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Review article

Nerve injuries associated with total hip arthroplasty

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ABSTRACT

Nerve injury is a relatively rare, yet potentially devastating complication of total hip arthroplasty (THA). Incidence of this ranges from 0.6 to 3.7%, and is highest in patients with developmental hip dysplasia and previous hip surgery. Apart from patient and surgeon dissatisfaction, this complication can have medico-legal consequences. Therefore, the purpose of this study was to review the risk factors, etiology, diagnostic options, management strategies, prognosis, and prevention measures of nerve injuries associated with THA. We specifically evaluated the: 1) sciatic nerve; 2) femoral nerve; 3) obturator nerve; 4) superior gluteal nerve; and 5) the lateral femoral cutaneous nerve.

1. Background

Nerve injury is a relatively rare, yet potentially devastating complication of total hip arthroplasty (THA). The reported incidence of nerve injuries associated with THA ranges from 0.6 to 3.7%, with a higher risk found in patients receiving revision THAs (7.6%).[1–8] Apart from patient and surgeon dissatisfaction, this complication may result in medico-legal consequences for the surgeon; therefore, proper assessment of risk factors, knowledge of commonly implicated anatomical structures and etiologies, and application of preventive measures is important.

2. Etiology

Nerve injuries can occur during THA due to compression, traction, ischemia, and/or transection.[9–13] Neural compression affects not only the nerve structure, but also its vascular supply.[10] It can occur perioperatively with patient positioning and draping, improper retractor placement, procedural hip dislocation, or in the setting of a developing hematoma.[9,12] With respect to patient positioning, special attention should be paid to the lateral aspect of the knee, as the common peroneal nerve is particularly susceptible to injury since it courses superficially in this region. Traction, or stretch injuries often occur with intraoperative manipulation, such as during dislocation and reduction of the hip, or with limb lengthening or lateralization as a result of THA.[12] The amount of traction required to cause injury is nerve-specific; unlike freely mobile nerves, nerves that are more fixed are at the highest risk.[10] For example, Edwards et al.[8] demonstrated that isolated palsy of the common peroneal nerve, which is relatively more fixed distally at the fibular head compared to that of the tibial nerve, which courses freely through the popliteal fossa, was associated with lengthening of less than 3.8 cm; whereas, involvement of the tibial division of the sciatic nerve did not occur until lengthening of greater than 4 cm. Furthermore, Dehart et al.[10] used rabbit models to quantify an association between limb-lengthening and nerve conduction failure, reporting that sciatic nerve dysfunction occurred at 25% lengthening, though histologic changes were seen earlier at 4 to 11% lengthening. Ischemic nerve injuries, previously described in Lundborg's experiments,[14] may occur secondary to compression, which has been shown to lead to earlier development of nerve injury, evidenced by endoneurial edema in as little as 2 to 4 h.[10] Compression causing ischemia may occur as a result of patient positioning. Direct neural transection or laceration commonly occurs from direct trauma by the scalpel, electrocautery, reaming, screws, or other implant or procedural equipment, including sutures.[10,12] Risk for transection is highest in nerves that have tightly packed fascicles, such as the common peroneal nerve, whereas multifasicular nerves with abundant connective tissue are

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less vulnerable.[10] Lastly, bone cement may also cause neural injury as a result of compressive and/or thermal damage, and therefore, leaked bone cement should be removed.[13] Despite awareness of these common etiologies, in 50% of cases where nerve injury is suspected, no underlying cause has been identified.[2,13]

3. Risk factors

Proper identification of perioperative risk factors associated with nerve injuries in THA may allow surgeons to avoid such complications. Some of the important risk factors have been listed in Table 1. The surgical approach chosen for THA may place certain nerves at an increased risk of injury and this has been listed in Table 2.

4. Prognosis

The prognosis of nerve injuries associated with THA can be related to various factors; however, the main prognostic factors are dependent on the initial neural insult, specifically, whether it was a complete or incomplete injury, traction injury and certain patient factors, especially body mass index (BMI).[5,15–17] Persistent dysesthesias have been a predictor of poorer outcomes in nerve injury cases and have been reported to occur 28% of the time.[5] Edwards et al.[8] and Park et al.[17] reported a worse prognosis associated with traction injuries and increasing BMI, respectively. With respect to BMI, the mechanism underlying the association with poorer outcomes currently remains unclear. Isolated sensory neuropathies have shown better recovery compared to those involving motor branches, and incomplete palsies have shown to have a more favorable outcome than complete nerve palsies.[17] Also, patients with early neurologic improvements tend to recover more completely.[2] Most patients achieve maximum recovery of neurologic function by seven months; however, recovery may continue for up to 12 to 18 months following the injury.[6] Unfortunately, complete neural recovery is not likely to occur, with one study reporting only 36% of complete nerve palsies, mostly sciatic or its divisions, fully recovered[9] and another showing full recovery occurring in 56% of patients with incomplete nerve palsies.[17]

