FEMORAL MOTOR NERVE CONDUCTION STUDY - A NOVEL TECHNIQUE FOR EARLY DETECTION OF DIABETIC PERIPHERAL NEUROPATHY

Abstract

The Femoral Motor Nerve Conduction study proves to be a highly sensitive test for detecting both clinical and subclinical neuropathies in individuals with diabetes. This chapter focuses on comparing the conduction of the femoral motor nerve conduction method and its abnormalities in type 2 diabetic patients. Abnormalities in femoral nerve conduction have been observed in diabetic individuals. The chapter highlights the potential utility of incorporating femoral nerve conduction studies as a routine examination alongside electrophysiological testing to enhance the sensitivity of diagnosing Diabetic Peripheral Neuropathy in those with diabetes mellitus.

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I. INTRODUCTION

1. **Diabetic Perpiheral Neuropathy:** A disorder that affects the peripheral nervous system in a wide range is peripheral neuropathies. It is one of the most common forms of neurological disorders and the incidence of neuropathies is widely increasing because of the increasing prevalence of diabetes and obesity [1]. The signs and symptoms of peripheral neuropathies can vary from one individual to another. Some of the common symptoms include burning and tingling [2]. The diagnosis involves a variety of assessment some of which includes monitoring the response of the nerves and the use of nerve conduction studies and electromyography. The treatment and management focuses mainly on managing the symptomatic issues of neuropathy [3].

   Diabetic neuropathy most often involves the autonomic system and since it is dependent on length, it generally affects the feet first [4]. The assessment of whether neuropathic pain is associated with diabetes mellitus is of importance for the treatment and management options [5]. Sometimes a number of events can lead to mild to moderate weakness in the distal upper and lower limbs thus, a syndrome known as symmetric sensory-motor diabetic peripheral neuropathy[6].

   Femoral neuropathy is another kind of neuropathy linked to diabetes mellitus. The femoral nerve is located below the iliacus muscle and passes through the psoas muscle. It enters the leg and travels under the inguinal ligament, passing roughly halfway between the pubic tubercle and the anterior superior iliac spine [7]. The pectineus and sartorius muscles, as well as the skin of the anterolateral thigh, are innervated by the anterior division of the femoral nerve. In the meantime, the quadriceps muscle is supplied by the posterior division, which also feeds the hip and knee joints before coming to an end as the saphenous nerve[18]. While nerve compression may occur at any point along its path, it is particularly susceptible in the iliopsoas groove, the inguinal ligament, and the psoas muscle [8].

   Weight loss, a sudden onset of pain, leg wasting, asymmetric proximal weakness, and atrophy are the hallmarks of femoral neuropathy. It usually progresses to the other lower limb and the more distant lower-limb segments [9]. In the diagnosis of femoral neuropathy, the femoral nerve conduction anomaly is distinct. It is usually necessary to perform a thorough examination of nerves and muscles in upper and lower limbs, in the related paraspinal muscles. Depending on the abnormalities noted additional extremities may need to be examined to appreciate fully the extent of both clinical and subclinical neural insults. The changes in the conduction of the femoral nerves in diabetic patients in India have to be determined. The current study compared the femoral nerve conduction times of patients with diabetes mellitus—both with and without neuropathy—with those of healthy individuals. When diagnosing diabetic patients, the femoral nerve conduction may be used to pinpoint the location of nervous system abnormalities, whether or not neuropathy is present.

II. NERVE CONDUCTION STUDIES

Nerve Conduction Study (NCS) is a commonly used noninvasive procedure for assessing the functions of both motor and sensory nerves. The process involves the cleaning of the skin, followed by the placement of electrodes on the skin along the selected nerves. A small electrical stimulus, in the form of an electric current, is applied to activate the nerves. The electrodes are responsible for measuring the current as it travels down the nerve pathway. In cases where the nerves are damaged, the current tends to be slower (resulting in a delay) and weaker (reduced). This characteristic is referred to as latency and is measured in milliseconds (ms). The size of the response, referred to as amplitude, is measured in millivolts (mV). The entire procedure typically takes approximately 30 to 90 minutes. There are usually no reported complications resulting from the procedure, although individuals may experience some discomfort due to the electrical current, which can be slightly painful. It's important to note that NCS is a non-invasive procedure.

III. FEMORAL MOTOR NERVE CONDUCTION

1. **Recording Electrodes:** Femoral Motor Nerve Conduction studies involve the use of surface electrodes for recording. In most cases, motor evoked responses have amplitudes that are large enough to be readily identified with surface electrodes. However, in pathological conditions, if a response is not observed using surface electrodes, further investigation may be necessary.

- **Ra (Active Electrode):** The vastus medialis muscle's midsection or most noticeable areas should be the location of Ra recordings. In order to obtain a negative deflection from the baseline, it might be required to gently reposition E-1 if a positive deflection is initially observed upon neural activation.
- **Rr (Reference Electrode):** Since the patella is a relatively electrically silent area, it is most practical to anchor Rr there or two to three centimeters in front of the active Ra electrode.
- **Ground (Gd):** Surface ground electrode placed between simulation and Recording active electrode.

