Relation of the accessory rootlets of the trigeminal nerve to its motor root

A microsurgical autopsy study

RICHARD L. SAUNDERS, M.D., AND ERNEST SACHS, JR., M.D.
Department of Neurological Surgery, Hitchcock Clinic, and Dartmouth Medical School, Hanover, New Hampshire

✓ Microsurgical dissection of trigeminal nerves in autopsy specimens demonstrates that the so-called "accessory rootlets" are really a component of the motor root. This confirms Meckel's description of 1748.

Walter Dandy noted small nerve filaments between the motor and sensory roots of the fifth nerve at the pons (Fig. 1). From clinical experience he felt that these were sensory components and coined the term "accessory sensory rootlets." His description of these small rootlets was generally forgotten until a few years ago when Jannetta and Rand confirmed the existence of accessory fibers using the operating microscope. This rediscovery stimulated our interest in these rootlets and led to our examination of their intracranial course in human autopsy material. We found that the multistranded motor fifth root arises as two separate groups of small rootlets, the inferior one being identical with the so-called "accessory rootlets."

Method

Study of both fifth nerves was carried out in 20 autopsies using the operating microscope. The hemispheres were removed by Gardner's method after sectioning the cerebral peduncles. It was then possible to take out the brain stem, fifth nerve, and Gasserian ganglion in one piece. The fifth nerve could thus be examined from the pons to the ganglion in the fresh and fixed state.

Findings

In all specimens examined we identified a 1 mm cluster of small rootlets at the rostral or medial aspect of the origin of the sensory root. The sites of origin, spacing, and individual caliber of the small rootlets varied. However, there were two consistent characteristics in all dissections: the rootlets always arose in two separate groups, and these two groups always joined to form one multistranded root within 1 cm of the pons (Figs. 2-5). Because of their relationship to the main sensory root, we have labelled these two rootlet groups "superior" (those located dorsal to the sensory root or toward the cerebellar side) and "inferior" (those located ventral to the sensory root).

Superior Motor Rootlets

The superior group, numbering three to six rootlets, represents the classical origin of the motor root, a conclusion based largely upon its relatively isolated position superior to the main sensory root. The most common
configuration had two to three rootlets of nearly equal size arising obliquely about 1 mm from the rostral aspect of the main sensory root. This separation varied between 0.3 and 4.0 mm. Occasionally this group arose more caudally, over the midpoint of the main sensory root or even at its caudal-superior margin (Fig. 6). The further caudal the group, the more oblique its origin as the rootlets tended to embrace the rostral aspects of the origin of the main sensory root. Commonly, there were as many as four much smaller rootlets in the superior group, overlapped and hidden by the larger rootlets. Anastomoses between this group and the other fifth nerve components were rare.

In several specimens, the fifth nerve was represented by a single extremely flattened root apparently lacking a motor root and other small rootlets. This structure arose with its greater diameter lying in a rostral-caudal plane. Only by identifying the distal motor root and tracing it back to thepons could the motor root be definitely delineated from the remainder of the fifth nerve. The motor root in this case was always the rostral edge of the conglomerate fifth nerve (Figs. 7 and 8).

**Inferior Motor Rootlets**

The inferior group of rootlets was readily seen by retracting the superior group from the main sensory root (Fig. 2). There were more of these rootlets than in the superior group, often as many as 10, although their aggregate diameter was smaller than that of the superior group. Their usual origin was in contact with the inferior rostral aspect of the main sensory root. In the rare specimen having any hiatus between these two components, the inferior group arose from the lip of the sulcus about the main sensory root. There was never more than a 0.3 mm separation. Occasionally part or all of the inferior group arose from the inferorostral aspect of the main sensory root (Fig. 4). In one specimen this group was clearly rostral, not inferior, and suggested a continuum of the rootlets with those of the superior group. Whereas the angle of origin of the superior group was often extremely oblique, that of the inferior rootlets was always identical to...
Accessory rootlets of motor $V^{th}$ nerve

**Fig. 2.** View of the fifth nerve through the tentorium with the motor root sectioned and retracted toward the dorsal pons. The cerebellum and arachnoid are seen in the right lower corner of the picture. Superior (MS) and inferior (MI) motor root components embrace the main sensory root ($S$). × 32.

the main sensory root or about 75° with the pons. Small proximal anastomoses were frequent between the inferior rootlets and main sensory root. Anastomoses between the inferior and superior rootlets within the first 0.5 mm from the pons were rare, however.

