Evaluation of the Superior Gluteal Nerve During Proximal Femoral Nailing

Proksimal Femoral Çivileme Sonrası Superior Gluteal Sinirin Değerlendirilmesi

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Özet

Amaç: Kalça cerrahisi sırasında süperior gluteal sinir etkilenebilir. Bu çalışmada stabil olmayan trokanterik kırıklar nedeni ile proksimal femoral çivileme uygulanan hastalar, süperior gluteal sinir hasarı mevcutdiyetini ve bunun klinik bulgularını değerlendirmek amacıyla retrospektif olarak değerlendirilmiştir. Gereç ve Yöntem: Bu çalışmaya 25 hasta dahil edilmiştir (14 kadın, 11 erkek). Çalışmaya Hastanemiz Ortopedi Bölümü'ne başvuran proksimal femoral çivileme uygunana hastalar dahil edilmiştir. Kırık fiksasyonu için aynı dizayna sahip iki ayrı çivi ve aynı cerrahi teknik uygulanmıştır. Serebrovasküler hastalık hikayesi olan, polinöropatinin elektromyografik bulguları olan veya dejeneratif vertabral hastalığı bulunanan hastalar çalışmadan çıkartılmıştır. Hastalar klinik ve radyolojik olarak değerlendirilmiştir. Gluteus maksimus kasında akut denervasyon ile ilişkili bulgular ve motor ünite aksyon potansiyelindeki değişiklikler superior gluteal sinir hasarı bulguları olarak kabul edilmişir. Bulgular: Sekiz hasta yürüme sırasında destek kullanmıştır, bu hastaların üçünde pozitif Trendelenburg belirtisi mevcttur ancak yalnızca bir hastada süperior gluteal sinirde akut denervasyon bulguları saptanmıştır. Tartışma: Bu çalışmaya göre iyatrojenik sinir hasarı insidansı proksimal femoral çivilemenin nadir görülen bir komplikasyonudur. Yaşlı hastalarda sinir hasarından bağımsız olarak, aksama ve destek kullanma ihtiyacı meydana gelebilir.

Anahtar Kelimeler

Hasar; Elektromyografi; Proksimal Femoral Çivileme; Süperior Gluteal Sinir

Abstract

Aim: The superior gluteal nerve may be compromised during hip surgery. We retrospectively evaluated the patients who underwent proximal femoral nailing for unstable trochanteric fractures in order to investigate the presence of superior gluteal nerve injury and its clinical findings. Material and Method: Twenty five patients (14 women, 11 men) were included in the study who had femoral nailing between January 2004 and March 2010 at Hamidiye Sisli Etfal Training and Research Hospital Department of Orthopaedics. Two different types of nails which have similar designs and surgical techniques were used for fracture fixation. Patients who had a history of cerebrovascular disease, electromyography findings of polyneuropathy, or degenerative vertebral disease were excluded from the study. Patients were evaluated clinically and radiologically. Findings related to acute denervation in the gluteus medius muscle and motor unit action potential changes were accepted as signs of superior gluteal nerve injury. Results: Eight patients were using support during walking and three of these patients had positive Trendelenburg sign, but only one patient had acute denervation signs of the superior gluteal nerve. Discussion: Based on the present study the incidence of iatrogenic nerve injury is a rare complication of proximal femoral nailing. Elderly patients, regardless of whether they have nerve injury, may limp and need to use a walking support.

Keywords

Damage; Electromyography; Proximal Femoral Nailing; Superior Gluteal Nerve

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Introduction

Proximal femoral fractures are frequently seen in daily orthopaedic practice [1]. The aim of the treatment is to obtain a stable fixation which allows early mobilization [2].

Intramedullary nails for stabilizing unstable fractures have been available since the early 1980s [3-5]. The nails are inserted percutaneously and allow the surgeon to minimize soft tissue dissection and bone damage, thereby reducing surgical trauma and wound complications and preserving the fracture hematoma that is essential for fracture healing [6-8].

Limping and abduction weakness as a result of damage to the nerves, abductor muscles, or change in neck shaft angle are important complications after hip surgery. Iatrogenic injury of the superior gluteal nerve (SGN) and gluteus medius muscle are most likely contributing factors, as shown in studies using electromyography (EMG). SGN and abductor muscles may be compromised during the surgical procedures. Especially in total hip arthroplasty, the SGN is at risk during the split and retraction of the gluteus medius muscle [9-11]. It may also be compromised during closed antegrade insertion of femoral nails. Although it has been asserted that the nails minimize soft tissue trauma due to percutaneous application, it is known that the entry points of these nails are not within the safe zone for the SGN. Anatomic studies have confirmed that the inferior branch of the SGN follows an oblique course anteriorly and caudally from piriformis fossa in the sagittal plane within the substance of gluteus medius muscle; therefore, injury to the nerve may be inevitable during percutaneous nail insertion [12-15].

