Click-evoked responses from the exposed intracranial portion of the eighth nerve during vestibular nerve section: bipolar and monopolar recordings

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Summary We compare the click-evoked compound action potentials from the exposed intracranial portion of the eighth nerve using bipolar and monopolar recording electrodes in patients undergoing vestibular nerve section. It is assumed that a bipolar recording electrode will only record propagated neural activity in the auditory nerve, whereas a monopolar recording electrode may in addition record electrical activity that is conducted passively to the recording site. The results of the present study confirm that the earliest detectable propagated neural activity in the intracranial portion of the auditory nerve occurs with a latency that is close to that of peak II of the brain-stem auditory evoked potentials, and the results also confirm that the late components in the click-evoked compound action potentials that have been demonstrated previously using the monopolar recording technique represent propagated neural activity in the auditory nerve. The results also indicate that the responses that are recorded by a bipolar recording electrode, when the small tips of which are placed on the eighth nerve when it is relatively dry, represent only small populations of nerve fibers. Even when an attempt is made to align the two tips of a bipolar electrode with the course of the auditory nerve, this type of electrode may record from different populations of nerve fibers.

Key words: Auditory nerve; Compound action potentials; Vestibular nerve section; Bipolar recordings

Previous studies, in which recordings of compound action potentials (CAPs) from the exposed intracranial portion of the eighth nerve in man were compared with brain-stem auditory evoked potentials (BAEPs) recorded from electrodes placed on the scalp, have provided important information regarding the neural generators of the BAEP (Møller et al. 1981a,b, 1982, 1988; Møller and Jannetta 1981, 1982, 1983a; Hashimoto et al. 1981, 1982; Spire et al. 1982). These earlier studies were based on recordings from the eighth nerve using monopolar recording techniques in patients undergoing operations in which the intracranial portion of the eighth nerve became exposed (microvascular decompression operations for disorders such as hemifacial spasm (HFS), trigeminal neuralgia (TN), disabling positional vertigo (DPV), and tinnitus). These studies have shown that the difference between the BAEP of man and those of the animals commonly used in auditory studies, including the monkey (Møller and Burgess 1986), can be explained by the fact that the intracranial portion of the eighth nerve is much longer in man than it is in these animals. The entire eighth nerve in man has a length of 2.6 cm (+/- 0.38 cm; Lang 1981, 1991), whereas in the commonly used experimental animals it is much shorter (0.8 cm in the cat, Fullerton et al. 1987). The time that it takes for the action potential to transverse this distance is approximately 1 msec, sufficient for the generation of two peaks (peaks I and II) in the BAEP, while in animals only a single peak is generated.

Some investigators have interpreted recordings from the eighth nerve to show that the cochlear nucleus may contribute to peak II (Hashimoto et al. 1981; Legatt et al. 1986), while others have interpreted similar recordings to show that the auditory nerve is the only contributor to peaks I and II (Møller et al. 1981a,b, 1982, 1988). One reason for this ambiguity may be that these conclusions were based on monopolar recordings. A monopolar electrode will not only record potentials that are the result of the propagated activity in the auditory nerve but also field potentials that are generated by stationary sources (such as the cochlear nucleus) and conducted passively to the recording site (Møller and Jannetta 1982). There is also the possibil-
ity that electrical potentials that are generated in the ear may be conducted to the recording site of the intracranial portion of the auditory nerve. The components that are generated by stationary sources can to some extent be distinguished from components that result from a propagated wave of neural activity in the auditory nerve, because the latency of potentials that is generated by a propagated wave change when the electrode is moved along the auditory nerve, while the latency of passively conducted potentials does not change (Møller and Jannetta 1982, 1984).

A more direct way to distinguish between potentials that are generated by propagated neural activity and those generated by stationary sources is to use a bipolar recording electrode. When the distance between the two tips of a bipolar electrode is small, the electrode will only record propagated neural activity when placed on a long nerve, because passively conducted potentials will appear identical at the two tips of a bipolar electrode and therefore become cancelled when using bipolar recording with a differential amplifier.