IV. STIMULATION

The usual method for femoral nerve conduction (Fig. 1) is surface stimulation (S). Although the practitioner finds a surface cathode/anode handy, the deep placement of the nerve may require higher current intensities and longer pulse durations. These conditions can potentially make the examination uncomfortable for the patient. If the patient finds it challenging to tolerate the stimulation, it might be advisable to consider a needle cathode. This is because the cathode is placed so close to the femoral nerve that it requires lower current intensity. A surface anode is located a few centimeters closer in this instance.

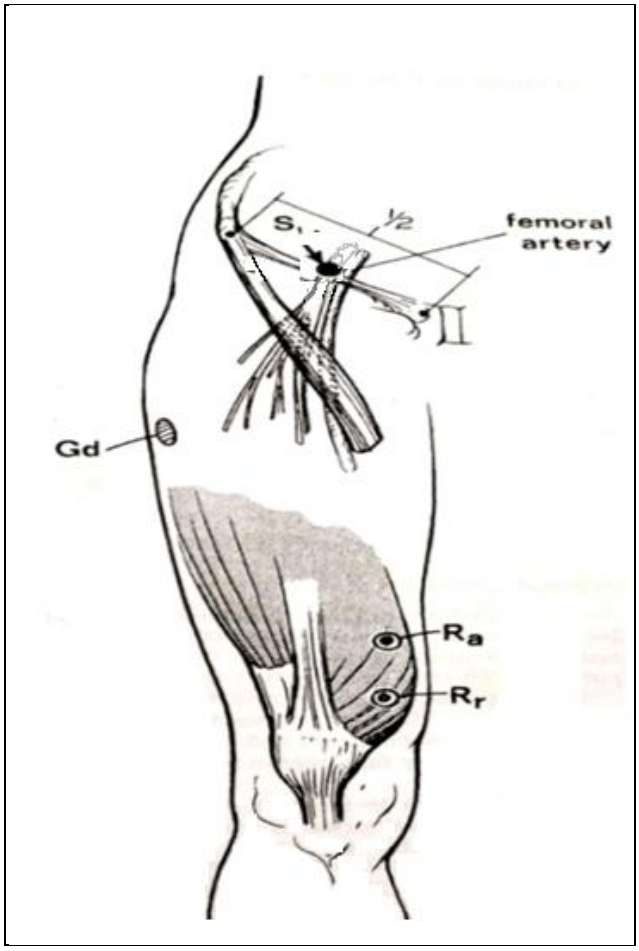

Figure 1: Femoral Motor Nerve Conduction Study

The stimulation site is 1 to 2 cm lateral to the femoral artery, which is situated in the inguinal region. There should be roughly 5 to 6 centimeters separating the two proximal cathodal stimulation sites. Between the proximal stimulation point and E-1, the femoral nerve measured 35.4± 1.9 cm in total length [10] [11]. HFF made up the instrumental parameter. 2 Hz, LFF - 10 kHz, Sweep - 5 ms, Duration - 1 ms, Intensity - 60 – 100 µV, Gain- 2000- 5000 µV /cm and Sensitivity - 5 mV[18].

V. FEMORAL MOTOR NERVE CONDUCTION CHANGES IN DIABETIC PERIPHERAL NEUROPATHY

Femoral neuropathy was shown to be relatively uncommon in a research by O'Hare JA, Abuaisha F, and Geoghegan M, with an incidence of 0.3% in type 1 diabetes and 1.1% in type 2 diabetes [12][19]. Researchers Bastron JA and Thomas JE studied a large cohort of 105 femoral neuropathy patients. They discovered that the average progression of symptoms was 6.2 months, with onset ages ranging from 36 to 83 years. Remarkably, painless muscular weakness was reported in 9.5% of the patients [13]. Said G, Lacroix C, Lozeron P, Ropert A, Planté V, and Adams D examined the findings of focal endoneural infarctions in the lumbosacral plexus and main proximal nerve trunks, which suggests an ischemic origin for

these neuropathies[14][19]. Based on morphological analysis, several proximal nerve pathologies were found depending on how the neuropathy presented clinically. This knowledge came from research done by Said G et al., Coppack SW, and Watkins PJ using biopsy samples from the femoral nerve's sensory branch, the intermediate cutaneous nerve of the thigh [15] [16] [19].

The manifestation of femoral nerve conduction abnormalities becomes more pronounced as the severity of polyneuropathy in patients increases. In simpler terms, these abnormalities tend to stand out more when patients experience severe polyneuropathy. This raises the possibility that, as polyneuropathy advances in severity, there may be involvement of the proximal nerves. It is possible to observe clinical diabetic femoral neuropathy in the absence of diabetes distal symmetric polyneuropathy. Discussions concerning the diagnosis of clinical diabetic femoral neuropathy and the importance of anomalies in femoral nerve conduction have arisen as a result of this circumstance. Femoral latencies in patients with and without polyneuropathy were found to be longer than those in the control group in a research that used clinical findings to diagnose polyneuropathy [17][19].

VI. CONCLUSION

Research confirms that neuropathy arises not just from vascular problems but also as an inherent part of the metabolic disruption associated with diabetes. Interestingly, anomalies in the conduction of the femoral motor nerve have been reported in diabetics without any clinical indication of femoral nerve involvement. Moreover, diabetes individuals without diabetic neuropathy can still have anomalies of the femoral nerve. As a result, including the femoral motor nerve conduction study in the assessment of diabetes mellitus can be considered a routine practice, enhancing the sensitivity of diagnosing Diabetic peripheral neuropathy in conjunction with other nerve conduction studies.

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