Although the inferior group of rootlets was relatively free of variation in contrast to the superior group, the inferior group occasionally had but two or three rootlets and was larger than the superior group.

**Course of Rootlets**

Regardless of their exact origin, the superior rootlets immediately swept around the rostral edge of the sensory root to be joined by the inferior rootlets within 1 cm of the pons. This merging of the two groups of rootlets was a constant finding and could usually be seen proximally without difficulty and always was confirmed by turning the distal motor root back on the pons. Even in the occasional conglomerate root where the motor root at the pons could not be immediately appreciated, by tracing that root from distal to proximal, a definite double motor origin with inferior and superior elements could be distinguished (Figs. 7 and 8). The closer together the origins of the two rootlet groups, the closer to the pons was their

**Fig. 3.** View through the operating microscope of the right fifth nerve during transtentorial section of the main sensory root for tic douloureux. The main sensory root ($S$) has been sectioned. The two whiter components of the motor root (MS and MI) are readily seen to the left of the sectioned sensory root ($S$). The dorsal pons ($DP$) is at the lower left corner of the photo. × 20.

**Fig. 4.** View of the left fifth nerve from the clivus with the ventral pons ($PV$) in the lower left half of picture. The loop is about the motor root. The inferior rootlets of the motor root (MI) arise in part from the anteroinferior aspect of the main sensory root ($S$). The superior rootlets (MS) arise well apart from the remainder of the nerve. × 64.
Fig. 5. Similar view to that in Fig. 4, with higher magnification and methylene blue to emphasize rootlets. Superior (MS) and inferior rootlets (MI) join to form multistranded motor root. A silk ligature lies between the motor root components and the main sensory root (S). × 100.

Fig. 6. View of the caudal origin of the superior component (MS) of the "classical motor root" from above, with the dorsal pons at the left (PD), and the main sensory root (S) at the right, and the rostral pons at the top of picture. × 64.
Accessory rootlets of motor \textsuperscript{V}th nerve

union. This conjoined root then passed to the floor of Meckel's cave, beneath the Gasserian ganglion, and thence to the foramen ovale, following the classical course of the motor root. This course identified the inferior as well as the superior group as components of the motor root. The inferior and superior rootlet components of this motor root were loosely bound together, and their separation demonstrated multiple intercommunicating anastomoses.

There were a few inconstant anastomoses between the conjoined motor root and the main sensory root. Distally beneath the ganglion, however, the motor root frequently enlarged and, in some specimens, forked into three or four large branches that often entered into the ganglion or joined the sensory root (Fig. 9). The motor root's relationship to the ganglion also varied; in some specimens it lay in a connective tissue sheath separating it from the substance of the ganglion; in others the root actually passed through the substance of the ganglion.

**Discussion**

A reasonable criticism of any work demonstrating small rootlet components of a cranial nerve is that these are artifacts created by teasing apart the nerve fascicles. We feel that the conglomerate type of fifth nerve where the motor root is not apparent at the pons is a good argument against this criticism; few would dispute the existence of a motor root but in some fifth nerves it can only be demonstrated distally beneath the ganglion. By dissecting this root away from the main sensory root a double origin is readily seen. In the same way, although the demonstration of rootlet components of the fifth nerve involves some manipulation, this process need not create anatomical artifacts. The double origin of the motor root can be readily appreciated during transventorial microsurgical section of the fifth nerve for tic douloureux (Fig. 3).

Thinking that recognition of a double motor root origin was a true discovery, we were disappointed but fascinated to find that in 1748 Johann Friedrich Meckel,\textsuperscript{12} the anatomist, had clearly described the motor root arising from the pons in two separate, inferior and superior, groups of rootlets as follows:

"The trifacial nerve, the fifth pair, appears nine lines (9/12 in.) from the median line of the pons and is composed of three distinct roots, a superior, a central, and an inferior.
Richard L. Saunders and Ernest Sachs, Jr.

The superior is situated further backward and higher than the central, and the inferior below and on the inside of it. The central is always much larger than those of the other two roots.

"The small roots do not contribute to the prominence of the ganglion, although on the lower surface of the latter and of the large root, a groove is formed by their passage. Soon after emerging, the superior root turns on the upper face and the inner edge of the large root, arrives at its lower face, and continuing to pass on, it reunites after about half an inch, with the small inferior roots. It is formed of from three to six fasciculi of different sizes.