The eighth cranial nerve consists of a vestibular portion and an auditory portion; the vestibular portion occupies the most rostral part of the intracranial portion of the eighth nerve, and the auditory portion occupies the most caudal part of the intracranial portion of the eighth nerve (Lang 1983, 1991).

In the present study, we compare the potentials recorded from the exposed intracranial portion of the eighth nerve using bipolar and monopolar electrodes in patients undergoing section of the vestibular portion of the eighth nerve, performed intracranially while brain-stem auditory evoked potentials (BAEP) were recorded from electrodes placed on the scalp. We also compare the bipolar recorded potentials with the difference between the monopolar recorded potentials and their delayed version to determine if the two tips of the bipolar recording electrode were recording from the same population of nerve fibers. After the vestibular nerve was severed and a portion of it removed, it was possible to record from a portion of the auditory nerve that is usually not accessible for recording because of its close contact with the vestibular nerve.

In patients with normal hearing the CAP in response to a click of high intensity (95–105 dB Pe SPL) mainly represents the neural activity in nerve fibers that are tuned to high frequencies (Møller 1986); in patients with hearing loss the activation of the fibers of the auditory nerve to click stimulation is more complex (Møller et al. 1991; Møller and Jho 1991a,b); and, in patients with high-frequency hearing loss the responses to fibers that are tuned to lower frequencies may become prominent (Møller and Jho 1991a,b). We have previously shown that in some patients with high-frequency hearing loss there are late oscillations in the click-evoked CAP recorded from the intracranial portion of the eighth nerve (Møller and Jho 1990, 1991a). The oscillations may last as long as 15 msec, and their phase is reversed when the polarity of the click stimulation is reversed. We have hypothesized that these oscillations are the result of a change from the normal traveling wave motion on the basilar membrane to a standing wave motion (Møller 1993). In the present study we compare these late components in monopolar and bipolar recordings to determine whether they represent propagated neural activity or are passively conducted from the cochlear nucleus to the recording site.

Materials and Methods

Brain-stem auditory evoked potentials (BAEPs) were recorded on two channels: vertex referenced to the neck (approximately at the level of the C3 vertebra), and earlobe-to-earlobe, using subdermal platinum needles (Type E2, Grass Instrument Co., 101 Old Colony Ave., Box 516, Quincy, MA 02169). Recordings from the exposed eighth nerve were done using multistrand, Teflon-insulated, silver wires (Type AG 7/40T, Medwire Corp., 121 South Columbus Ave., Mt. Vernon, NY 10553), with their uninsulated tips placed 1–1.5 mm apart. The electrodes were attached to a handle so that they could be placed in appropriate location and were held in place by the surgeon while the recordings were being made (Colletti and Fiorino 1993). The bipolar recording electrode was placed on the exposed eighth nerve so that a line through its two tips was parallel with the long axis of the eighth nerve. The recordings from the bipolar electrode were made on two channels: one recorded differentially between the two tips of the electrode, and the other recorded between one of the two tips of the bipolar electrode, with a reference electrode placed at the contralateral earlobe. In this way both bipolar and monopolar recordings from the exposed eighth nerve were recorded between vertex and neck (V-N) and between the two earlobes (E-E). A: monopolar recordings (from the most proximal tip of the bipolar electrode) done at 3 locations along the intracranial portion of the eighth nerve. B: bipolar recordings made simultaneously with the monopolar recordings in A. Negativity of the monopolar recording is shown as an upward deflection and negativity of the most distal of the bipolar electrodes is shown as an upward deflection. BAEP were obtained immediately before the recordings from the exposed eighth nerve. The records were digitally filtered (W25; Møller 1988b) to enhance the peaks and is shown with vertex-positivity as a downward deflection. The earlobe-earlobe recording is shown with the positivity on the stimulated side as an upward deflection. The solid lines represent responses to rarefaction clicks and the dashed lines represent responses to condensation clicks.