5. Diagnosis and work-Up

Nerve injuries are diagnosed clinically in most cases; therefore, the most important diagnostic tool is a well-documented preoperative and postoperative physical exam. However, Weale et al.[18] reported that certain nerves may present with subclinical findings in approximately 70% of patients, thereby leading to an underestimation of injuries.[1] In such instances, more objective measures can be obtained through use of electromyography (EMG), somatosensory evoked potentials (SSEP), and measurement of nerve conduction velocities (NCV).[19–21]

Guidelines for postoperative use of EMG for diagnosis and management of nerve injuries has not been well established, but some studies have recommended routine electrodiagnostic testing in high-risk patients[8,22] and other have recommended the use of EMG when suspecting injury to nerves known to have obscure presentations, such as the obturator nerve.[12] On the other hand, Farrell et al.[9] obtained EMGs eight to twelve weeks after nerve injury in patients who were failing to recover, in order to gather information pertaining to the level of nerve injury and prognosis. The American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) issued a policy for electrodiagnostic medicine in 2010 after reporting that its use was poorly understood by many in the medical community, leading to overutilization in inappropriate settings.[23] The AANEM reported that physicians may benefit most when utilizing the combination of EMG and NCV several weeks after injury. However, with nerve transections, NCVs are useful more acutely, since delayed use may prevent the precise identification of the injured region, which could delay treatment.

Table 1
Major Risk Factors of Nerve Palsy in THA.

Risk Factor	Literature	Etiology of Injury
Preoperative Diagnosis of Developmental Dysplasia of the Hip (DDH) or Post-Traumatic Arthritis	Farrell et al.[9] found that patients with DDH had a 4.06 higher odd of nerve injury ($p = 0.00004$), and those with post-traumatic arthritis had a 3.42 high odd of nerve injury ($p = 0.01$) when compared to those receiving a THA with only a diagnosis of osteoarthritis. Other studies in the literature agree that these risk factors increase patient susceptibility to nerve injury.[10,12]	Nerve injury has been attributed to the technical difficulty of the THA in such patients. Previously, nerve injury in these patients was believed to be due to limb lengthening, but the literature has since dismissed this idea.[1,15,51,52]
Revision THA/Previous Hip Surgery	Patients receiving revision THA or those with a history of previous hip surgery are at increased risk of nerve injury. This is thought to be due to nerve embedment in scar tissue which alters nerve blood supply and increases vulnerability to traction injury.[8,10,21]	Ischemia and Traction injury
Female Gender	Numerous studies have shown females to be nearly twice as likely to experience nerve injury during THA [2,5,8,10] with one study demonstrating an increased ratio of 80:20.[4] However, a more recent study spanning over 30 years failed to show a significant increase in nerve injury trend in female patients ($OR = 1.39$; $p = 0.27$).[9]	1) Unknown, but two hypotheses exist. 2) Females tend to have lower soft tissue mass, increasing their susceptibility to nerve injury.[1] 3) Females have higher rates of DDH.[53]
Limb Lengthening	There is consensus that increasing limb length beyond a certain length is associated with increased risk of nerve injury.[5,11] Edwards et al.[8] showed a 28% increased risk of nerve injury in patients with greater than 4 cm lengthening following THA.	Traction
Cementless Surgical Technique	Despite cement being an etiology of nerve injury itself by its ability to cause compression and thermal injuries, THAs that involve cementless fixation of the implant are in fact associated with a higher risk of nerve palsy.[9,17]	Cementless fixation: Farrell et al.[9] hypothesized that due to the requirement of an inference fit with the cementless prosthesis, surgeons tend to ream and fixate the prosthesis with more force, thus increasing the likelihood of more transection nerve injuries.
Spinal Issues w/Pre-Existing Nerve Injury	Note: Controversial in the literature	"Double crush syndrome": Nerves become less tolerant of compression at the same or second locus if they have pre-existing compression, such in the case of spinal disc herniation disease.