In this study we retrospectively evaluated the patients who underwent proximal femoral nailing for trochanteric fractures, in order to investigate the presence of SGN injury and its clinical findings.

Material and Method

This study is based on a retrospective analysis of a prospectively-maintained database to detect superior gluteal nerve (SGN) injury and the effects it might have on the outcome of proximal femoral nailing surgery performed on patients between January 2004 and March 2010 at Hamidiye Sisli Etfal Training and Research Hospital Department of Orthopaedics. The study was approved by the local ethics committee. Our research is being reported aligned with the STROBE statement for case-control studies.

Inclusion criteria were patients who were treated for unilateral unstable intertrochanteric femur fractures (Orthopaedic Trauma Association 31A2 and 31A3) with Proximal Femoral Nail and Proximal Femoral Nail Antirotation (PFN and PFN-A; Synthes, Oberdorf, Switzerland) with a follow-up of at least one year. Exclusion criteria were: patients who had pathological fractures, fractures associated with polytrauma, previous surgery on the ipsilateral hip or femur, advanced osteoarthritis of the affected hip, inability to walk before injury, previous spinal surgery, or a history of cerebralvascular disease. The data of patients were retrieved from their medical files, operative reports, and regular follow-up records. We initially included into the study 51 (28 women and 23 men) patients who agreed to electromyographic investigation (EMG), from an overall total of 349 (193 women and 156 men) patients.

All of the procedures were done by the six regular surgeons.

An initial radiological examination of pelvis with both hips AP view was performed and neck shaft angles were measured for both hips. The neck shaft angle was measured to determine varus/valgus alignment as compared to the unaffected side. Radiographic measurements were performed by two investigators. Of the initial group of 51 patients, 17 patients (13 women and 4 men) who had an avulsion fracture of the greater trochanter or neck shaft angle less then 120 degrees or greater than 140 degrees were excluded because of the secondary varus or valgus deformity.

For clinical evalution, walking ability status was analyzed according to Kyo et al. [16]. In this system, patients are divided into four groups. Group 1 includes patients who can walk unassisted, group 2 includes patients who can walk with assistance, group 3 includes wheelchair-dependent patients, and group 4 includes bedridden patients. Patients were evaluated for Trendelenburg sign. Patients who could balance using finger support only were then asked to stand on one leg, flexing the other leg at the knee, while keeping the hip in extension. The examiner knelt in front of the patient to observe pelvic tilt. The test was negative when the unsupported pelvis was raised normally while standing on one leg and held there for at least 30 seconds [17]. The abductor power of the patients was assessed by the same physician according to the scale proposed by the Medical Research Council (MRC) (Table 1) [18].

Table 1. Medical Research Council Scale for muscle strenght.

0	No contraction
1	Flicker or trace contraction
2	Active movement with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

EMG was carried out to examine the SGN for the remaining 34 patients (21 women and 13 men). The vastus medialis, gastrocnemius, and extensor hallucis longus muscles were also assessed to determine any evidence of spinal-originated problems. The EMGs were performed by the same neurophysiologist. The mean time between surgery and EMG examination was 18.2 [14-21] months. The muscles were evaluated by the criteria of the American Academy of Electrophysiological Medicine for needle EMG. In order to exclude patients with polyneuropathy, radiculopathy, or plexopathy, nerve conduction studies of both lower extremities were performed. Then, gluteus medius muscles were assessed bilaterally to evaluate the SGN, the vastus medialis muscle for L4 root, extensor hallucis longus muscle for L5 root, and gastrocnemius muscle for S1 root. First, resting activities were assessed for the signs of acute denervation (fibrillation and positive sharp waves), followed by observation of the recruitment pattern, examination of the motor unit action potential (MUAP) amplitudes, and time characteristics. Finally, motor patterns of interferences were investigated during muscle contractions to obtain information about denervation and reinnervation of examined muscles.

Results

After EMG evaluation, 9 patients (7 women and 2 men) with polyneuropathy, radiculopathy, or plexopathy findings were excluded. The remaining 25 patients (14 women and 11 men) were included in the study. The mean age was 59.2 (21-89) years.

The mean collodiaphyseal angle was 131.44° (125-140). Eight patients were walking with support in daily life, of whom only three had positive Trendelenburg sign. The mean age of these patients was 82 (74-89) years and none of them used any walking support before surgery.

Muscle strengths according to the MRC were 2 in one patient, 3 in two patients, and 5 in 22 patients.

Acute denervation signs of the SGN on the affected side was detected in only one patient. This patient's muscle strength was 2. In addition to the reinnervation MUAPs, discrete, long-duration poliphasic MUAPs were observed in the gluteus medius muscle of this patient. This patient had a positive Trendelenburg test and he was using walking support in daily life. There was no sign of acute denervation in the EMG evaluations of other Trendelenburg sign positive patients. Only sparse MUAPs were detected and there was no sign of poliphasic MUAPs (Table 2).