The stimulus intensity was 98 dB Pe SPL. C: the recording electrode, placed at the middle of the auditory nerve.
CLICK-EVOKED RESPONSES FROM THE EIGHTH NERVE

A

MONOPOLAR

VAEP

V - N

E - E

N VIII

DISTAL

MIDDLE

PROXIMAL

TIME IN MILLISECONDS

0 1 2 3 4 5 6 7 8 9 10

0.05 μV

10 μV

B

BIPOLAR

VAEP

V - N

E - E

N VIII

DISTAL

MIDDLE

PROXIMAL

TIME IN MILLISECONDS

0 1 2 3 4 5 6 7 8 9 10

0.05 μV

3 μV

C

TIME IN MILLISECONDS

0 1 2 3 4 5 6 7 8 9 10

12:24
 recordings were obtained at the same time. For monitoring purposes during vestibular nerve section, recording was done using a wick electrode (Møller and Jannetta 1983a; Møller 1988a) placed on the eighth nerve near the brain-stem.

Click sounds were generated by applying rectangular impulses of 20 μsec duration (delivered by a Type SD9 stimulator, Grass Instrument Co.) to a miniature stereo earphone. The earphone was sealed in the outer ear with several layers of adhesive tape (Møller 1988a). The sound delivered by this system was measured by a 0.25 inch condenser microphone (Type 4135, Brueel and Kjaer, 18 Naerum Hovedgade, 2850 Naerum, Denmark) placed at the entrance of the ear canal of an individual, with the earphone placed in a way similar to that done intraoperatively, and it showed a short condensation or rarefaction click, with little ringing (Møller 1988a). The spectrum of the click sounds measured in this way was within ±8 dB from 100 Hz to 7 kHz, with a broad peak around 2500 Hz.

The recorded potentials were amplified (Type P511 amplifier, Grass Instrument Co.) with the filter set at 10 Hz highpass and 3 kHz lowpass. The amplification was 100,000 × when recording BAEP and 10,000 × or 20,000 × when recording directly from the exposed eighth nerve.

The recorded potentials were collected, averaged and stored using a personal computer (IBM-compatible with an Intel 486DX) equipped with a data acquisition board (Type ISC-16, R.C. Electronics, 6464 Hollister Ave., Santa Barbara, CA 93117), that had a 12-bit analog-to-digital converter. A sampling interval of 40 μsec was used and each record had 1024 samples. Custom software was used to average and display both the unfiltered averaged BAEP and the digitally filtered BAEP (Møller 1988a,b) and/or the recorded CAP from the exposed auditory nerve for monitoring purposes. The stored data were analyzed off-line using an Apollo Domain 4000 Computer System. All recordings were digitally filtered with a triangular weighing function having a 0.2 msec long base. Some of the BAEP recordings were digitally filtered using filters with a W-shaped weighing function (W25; Møller 1988b).

The results reported in this paper were based on recordings from 5 patients undergoing vestibular nerve section to treat severe vestibular symptoms. The patients were under the care of one of the authors (V.C.), and the recordings were done in compliance with guidelines for using patients in medical experiments as outlined in the Declaration of Helsinki. All patients gave their informed consent to these recordings.

