Hip abductor function following lateral Hardinge approach

Yasser S. Hannout

Department of Orthopedics and Traumatology, Faculty of Medicine, Menoufia University, Menoufia, Egypt

Correspondence to Yasser S. Hannout, MD, Department of Orthopedics and Traumatology, Faculty of Medicine, Menoufia University, Menoufia, Egypt. Tel: +20 100 663 9262; e-mail: dryasserhannout@yahoo.com

Received: 9 August 2017
Revised: 2 September 2017
Accepted: 19 September 2017
Published: 6 August 2021

The Egyptian Orthopaedic Journal 2020, 55:182–186

Background
Although the direct lateral approach to the hip gives excellent exposure of the hip joint and a clear operating field, this approach creates a potential functional risk for the abductor musculature by damaging the superior gluteal nerve or inadequate reinsertion of the musculotendinous cuff into the greater trochanter. The present study investigates the incidence of clinical and electrophysiological evidence of damage to the superior gluteal nerve after this approach.
Objective
The aim of this study was to evaluate the role of needle EMG in the assessment of hip abductors function following lateral approach of the hip.
Patients and Methods
Sixty cases were subjected to Hardinge lateral approach in the department of orthopedic surgery and traumatology, Menoufia University Hospital from March 2014 to March 2016.
Hemiarthroplasty, after a fracture of the neck of the femur, was performed in 30 patients and total hip replacement for advanced osteoarthritis of the hip joint in 30 patients. After operation all patients were assessed clinically and electrophysiologically.
Results
In base line EMG performed three weeks postoperatively to all patients, 18 patients (30%) showed EMG evidence of acute denervation of hip abductors while the remaining 42 patients (70%) showed normal EMG studies.
Conclusion
EMG detection of superior gluteal nerve injury was frequent in lateral approach to the hip. The injury recovered spontaneously within 3 months post-operatively. Good surgical technique and awareness of the anatomy of the nerve supply are the key factors in preserving good abductor strength.

Keywords:
abductor function, Hardinge, hip

Egypt Orthop J 55:182–186

1110-1148

Introduction

The direct lateral approach to the hip described by Hardinge [1] entails splitting of gluteus medius and retracting a portion of the muscle anteriorly. However, there is a risk of damaging the superior gluteal nerve (SGN), with the potential consequence of denervation of the anterior part of the gluteus medius and tensor fascia lata, which causes abductor weakness, pain, and limping [2].

The clinical effect of SGN damage may be ascertained by a positive Trendelenburg test or may remain subclinical [3]. The mechanism of damage is variable and not completely understood; many authors confirm that excessive proximal extension of the split in the gluteus medius could damage the SGN, ad traction and compression during the operation might contribute significantly to postoperative nerve dysfunction [2]. Hardinge [1] was aware of these problems and cautioned against excessive retraction of the gluteal flap. Jacobs and Buxton [4] advised manual traction, which is considered to be safer than the use of the self-retaining retractor. Dall [5] described a modification of the technique, in which a sliver of trochanteric bone is taken with the gluteal flap so as to allow better fixation of the flap to the greater trochanter during closure [3].

The most inferior branch of the SGN is vulnerable to damage during direct lateral approach to the hip. A safe distance proximal to the tip of the greater trochanter varying from 3 to 5 cm has been reported in different studies. Numerous efforts have been made to standardize the safe zone using patient characteristics such as body height; however, contradictory results have been reported [6]. The understanding of the exact distance of the superior gluteal pedicle from the greater trochanter is a relevant clinical problem, because it is evident that the superior gluteal neurovascular pedicle does not follow an equidistant course around the greater trochanter but descends from posterior to anterior [7].

 DOI: 10.4103/eoj.eoj_54_21

A question was raised whether the patients who had hip arthroplasties with the Hardinge approach had abnormalities of the SGN detectable by electromyography (EMG). The second question was whether patients with EMG signs of impairment of the SGN evolve with a positive Trendelenburg sign.

The aim of this study was to evaluate the role of needle EMG in the assessment of hip abductors function following Hardinge lateral approach of the hip.

Patients and methods

In this study, 60 cases were subjected to Hardinge lateral approach of the hip in the Department of Orthopedic Surgery and Traumatology, Menoufia University Hospital, from March 2014 to March 2016. Patients with preexisting neuromuscular abnormality or preoperative immobility were excluded. Hemiarthroplasty, after a fracture of the neck of the femur, was performed in 30 patients and total hip replacement for advanced osteoarthritis of the hip joint in 30 patients. The study was approved by the ethical committee of the faculty. Informed consent was taken from each patient.