"The small inferior root is generally nearer the central root than the superior, seldom more than one line (1/12 in.) distant from it. They (sensory and inferior roots) often arise from the same groove. There are six to eight fasciculi. It (the inferior root) leaves the annular protuberance on the lower face of the large root, and reunites with the small superior root in the manner stated. The trunk formed by this union passes first under the large root, then under the ganglion and to the third branch of the fifth nerve. These two small roots (superior and inferior) form a small portion of the fifth nerve which is whiter and harder than the large (portion) 12

Had he but known of Meckel's description, Dandy probably would have identified his accessory fibers as inferior rootlets, and Stookey and Ransohoff 16 probably would not have written off accessory fibers as "not anatomically established." Dandy's illustrations 4,5 and Rand's photographs 13 show the accessory fibers or portio intermedium to be inferior to and between the classical motor and sensory roots, the exact position of the inferior group of rootlets. If the superior rootlets are accepted as the classical motor root, then the only other small rootlets to be labelled "accessory" are the inferior rootlets. Sjoqvist 14 mentions that embedded in the sensory

Fig. 9. Inferior view of the Gasserian ganglion with apparent branching of the motor root (M) and entering into the ganglion (G) and sensory root (S). x 64.
Accessory rootlets of motor V\textsuperscript{th} nerve

root close to the pons are some motor bundles; we would presume these to be the accessory fibers or the inferior rootlets. The fact that the accessory fibers are rootlets of the motor component is significant in that the accessory fibers were previously presumed to join the main sensory root.\textsuperscript{5}

Whether we call the small rootlets accessory and motor,\textsuperscript{5} portio intermedia and portio minor,\textsuperscript{7} or inferior and superior,\textsuperscript{12} is not of major importance. The significance of accessory fibers lies not so much in their anatomical existence as in their exact function. Jannetta and Rand,\textsuperscript{7} and Kurze,\textsuperscript{9} as well as Dandy,\textsuperscript{6} have suggested that these rootlets are an afferent component of the fifth nerve. This assumption becomes particularly intriguing as one recalls the apparent preservation of facial sensation after a complete sensory root section at the pons which, however, spared the small "motor" rootlets.\textsuperscript{10}

This apparent paradox, namely, that the accessory fibers are clinically sensory but anatomically motor, is entirely compatible with conclusions drawn from research on the mesencephalic nucleus. May and Horsley\textsuperscript{11} many years ago established that afferent fibers to the mesencephalic nucleus ran in the motor root. This was a degeneration study based on peripheral fifth nerve sectioning. Their reference to the existence of pontine fibers between the sensory and motor root may be the first contemporary recognition of the so-called accessory fibers. Corbin\textsuperscript{2} made electrocoagulative lesions in the mesencephalic nucleus of cats and then by a Marchi technique studied the cranial nerve degeneration patterns. This of course only revealed the myelinated fibers coming to the mesencephalic nucleus but most of the degeneration was in the motor root. Thelander's work\textsuperscript{17} was very much like Corbin's but his illustration of the degenerating fibers leaving the pons is noteworthy. These fibers are shown at the rostral-inferior margin of the sensory root, a position curiously similar to that of the inferior rootlet component of the motor root, or as we would have it, the so-called accessory fibers. Jerge\textsuperscript{8} placed recording electrodes in the mesencephalic nucleus and concluded that this nucleus subserved masticator muscle proprioception and gingival pressure sense. The work of Smith, et al.,\textsuperscript{15} and Allen\textsuperscript{1} is in general agreement with that of Jerge and Corbin. There is still no evidence that the efferent and afferent fibers of the motor root are grossly separable, however.

We have found that the accessory fibers form a component of the motor root. It seems possible that these may be afferent fibers arising in the mesencephalic nucleus, although this nuclear origin has not yet been proven. It is no revelation that the operating microscope has brought new dimensions to cranial nerve surgery. As specific mesoscopic anatomy is appreciated, mesoscopic physiological studies must follow before we fully understand the significance of these observations.

References


Received for publication August 22, 1969.
Presented at the Annual Meeting of the American Association of Neurological Surgeons, Cleveland, Ohio, April, 1969.
Supported by Grants 250-E and 65 from the Hitchcock Foundation, Hanover, New Hampshire.
Address requests for reprints to: Richard L. Saunders, M.D., Department of Neurological Surgery, Hitchcock Clinic, Hanover, New Hampshire 03755.