Results

Fig. 1 compares BAEP recordings with potentials recorded from 3 different locations along the exposed intracranial portion of the eighth nerve. A: monopolar recording; B: bipolar recordings. The brain-stem auditory evoked potentials (BAEPs) were recorded just prior to this recording. The recordings from the auditory nerve were made from the cochlear (caudal) portion of the eighth nerve near the demarcation line between the cochlear and the vestibular portions. The response recorded with a monopolar electrode (Fig. 1A) is dominated by a negative peak that is preceded by a small, positive peak — thus typical for recordings with a monopolar electrode from a long nerve where a brief depolarization propagates. The latency of the negative peak in the compound action potentials (CAPs) increased as the electrode was moved from the region of the porus acusticus (distal) to a position that was close to the brain-stem (proximal), and the amplitude of the CAP decreased. The negative peak in the monopolar recordings from the middle portion of the eighth nerve appears with a latency similar to that of peak II in the BAEP. The bipolar recorded potentials have a slightly shorter latency and a wave form that is typical for a bipolar recording from a long nerve. This is taken as support for the assumption that monopolar recorded potentials are mainly generated by a propagated wave of neural activity in the auditory nerve. The main peak has a latency that is close to that of peak II when recorded from the middle portion of the nerve. The results also support the assumption that it is the middle portion of the intracranial portion of the auditory nerve that generates peak II of the BAEP.

Peak II is not prominent in the recording from the vertex-neck area in this patient, but it is clearly seen in the earlobe-to-earlobe recording. Peaks II and III appear at slightly different latencies in the vertex and in the earlobe recordings, because the two sets of electrodes record potentials in different planes and therefore the recorded potentials depend on the orientation of the generator dipole of these peaks. This patient was 35 years old, female, and had classical Menière's disease (for 3 years) with a low- and high-frequency hearing loss (Fig. 2A) with good speech discrimination (100%), indicating that the hearing loss was of cochlear origin.

There was very little change in the BAEP during this patient's operation, as seen in Fig. 2B.

In some patients there is second negative peak of relatively large amplitude in the CAPs recorded from the exposed intracranial portion of the eighth nerve. This second peak is usually more pronounced when the recording electrode is placed on the auditory nerve closer to the brain-stem, and it has been previously assumed that at least under certain circumstances this component may not be a result of propagated depolarization but rather a result of passively conducted potentials to the recording site on the auditory nerve from, for instance, the cochlear nucleus, conducted to
Fig. 2. A: pure tone audiogram obtained the day before the operation (crosses) and about 1 month after the operation (triangles) from the patient illustrated in Fig. 1. B: BAEP (vertex-neck) recorded at different stages of the operation in the patients illustrated in Fig. 1. No digital filtering was applied to these recordings.
the bipolar recorded activity would be equal to the difference between the potentials that are recorded by one of the tips and the same potential shifted in time by an amount that corresponds to the propagation time in a length of the auditory nerve that is equal to the distance between the tips of the bipolar recording electrode. Passively conducted potentials will appear identical at the two tips of a bipolar electrode and,

![Image of diagrams](image.png)

Fig. 3. Responses similar to those in Fig. 1, but from another patient. The stimulus intensity was 108 dB Pe SPL. A: monopolar recording obtained from the most distal of the bipolar electrode tips with a reference on the shoulder. B: bipolar recording, with the location of the recording electrode in a line that was parallel to the long axis of the auditory nerve, about midway between the demarcation line to the vestibular portion and the facial nerve. BAEPs shown were processed in the same way as those in Fig. 1 and obtained at the time the dura was opened. C: pure tone audiograms obtained before the operation (crosses) and about 1 month after (triangles) the operation.
therefore, become cancelled when using bipolar recording with a differential amplifier. The "simulated" bipolar recordings, obtained by taking the difference between the potentials recorded by one of the two tips and subtracting it from its time-shifted version, will include such passively conducted potentials. Discrepancy between the actually recorded bipolar potentials and the difference between monopolar recorded potentials their time-shifted version (simulated bipolar recordings) could also be caused by a dissimilarity in the amplitudes (or wave form) of the two potentials that are picked up by the two tips of the bipolar electrode. The difference between the actually recorded potentials with the bipolar electrode and the simulated bipolar recording indicates that there was a contribution from passively conducted potentials to the monopolar recorded potential.