All 60 patients were subjected to the direct lateral approach as described by Hardinge. The gluteus medius was detached from the trochanter anteriorly in continuity with the vastus lateralis. The posterior two-thirds were left in position, whereas the anterior third was detached. The incision was extended proximally from the apex of the greater trochanter, and the fibers of gluteus medius were split, taking care to remain within 3 cm of the tip of the greater trochanter. After the operation, all patients were assessed clinically and electrophysiologically.

Clinical assessment

Abductor power was assessed by the modified Trendelenburg test as described by Hardcastle and Nade [8] performed 3 months postoperatively for all patients. The patient was asked to stand on the operated side and lift the opposite leg by flexing the hip to between neutral and 30° and flexing the knee enough to lift the foot from the ground. The examiner observed the patient from the back and studied the line of the iliac crests. The test was negative when the unsupported pelvis was raised normally while standing on one leg and held there for at least 30 s and was considered positive when the patient could not elevate the unsupported pelvis or maintain elevation for 30 s.

Electrophysiological assessment

All 60 patients were subjected to a baseline EMG, 3 weeks postoperatively, to examine the SGN supplying the gluteus medius, gluteus minimus, and tensor fascia lata. This was carried out by a clinical neurophysiologist using concentric needle electrodes which were inserted into gluteus medius and tensor fascia lata. The surface landmark for the site of insertion of the needle for gluteus medius was 5 cm below the iliac crest on a line drawn vertically down from a line joining the anterior and posterior iliac spines. Recordings were taken at two other sites in gluteus medius each 1 cm apart. Tensor fascia lata was studied by inserting the needles at the junction of a line drawn vertically downward from the anterior superior iliac spine and a horizontal line drawn from the greater trochanter. Two other sites 1 cm apart in the tensor fascia lata were also sampled. The sequence of examination comprises recording of three types of activity: (a) the activity that occurs with or following each needle movement at rest (insertional activity), (b) spontaneously firing activity at rest with the needle stationary in each position (spontaneous activity), and (c) activity during voluntary muscle contraction to induce the motor unit action potentials (voluntary activity).

Special attention was given to find fibrillation potentials and positive sharp waves while examining a resting muscle as well as changes in the morphologic features of the motor unit action potentials while examining a contracting muscle. The diagnosis of acute denervation required the presence of fibrillation potentials and/or positive sharp waves (abnormal rest potentials or spontaneous activity) as they are the action potentials of single muscle fibers that fire spontaneously at rest in the absence of innervation.

When an abnormality was detected in the baseline EMG, the tests were repeated 3 months postoperatively, and signs of reinnervation were determined by normalization of the morphologic features of the motor unit action potentials and disappearance of positive sharp waves and/or fibrillation potentials.

Statistical analysis

Statistical analysis was performed using SPSS software, version 23 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). Data were expressed as mean±SD for quantitative parametric measures in addition to both number and percentage for categorized data. Student t test was used for comparison between two independent mean groups for parametric data. χ^2 test was used to study the association between each two variables or comparison between two independent groups regarding the categorized data. The probability of error at 0.05 was considered significant, whereas at 0.01 and 0.001 was considered highly significant.

Results

Electrophysiological studies

In baseline EMG performed 3 weeks postoperatively for all patients, 18 (30%) patients showed EMG evidence of acute denervation of hip abductors, whereas the remaining 42 (70%) patients showed normal EMG studies.

However, follow-up EMG was performed only for the 18 positive cases 3 months postoperatively, where 16 patients showed EMG signs of reinnervation determined by normalization of the morphologic features of the motor unit action potentials and disappearance of positive sharp waves and/or fibrillation potentials, whereas two patients showed EMG evidence of persistent denervation.

Clinical assessment

In this study, the two patients who had EMG evidence of persistent denervation of the hip abductors, 3 months after the operation, have positive Trendelenburg test (with dropping of the unsupported pelvis). In addition, nine (15%) patients whose EMG results were normal or progressed to normalization, 3 months after the operation, had positive Trendelenburg test.

The presence of a positive Trendelenburg test with dropping of the pelvis did not correlate with the electrophysiological evidence of acute denervation of the hip abductors ($P>0.05$) but correlated with the electrophysiological evidence of persistent denervation ($P<0.05$). There was a slightly higher incidence of nerve damage after total hip replacement than after hemiarthroplasty, but the numbers were too small to establish statistical significance. This may be owing to excessive retraction for acetabular exposure.

Discussion

The most appropriate surgical approach for hip arthroplasty continues to stimulate debate. The two most commonly used techniques are the lateral approach, where the abductor muscles are divided mid-tendon and reflected from the anterior aspect of the femoral neck, and the posterior approach, where the joint capsule is approached through the external rotator muscles on the posterior aspect of the femoral neck [9].