Discussion

Although there is no consensus on this point, intramedullary fixation of unstable trochanteric fractures is often considered to be superior to extramedullary fixation because it provides more stable fixation and minimally invasive application [6,13,18]. Deficiency of the abductor mechanism is a well-recognised cause of pain and limping after hip surgery. This can be found incidentally at the time of surgery or it may arise as a result of damage to the SGN intra-operatively due to mechanical failure of the abductor muscle's detachment from the greater trochanter or malunions resulting in coxa vara or valga [19]. Morbidity attributable to SGN injury is difficult to define. The purpose of the current study was to determine the incidence of the damage to the SGN in patients treated with PFN and PFN-A.

The anatomic course of the SGN has been documented in various anatomical and clinical studies [9-15,20,21]. Branches of the nerve are within the surgical field during the gluteal splitting approach to the piriformis fossa as well as the greater trochanter tip. The average distance from the greater trochanter tip to the lowest branch of the SGN is more than 5 cm farther than the nerve's distance from the piriformis fossa entry portal [21]. Therefore, using the greater trochanter tip as an entry point may reduce the risk of damage to these nerve branches. Even though the nail is placed with minimally invasive techniques, iatrogenic damage may occur in the bone and soft tissues, especially during the reaming of the entry point. The entry point of PFN AND PFN-A is the tip of the greater trochanter. A 5 cm incision proximal to the greater trochanter has been described for this procedure [6]. The abductor muscles are dissected on the way to the entry point. Out of three patients who had positive Trendelenburg test and were using support while walking, only one patient had evidence of acute denervation in EMG. Muscle strenghts were found in the two patients who had

Table 2. Demographic features, radiologic and functional results of patients.

No	Age	Gender	Fracture type	Side	Follow-up (months)	Trendelenburg (0 = negative, 1 = positive)	Walking Ability (Group)	MCR Scale	Neck Shaft Angle	EMG
1	35	M	31A2	L	36	0	1	5	135	Normal
2	33	F	31A2	R	6	0	1	5	130	Normal
3	22	F	31A3	L	7	0	1	5	130	Normal
4	74	F	31A2	R	36	1	2	3	128	Normal
5	65	M	31A2	L	33	0	1	5	134	Normal
6	67	F	31A2	L	25	0	1	5	135	Normal
7	74	F	31A2	R	25	1	2	3	125	Normal
8	77	F	31A3	L	36	0	2	5	130	Normal
9	69	M	31A2	L	13	0	1	5	136	Normal
10	22	M	31A2	R	14	0	1	5	132	Normal
11	32	F	31A2	L	16	0	1	5	128	Normal
12	70	F	31A2	L	18	0	1	5	130	Normal
13	78	F	31A2	R	18	0	1	5	130	Normal
14	89	F	31A2	R	16	0	2	5	140	Normal
15	77	M	31A2	R	15	0	1	5	130	Normal
16	40	M	31A3	L	14	0	1	5	130	Normal
17	78	M	31A3	R	20	0	2	5	138	Normal
18	71	M	31A3	L	12	0	1	5	132	Normal
19	42	M	31A2	L	14	0	1	5	135	Normal
20	70	F	31A2	R	16	0	2	5	125	Normal
21	58	F	31A2	L	15	0	1	5	125	Normal
22	85	M	31A3	R	17	0	2	5	132	Normal
23	21	M	31A2	R	19	1	2	2	130	Right reduced, poliphasic MUAP, acute denervation
24	71	F	31A2	L	21	0	1	5	130	Normal
25	67	F	31A2	R	22	0	1	5	136	Normal

no evidence of nerve injury. Various anatomic studies have also revealed damage to the gluteus medius and minimus muscles with nail insertion at the trochanteric fossa versus minimal damage to these muscles when using the tip of the greater trochanter [22]. In our opinion this can only be a result of tendon or muscle damage.

The fracture of the greater trochanter during trauma or surgery and change in neck shaft angle after fracture union may lead to compromise of the abductor arm. The greater trochanter was intact for all patients in this study and mean collodiaphyseal angle was 131.4°.

There was no evidence of nerve injury or positive Trendelenburg test in 5 of 8 patients who were using support while walking. The mean age of these patients was 82 (74-89) years. When we asked patients why they use support, they declared that they use it to feel confident and because of they are afraid of falling. The main limitations of this study are its retrospective nature and low number of patients. More extensive follow-up is needed with a larger sample size, including younger patients, to reach more objective and significant results. In addition it is not possible to determine whether the nerve was injured during trauma. However, based on the present study the incidence of iatrogenic nerve injury is a rare complication of proximal femoral nailing. Elderly patients, regardless of whether they have nerve injury, may limp and need to use a walking support.

Competing interests

The authors declare that they have no competing interests.

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