Hanging Foot Switch for Bipolar Forceps: A Device for Surgeons Operating in the Standing Position

—Technical Note—

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Abstract

For surgeons operating in the standing position, the manipulation of foot switches involves shifting of the weight to the pivoting leg and the possible loss of contact between the switch and the foot. We solved this problem by changing the position of the switch that operates bipolar forceps. Our novel device is made of aluminum plates. The base plate features a foot strap and a height-adjustable overhang over the switch-operating foot. A commercially-available disc type foot switch is attached to the underside of the overhang in upside-down position, so the switch is operable with the toe. To turn on the switch, the toe is flexed dorsally to push the switch pedal, so the action is limited to the part distal to the metatarsophalangeal joints. Our switch was used in more than 100 consecutive microsurgeries performed by surgeons operating in the standing position. The switch manipulation required no shifting of the weight and was easier and quicker than manipulation of conventionally-placed switches. The surgeons were able to change the foot position freely with the modified switch, thereby avoiding loss of contact with the switch. The modified switch placement reduced physical fatigue in the lower extremities, annoyance related to the manipulation of conventionally-placed switches, and increased the comfort of surgeons operating in the standing position.

Key words: bipolar forceps, ergonomics, foot switch, standing position

Introduction

For neurosurgeons, bipolar forceps operated by foot switches are indispensable during surgical procedures. However, surgeons operating in the standing position may lose contact with the switch and its manipulation may elicit physical discomfort in the lower extremities. Contact with floor switches is easily lost when the surgeon changes position, and the switch can be accidentally hit by the surgeon’s foot. When contact is lost, the surgeon must look for, feel around with the foot, or require repositioning of the switch by the circulating nurse. Especially in the course of prolonged surgical procedures, serial actions to activate the switch that require a shifting of the weight to the pivoting leg, moving the foot to the switch by dorsal flexion, and plantar flexion of the foot result in physical discomfort. The repeated loss and activation of the switch is time-consuming and may result in missing the optimal timing for coagulation, in inappropriate fine manipulations under magnification, and in accelerated surgeon fatigue. We have solved these problems by designing a novel foot-switch device.

Technique

Our modification consists of a commercially-available foot switch for bipolar forceps (SYNERGY™ MALISTM Precision Bipolar Coagulator; Codman & Shurtleff Inc., Raynham, Massachusetts, USA) and a switch-holding device designed in-house (Fig. 1). The device consists of two 2-mm-thick bent alumi-
Fig. 1 Photograph (A) and diagram (B) show the modified foot switch for bipolar forceps. Our device consists of an ordinary foot switch and a switch-holding device. The foot is placed on the base plate; the foot switch is located on the overhanging plate. The overhang is attached to the base plate via a screw whose position can be changed, thereby adjusting the height of the overhang harboring the switch. The switch is attached to the underside of the overhang with a hook-and-loop fastener. Dimensions (in mm) are shown in the diagram (B).

num plates. One is the base plate for the foot, the other overhangs the foot and its underside harbors the switch. The overhang plate is inclined to facilitate switch manipulation, and is attached to the base plate with a screw in the vertical part of the base plate. The position of the screw can be changed, so the height of the overhang is adjustable. A pair of hook-and-loop fasteners is applied to the underside of the overhang and the bottom of the switch, and the switch is attached to the underside of the overhang in the upside-down position. The switch cable is placed so as not to touch the base plate. To accommodate the surgeon’s foot, the base plate incorporates a loop fashioned from a strap with a hook-and-loop fastener.

At surgery, the surgeon slips the sock-covered foot through the loop attached to the base plate; the switch pedal is located above the medial toe. The operating surgeon can adjust the height of the overhang, the horizontal position of the pedal, and the loop tightness. In the standby position, the switch is located just above the switch-operating toe (Fig. 2A). To turn on the switch, this toe is flexed dorsally to push the pedal (Fig. 2B), i.e. the action limited to the part distal to the metatarsophalangeal joints. An elevation of approximately 4 mm with a force of 4 kg is required for activation. The switch is turned off by ventral toe flexion.

Surgeons operating in the standing position tested our device in more than 100 consecutive microsurgeries for lesions in the posterior cranial fossa and spine, such as cerebellar hemorrhage and tumor, posterior circulation aneurysm, cervical and lumbar spine degeneration, and spinal intradural lesions (tumor, vascular malformation, syrinx). Seven surgeons who monitored their sensations in the course of manipulating the switch reported that manipulation was easier and quicker than using conventionally-placed switches, and that slight supination of the leg manipulating the switch facilitated manipulation. No shifting of the weight to the pivoting leg was required for switch operation, and although the weight was shifted to the leg manipulating the switch, manipulation was comfortable. The surgeons could stably stand on the thin base plate and change the foot position freely with the modified switch weighing about 280 g. As there was no loss of contact with the switch, fatigue in the lower

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extremities was reduced, especially during prolonged operations and procedures that necessitated the wearing of radioprotectors. None of the surgeons testing our device encountered problems such as failure or unexpected activation of the switch. At initial use, all surgeons felt some incompatibility in action to operate the switch with dorsal flexion of the toe instead of the serial actions required to activate the conventionally-placed foot switches including plantar flexion of the foot, but became used to operate the switch at every surgery.

Discussion

Assessment of the problems that surgeons operating in the standing position encountered with foot switches of diathermic equipment found that almost all surgeons occasionally lost contact with the switch and reported obstructed foot movement, activation of the wrong switch, and physical discomfort in the legs and/or feet. Proposed ergonomic guidelines for foot switches used by these surgeons included avoidance of prolonged dorsal flexion of the foot, limiting dorsal flexion to 25°, and 10 N as the maximum force required for switch activation. Subsequently, they developed a new foot switch in the shape of a large 4-mm high disc that reduced the physical discomfort and the risk of their losing contact with the switch.

We have completely changed the position of the switch. Switch activation involves minimum movement of the lower extremity, i.e. dorsal flexion of the switch-operating toe replaces the serial actions required to activate conventionally-placed foot switches, such as shifting of the weight to the pivoting leg, moving the switch-manipulating foot to the switch with dorsal flexion, and plantar flexion of the foot. Consequently, the surgeons were able to activate the switch quickly while maintaining a stable position for prolonged periods. The switch pedal over the foot traces the surgeon’s foot position and avoids loss of contact between the switch and the foot. This improved maneuverability provides for optimal activation-timing, avoids compromising the stability of the hand, aids concentration on the operative field, and mitigates surgeon fatigue.

The present switch design is a modification of the foot switch manipulated by surgeons operating in the standing position. The development of more ergonomically-suitable switches for surgical instrumentation is highly desirable.

Conflicts of Interest Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices in the article. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

Reference


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