Critics of the direct lateral approach suggest that the violation of the hip abductors may lead to delay in recovery of abductor strength, injury of the SGN, inadequate reinsertion of the musculotendinous cuff into the greater trochanter, and late Trendelenburg gait. The advantage proposed is the good exposure of the acetabulum, facilitating cup positioning, which may decrease the rates of dislocation and risk of sciatic nerve injury, which is not close to the operative field, as compared with the posterior approach [10], but despite the extensive research in this area, a meta-analysis could not find sufficient evidence to conclude which of the two most commonly used surgical approaches is superior [11].

The exact mechanism of damage to the SGN during Hardinge approach is variable and is not completely understood [2]. Using continuous intraoperative EMG, three maneuvers, described as endangering the nerve, are splitting the gluteus medius muscle, excessive retraction for acetabular exposure, and positioning the leg across the table for preparation of the femur [12].

The SGN is derived from the posterior branches of the fourth and fifth lumbar and the first sacral spinal nerves. Comprised of only motor fibers, it is the only nerve exiting from the greater sciatic foramen superior to the piriformis muscle. After exiting from the foramen, the SGN divides into the superior and inferior branches. The superior branch innervates the gluteus medius and minimus muscles, whereas the inferior branch innervates the gluteus medius, minimus, and the tensor fascia latae muscles[13].

The incidence of physical damage to the SGN depends largely on the branching pattern of the nerve. The presence of two different branching patterns of the SGN (a spray pattern and a transverse neural trunk pattern) was first described by Jacobs and Buxton [4] in 1989 and then confirmed by Basarir *et al.* [6] and by Apaydin *et al.* [14] in 2012. According to Khan and Knowles [15].

Apaydin *et al.* [14] observed two different branching patterns as previously described in the literature: (a) transverse neural trunk pattern with a principal trunk and a few peripheral ramie and (b) spray pattern in which the main trunk was divided into many ramie.

The closest mean distance between the SGN and the greater trochanter was measured with a mean of 3.8 cm (minimum: 2.8, maximum: 5.0) in transverse neural trunk pattern. The area between this closest nerve branch and the greater trochanter was considered a 'safe zone' as this area was devoid of any neurovascular structures. However, such a distance was not valid for the spray pattern where the tensor fascia lata branches traveled just above the greater trochanter. Therefore, in this pattern, a safe zone does not exist [14]. Stecco *et al.* [2] stated that the true 'safe zone' is very small when performing direct lateral approach to the hip joint. The proximal extension of the incision has to be restricted at 3.5 cm from the trochanteric apex and any extension of the exposure should be obtained by distal splitting of vastus lateralis, but also with this expedient, it is not sure to avoid the damage of the inferior branches of the SGN to the tensor fasciae lata muscle [2]. For this variability in the 'safe zone,' in the current study, proximal splitting of the gluteus medius muscle was limited to 3 cm proximal to the tip of the greater trochanter.

There is controversy concerning the clinical effects of the SGN damage. Ramesh *et al*. [16] and Siebenrock *et al*. [12] associate this damage with a positive Trendelenburg test, whereas Abitbol *et al*. [17], Kenny *et al*. [18], and Picado *et al*. [19] report no direct correlation.

In this study, 18 (30%) patients showed EMG evidence of acute denervation of the hip abductors 3 weeks postoperatively. This result was slightly higher than that reported by Ramesh *et al*. [16] and Mostafa *et al.* [20] (23 and 18%, respectively), but still less than that reported by Baker and Bitounis [3], Kenny *et al.* [18], Abitbol *et al.* [17], and Picado *et al.* [19] (34, 56, 77, and 42.5%, respectively). Spontaneous recovery from this damage occurred in 16 of 18 patients by 3 months postoperatively, suggesting these lesions may correspond to partial axonal damage to the fibers that form the nerve and/or to neurapraxia of a limited number of fibers. The two remaining patients who had EMG evidence of persistent denervation presented with a positive Trendelenburg test and limp 3 months postoperatively. However, nine patients with normal EMG results presented with a positive Trendelenburg test and limp 3 months postoperatively.These observations suggest that there was no absolute correlation between clinical results and EMG results. Therefore, other factors than injury to the SGN may be responsible for a positive Trendelenburg sign. A persistently positive Trendelenburg test in the absence of EMG evidence of denervation may be explained by avulsion of the gluteal flap after operation. This complication can be reduced by taking sliver of trochanteric bone with the gluteal flap so as to allow better fixation of the flap to the greater trochanter during closure. However, sliver osteotomy may create problems when the bone of poor quality or after a low-neck osteotomy. Matharu *et al.* [21] used a braided wire suture marker to assess the integrity of abductor muscle repair following direct lateral approaches to the hip. Repairs appeared to be detached in 11% of cases, and the remaining 89% of the repairs were either convincingly intact or showed only minimal movement cephalad.