The average diameter of cochlear nerve fibers is about 3 μm (Spoendlin and Schrott 1989), which would correspond to a propagation velocity of 10 m/sec. Assuming an electrode distance of 1.5 mm, the propagated depolarization would appear at the two electrode tips within 150 μsec.

![Graphs and diagrams illustrating click-evoked responses from the eighth nerve.](image)

Fig. 4. A: recordings from a patient with a low-frequency hearing loss from a location near the porus acusticus on the auditory nerve near the demarcation line between the auditory and vestibular portions. Top trace: monopolar recordings (solid lines) together with their shifted version (dashed line) to illustrate the potentials that the two tips of a bipolar recording electrode would record if perfectly aligned, so that both tips are placed on the same population of nerve fibers. Middle trace: difference between the two top tracings (simulated bipolar recording). Bottom trace: actual bipolar recording. The two top tracings were shifted 160 μsec. The stimulus intensity was 108 dB Pe SPL and rarefaction clicks were used. B: pure tone audiograms obtained before (open circles) and about 1 month after (filled squares) the operation. C: same patient as illustrated in Fig. 1 recorded from the most caudal and distal location on the auditory nerve.
Fig. 5. Recordings from the rostral portion of the auditory nerve obtained after the vestibular nerve was severed and a portion removed (from the same patient as illustrated in Fig. 1). Recordings from 3 different locations along the eighth nerve are shown. A: recordings from the most distal tip of the bipolar electrode. B: differential recording between the two tips of the bipolar recording electrode. The electrode distance was 2 mm. C: difference between the monopolar recording shown in A and its delayed version. The delay between the monopolar recordings used to obtain the simulated bipolar recording was 200 μsec. Solid lines indicate the response to rarefaction clicks and dashed lines indicate the response to condensation clicks. D: CAPs from the proximal and caudal portion of the eighth nerve before and after vestibular nerve section using a monopolar wick electrode in response to 108 dB clicks.
Fig. 6. Recordings from the auditory nerve after vestibular nerve section in the patient illustrated in Figs. 1 and 5 to compare the difference between the potentials recorded by one of the tips of the bipolar electrode and its time-shifted version with the actually recorded bipolar potentials. A: in response to rarefaction clicks, B: in response to condensation clicks. The time shift was 320 μsec and the recordings were obtained from the middle portion of the rostral surface of the auditory nerve. C: CAP recorded with a wick electrode from the proximal portion of the eighth nerve before and after vestibular nerve section.
tips with a time interval of 0.16 msec. The patient illustrated in Fig. 4A was a 39-year-old male who was operated on for classical Menière's disease (of less than 3 years duration). The difference between the monopolar response recorded by one of the tips of the bipolar electrode and its time-shifted version was similar to the actually recorded bipolar response in the recordings shown in Fig. 4A. In other recordings (Fig. 4C), such as some of those obtained in the patient illustrated in Fig. 1, there are late components in both the monopolar recording and the bipolar recording that are not seen in the simulated bipolar recording obtained by subtracting the monopolar recording from its delayed version. This is because such slow components have a longer wave length than the initial components of the CAP and, therefore, give rise to only small potentials when recorded by a bipolar recording electrode. The only way that a broad depolarization along the nerve can result in a large potential when recorded by bipolar electrodes is if the two tips of the recording electrodes are far apart or if the electrodes are placed so that the recorded potentials appear at each of the two electrodes with different amplitudes or wave forms. The fact that the actual bipolar recording shows late components of a rather large amplitude indicates therefore that the potentials recorded by the two tips of the bipolar electrode were different, and thus the two tips were probably placed on two different populations of auditory nerve fibers. In other recordings there were distinct late oscillatory components in both the bipolar and monopolar recorded potentials for both condensation and rarefaction clicks. These late potentials reverse in phase when the polarity of the clicks is reversed for monopolar as well as for bipolar recorded potentials (Fig. 4). This supports the assumption that these late components are results of propagated neural activity in specific populations of auditory nerve fibers.

