is of low mortality (as in GTP of the present study), the sensitivity and specificity levels of diagnostic tests performed in medical sciences should be around 75\% and 90\%, respectively. These values allow the test to diagnose about 25\% of would-be patients as healthy and 10\% of healthy individuals as patients.

Many researchers have used pressure algometer to assess the effect of different treatment modalities such as intramuscular injections,\textsuperscript{12,28,29} physiotherapy, and acupuncture\textsuperscript{4,29} on the PPT. The good validity of algometer shown in this study and the determined ratio indicate the possibility to use this instrument in evaluating the effect of different types of GTP treatment on the PPT in a more reliable way compared with finger palpation or VAS index.

REFERENCES