Conclusion

EMG detection of SGN injury was frequent in lateral approach to the hip. The patients with the injury recovered spontaneously within 3 months postoperatively. Good surgical technique and awareness of the anatomy of the nerve supply are the key factors in preserving good abductor strength.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Hardinge K. The direct lateral approach to the hip. J Bone Joint Surg Br 1982; 64:17–19.

2 Stecco C, Macchi V, Baggio L, Porzionato A, Berizzi A, Aldegheri R, *et al.* Anatomical and CT study of superior gluteal neurovascular pedicle. Surg Radiol Anat 2013; 35:107–113.

3 Baker AS, Bitounis VC. Abductor function after total hip replacement. An electromyographic and clinical review. J Bone Joint Surg Br 1989; 71:47–50.

4 Jacobs LGH, Buxton RA. The course of the superior gluteal nerve in the lateral approach to the hip. J Bone Joint Surg Am 1989; 71:1239–1243.

5 Dall D. Exposure of the hip by anterior osteotomy of the greater trochanter: a modified anterolateral approach. J Bone Joint Surg Br 1986; 68-B:382–386.

6 Basarir K, Ozsoy MH, Erdemli B, Bayramoglu A, Tuccar E, Dincel VE. The safe distance for the superior gluteal nerve in direct lateral approach to the hip and its relation with the femoral length: a cadaver study. Arch Orthop Trauma Surg 2008; 128:645–650.

7 Lavernia CJ, Cook CC, Hernandez RA, Sierra RJ, Rossi MD. Neurovascular injuries in acetabular reconstruction cage surgery: an anatomical study. J Arthroplasty 2007; 22:124–132.

8 Hardcastle P, Nade S. The significance of the Trendelenburg test. J Bone Joint Surg Br 1985; 67-B:741–746.

9 Jameson SS, Mason J, Phil D, Baker P, Gregg PJ, McMurtry IA. A comparison of surgical approaches for primary hip arthroplasty: a cohort study of patient reported outcome measures and early revision using linked national databases. J Arthroplasty 2014; 29:1248–1255.

10 Müller M, Schwachmeyer V, Tohtz S, Taylor WR, Duda GN, Perka C. The direct lateral approach: impact on gait patterns, foot progression angle and pain in comparison with a minimally invasive anterolateral approach. Arch Orthop Trauma Surg 2012; 132:725–731.

11 Lindgren JV, Wretenberg P, Kärrholm J, Rolfson O. Patient reported outcome is influenced by surgical approach in total hip replacement. Bone Joint J 2014; 96:590–596.

12 Siebenrock KA, Rösler KM, Gonzalez E, Ganz R. Intraoperative electromyography of the superior gluteal nerve during lateral approach to the hip for arthroplasty: a prospective study of 12 patients. J Arthroplasty 2000; 15:867–870.

13 Eksioglu F, Uslu M, Gudemez E, Atik OS, Tekdemir I. Reliability of the safe area for the superior gluteal nerve. Clin Orthop Relat Res 2003; 412:111–116.

14 Apaydin N, Kendir S, Loukas M, Tubbs RS, Bozkurt M. Surgical anatomy of the superior gluteal nerve and landmarks for its

localization during minimally invasive approaches to the hip. Clin Anat 2013; 26:614–620.

15 Khan T, Knowles D. Damage to the superior gluteal nerve during the direct lateral approach to the hip: a cadaveric study. J Arthroplasty 2007; 22:1198–1200.

16 Ramesh M, O'byrne JM, Mc Carthy N, Jarvis A, Mahalingham K, Cashman WF. Damage to the superior gluteal nerve after the hardinge approach to the hip. J Bone Joint Surg Br 1996; 78-B:903–906.

17 Abitbol JJ, Gendron D, Laurin CA, Beaulieu MA. Gluteal nerve damage following total hip arthroplasty: a prospective analysis. J Arthroplasty 1990; 5:319–322.

18 Kenny P, O'Brien CP, Synnott K, Walsh MG. Damage to the superior gluteal nerve after two different approaches to the hip. J Bone Joint Surg Br 1999; 81:979–981.

19 Picado CHF, Garcia FL, Marques W. Damage to the superior gluteal nerve after direct lateral approach to the hip. Clin Orthop Relat Res 2006; 455:209–211.

20 Mostafa MS, Fadel MEA, Mohamed AE. Damage of the superior gluteal nerve after the lateral transgluteal approach of the hip. Anatomical, clinical and electrophysiological study. Pan Arab Orthop Assoc 2001; 5:125–130.

21 Matharu G, Thomas A, Pynsent P. Hip abductor re-attachment audited using a wire marker. Acta Orthop Belg 2011; 77:494–496.