The pronounced second peak seen in the monopolar recordings from 3 different locations on the rostral side of the auditory nerve (Fig. 5A) that are normally covered by the vestibular nerve, obtained from the patient illustrated in Fig. 1, is absent in the bipolar recordings (Fig. 5B). This could be because of the long wave length of these late potentials, but when the differences between the monopolar recorded potentials and their delayed versions are obtained (Fig. 5C) then no noticeable slow waves are seen in these simulated bipolar potentials. This indicates that the reason that there is no noticeable second peak in the actual bipolar recordings is that the second peak in the monopolar recordings does not represent propagated neural activity, but that the source of these potentials is located at a distance and conducted passively to the recording site. There was little change in the CAP recorded from the proximal portion of the eighth nerve near the brain-stem using a wick electrode before and after vestibular nerve section (Fig. 5D).

Recordings from the rostral portion of the auditory nerve after vestibular nerve section in the patient illustrated in Fig. 6 revealed a positive deflection of a kind generally assumed to indicate that there is a conduction block in the nerve from which the recording is made. This occurred when recording from one of the tips of the bipolar electrode when the recording electrode was placed at a certain location (Fig. 6). Such a "cut end" potential is thought to be generated when depolarization is approaching the recording electrode but never reaches it, and it may therefore be assumed that the block had occurred peripheral to the location of the recording electrode. A bipolar recording electrode would consequently not be expected to record anything, because there would not be any difference in the potentials that were recorded by the two tips of the recording electrode. However, it is seen clearly from Fig. 6A that the bipolar electrode recorded potentials of considerable amplitude, and that the wave form and amplitude of the actual recorded potentials were similar to the difference between the potentials that are recorded by the monopolar recording electrode and their delayed version (simulated bipolar recording). This would indicate that the neural activity that produced the monophasic positive deflection is in fact a result of propagated neural activity in the auditory nerve, beyond the location from where the recording was made (Lorente de Nó 1947). The small negative peak in the CAP that is recorded by a monopolar electrode probably reflects the activity of conducting nerve fibers. A peak that corresponds to a second negative peak is seen in the simulated bipolar recording, but in the actual bipolar recorded potentials a corresponding second peak has a much lower amplitude than that in the simulated recording, which indicates that at least the larger portion of this peak is a result of passively conducted evoked potentials (presumably from the cochlear nucleus). It is interesting that the wave form of the CAP recorded from one tip of the bipolar electrode is rather different when elicited by rarefaction clicks (Fig. 6A) than when elicited by condensation clicks (Fig. 6B), while the bipolar recorded potentials are rather independent of the polarity of the click stimuli.

A discrepancy between the actual recorded bipolar recordings and the simulated bipolar recordings could be explained by a difference in amplitude or wave form of the potentials recorded by the two tips of the bipolar electrode or it could be the result of potentials that appear at the two tips without a shift in time, as would be the case for passively conducted potentials, or it could be a result of the two tips of the bipolar recording electrode being placed on different populations of
nerve fibers. Whether the two tips of a bipolar electrode did record potentials with different wave forms can be tested by comparing the wave form of the potentials that are recorded by the two tips of the bipolar electrode. We did not record from the two tips separately, but the potentials recorded by the tip from which we did not record separately can be estimated by taking the difference between the bipolar recorded potentials and the monopolar recorded wave form. When this was done in the recording shown in Fig. 6A and B, it was seen that the wave form of the potentials that were recorded by one of the tips of the bipolar electrode is nearly a single positive deflection, while the other electrode recorded potentials that had a large negative peak. It is interesting that there is little difference between the bipolar recorded potentials to condensation clicks and those to rarefaction clicks, while there are considerable differences between responses recorded by a monopolar recording electrode. The large discrepancy between the simulated bipolar recorded potentials and the actually recorded bipolar wave form could be explained by the two tips being placed on different populations of nerve fibers. This supposition is supported by the finding that the wave form recorded by the other tip had a clear negative component (dashed lines in Fig. 7), thus indicating propagated neural activity in the population of nerve fibers from which the other electrode had recorded. This indicates that one of the tips was recording from a population of nerve fibers in which there was a conduction block, whereas the other tip was recording from nerve fibers that had normal propagated neural activity. Thus the conduction block probably had been restricted to a small number of nerve fibers, which also explains why no change before and after severing the vestibular nerve was seen in the CAP recorded by a wick electrode that recorded from a large population of nerve fibers or in the BAEP.

