Evaluation of the Neurosensory Function of the Medial Meniscus in Humans

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Purpose: Menisci are known to have receptors mainly concentrated at the anterior and posterior horns. Although they are purported to send afferent impulses to the central nervous system, this function has not been thoroughly evaluated. The purpose of the study was to investigate whether stimulation of the menisci initiates a cortical response. The reaction of the end organ to the reflex arc is also evaluated. **Type of Study:** Prospective case series. **Methods:** Fourteen patients with normal medial menisci were included in the study. Different parts of the knee joint (the posterior horn and the body of the medial meniscus, the medial femoral condyle, the capsule, and the joint space) were electrically stimulated by a probe during arthroscopy. The cortical response was monitored with somatosensory-evoked potentials (SEPs). The compound muscle action potentials (CMAPs) of the semimembranosus, quadriceps, and biceps femoris muscles were also monitored with electroneuromyography (ENMG). **Results:** Among the stimulated parts, only the posterior horn of the meniscus produced cortical responses. No response was obtained with stimulation of the medial femoral condyle, the body of the medial meniscus, the capsule, or the joint space. Stimulation of the posterior horn of the medial meniscus produced a measurable amount of CMAP latency for the semimembranosus muscle, but not for the quadriceps and biceps femoris muscles. **Conclusions:** Stimulation of the posterior horn of the medial meniscus produces reproducible cortical SEPs and results in ENMG-verified response of the semimembranosus muscle where no response of the semimembranosus muscle is detected with stimulation of the other parts of the knee. **Clinical Relevance:** The knowledge that only the horns of the medial meniscus have mechanoreceptors in the medial compartment of the knee helps to understand patients' signs and symptoms in medial compartment disease. **Key Words:** Meniscus—Somatosensory evoked potentials—Electroneuromyography—Neurosensory—Semimembranosus.

A systematic sensory-motor synergy has been proposed around the anatomic structures of the knee including the ligaments, antagonistic muscle pairs and sensory mechanoreceptors in the ligaments, the capsule, and the associated muscles.[1] Among them, anterior cruciate ligament (ACL) has been the commonly investigated structure owing to its importance in knee stability.[1,2] Histologic studies have defined presence of mechanoreceptors in the ACL.[3] An ACL-hamstring reflex arc via the receptor afferents was reported that excites the hamstrings but simultaneously inhibits the quadriceps with stressing of the ACL.[1] The existence of similar mechanoreceptors was also defined for menisci in anatomic and histologic studies.[4-6] The mechanoreceptors might be expected to provide reflex sensory information with stimulation. However, activation of the menisci mechanoreceptor, whether initiated as a cortical response and a reflex arc similar to ACL receptors, had not been evaluated before.

The aim of the present study was to monitor the cortical response of the reflex arc with stimulation of

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the mechanoreceptors at the posterior horn of the medial menisci. Somatosensory-evoked potentials (SEPs) were used to monitor the cortical component of the reflex arc. Reaction of the end organ to the cortical reflex was evaluated with electroneuromyography (ENMG). The hypothesis is that stimulation of the mechanoreceptors located at the posterior horn of the menisci has the capacity to initiate a cortical response and also cause a meniscus muscle reflex arc that has an effect on mobility of the menisci. Any event interfering with the mechanoreceptor mechanism may alter the meniscus mobility.

METHODS

Fourteen patients with normal medial menisci were studied during arthroscopy of the knee for other conditions. Electrophysiological studies were conducted by an ENMG-SEP machine (Medelec/TECA Sapphire, Surrey, England). The patients were anesthetized by use of a narcotic (alphentanyl) and a hypnotic (propofol). Inhalation anesthetic agents were avoided because of their depressant effects on cortical responses.[2] Muscle relaxants were also avoided so as not to affect the ENMG results. No local anesthesia was used.

SEPs

SEPs are defined as the cortical potentials evoked in response to mechanical or electrical stimulation of peripheral nerves of the lower or upper extremities.[7] They monitor peripheral nerve and posterior column proprioception and abnormalities are associated with disorders of joint positions, stereognosis, and vibration.[2] Waves are labeled by polarity (P, positive; N, negative) and latency (expressed in milliseconds).

Posterior Tibial Nerve SEP Responses: In all of the cases, the posterior tibial nerve was stimulated in the electrophysiology laboratory with a square current wave of 0.2 ms in duration at an intensity of 10 mA and a frequency of 2.0 pps. Trials were performed 3 times and superimposed to ensure consistency and also to confirm that the posterior tibial nerve SEPs were within normal limits.

Medial Meniscus SEP Responses: Medial meniscus SEP recordings were monitored during arthroscopy. The middle part of the posterior third (posterior horn) of the medial meniscus was electrically stimulated by a flush-tip monopolar electrode probe placed through the anteromedial portal. The probe is Teflon coated to its tip (Medelec). The stimulus thus comes only from the extreme tip of the probe, is localized to posterior horn of the medial meniscus, and does not spread through the synovial fluid or to other structures of the knee. Electrolyte-free resection fluid (5% mannitol in water) was used during the surgery to prevent intra-articular conduction.

The stimulus used was a wave of 0.2-ms duration at an intensity of 10 mA and a frequency of 2.0 pps. The response was recorded over a bandwidth of 20 to 200 Hz for a duration of 200 ms (Fig 1). Trials were performed 3 times. For each trial, 342 epochs were averaged and superimposed to ensure consistency.

Cortical response was monitored by an electrode inserted subcutaneously into the scalp at the CZ position of 10/20 (according to the international encephalography system) with FZ reference. The medial femoral condyle, the body of the meniscus, the capsule, and the joint space (through the resection fluid within the joint) were also stimulated in addition to the posterior horn of the medial meniscus.

ENMG Study

Medial Meniscus Muscle Reflex: The ENMG study to evaluate the meniscus muscle reflex arc was recorded during the arthroscopy. A concentric needle-recording electrode was inserted into the motor point of semimembranosus muscle to record the compound muscle action potential (CMAP). The ground electrode was placed at the posteromedial part of the knee between the stimulation and recording electrodes. The

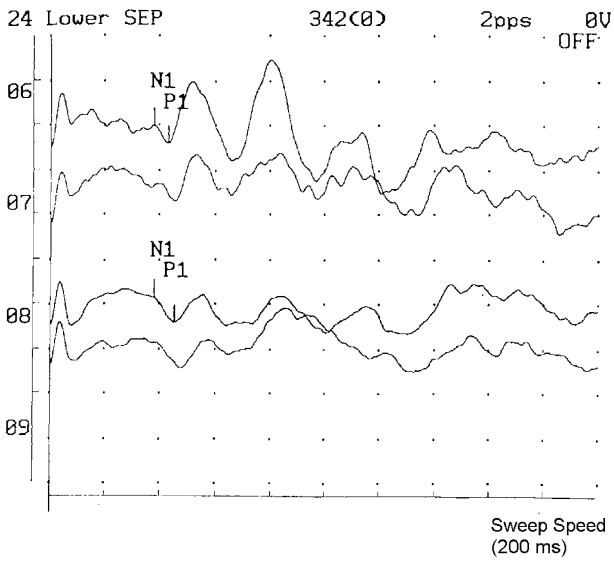

FIGURE 1. SEP response of case 10 obtained during the procedure. N1 is the first negative latency of each wave and P1 is the first positive latency of each wave.