Discussion

The results of the present study show that the compound action potentials (CAPs) that are recorded from the exposed intracranial portion of the eighth nerve using a monopolar recording electrode generally represent both propagated neural activity in the auditory nerve and potentials that are conducted passively to the recording site. The initial component of the monopolar recorded CAP seems to generally represent propagated activity in the auditory nerve, while the passively conducted potentials seem to appear with longer latencies. This would be in good agreement with the previous assumption that such passively conducted potentials are generated in the cochlear nucleus and that potentials that are generated in the ear do not contribute noticeably to potentials that are recorded from the exposed intracranial portion of the eighth nerve. The results confirm earlier findings that show that the main negative peak in the click-evoked CAP recorded from the middle portion of the intracranial portion of the auditory nerve occurs at a latency that is close to that of peak II of the BAEP (Møller et al. 1988) when using a monopolar electrode. There are late components in the CAP recorded from patients with high-frequency hearing loss that represent propagated neural activity. Such components show a large shift in time when the polarity of the click stimuli is reversed, which indicate that these components are generated by activity of fibers that are tuned to low frequencies.
The results of the present study also show indications that wave forms and amplitudes of the potentials that are recorded by the two tips of a bipolar electrode are not always the same, suggesting that the two tips of a bipolar recording electrode are not positioned on the same population of auditory nerve fibers. Reasons for this may be that the electrode tips are not aligned correctly with regard to the long axis of the eighth nerve, as was attempted, or that the different bundles of auditory nerve fibers do not travel exactly in the direction of the long axis of the eighth nerve. In fact, it has been shown that the eighth nerve is twisted throughout its intracranial course (Lang 1991). However, even if the tips of the bipolar recording electrode were not aligned with the direction of the nerve fibers, such an electrode in connection with a differential amplifier will not record potentials that are passively conducted to the recording site because such potentials will appear equal at the two tips of the electrode and therefore be cancelled in the differential amplifier.

The discovery of a situation in which a monopolar recording electrode recorded a single positive potential, which is usually regarded as a sign of conduction block ("cut end potentials"), while bipolar recordings indicated that there was propagated neural activity in the auditory nerve, is intriguing. This situation may be explained partly by assuming that the block occurred in only a very small population of nerve fibers. The manipulation of the auditory nerve that might have occurred in connection with severing the vestibular nerve could have caused an injury to a small population of nerve fibers of the auditory nerve that could have resulted in a conduction block. That only a small portion of the auditory nerve had abnormal neural conduction is also supported by the finding that there were no noticeable changes in the CAP recorded from the proximal portion of the eighth nerve with a monopolar electrode nor were there any detectable changes in the BAEP as a result of surgical manipulations in connection with exposing the vestibular nerve. We have previously shown evidence that injury to the auditory nerve, such as what may occur from heat (due to, e.g., electrocautery), changes the click-evoked potentials that are recorded from the eighth nerve when using a monopolar recording electrode into a single positive deflection (Møller 1988a), thus resembling the "cut end" potential (Lorente de Nó 1947).

The fact that the two tips of the bipolar electrode we used occasionally seem to record from different populations of nerve fibers, despite the fact that we attempted to align the electrodes with regard to the long axis of the eighth nerve, seems to indicate that a single tipped electrode of the type used in this study will record rather selectively from a small population of nerve fibers, most likely from fibers located at or near the surface of the nerve.

References


