Is the abducens nerve sometimes duplicated at the skull base or just split? Anatomical and histological study with applications to skull base surgery.

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Background

The abducens nerve is frequently encountered during skull base approaches and, given its long and tortuous intracranial course, is particularly susceptible to iatrogenic injury. It is the cranial nerve most commonly associated with extraocular motor palsy.[1] Some authors have reported that the nerve can be duplicated (supernumerary) at the skull base, where it pierces the dura mater overlying the clivus. The reported prevalence of duplicated abducens nerves is 6%-28.6%.[2] In most instances, this anatomic variant is identified incidentally and does not appear to produce overt clinical dysfunction. Notably, no other cranial nerve demonstrates such a relatively high frequency of duplication.[1] Despite its reported prevalence, the clinical implications of a duplicated abducens nerve remain unclear. It is unknown whether this variant alters lateral rectus innervation, affects muscle strength, or modifies the consequences of injury to one of the nerve divisions. We hypothesized that these cases do not represent true duplication with increased neural content, but rather a bifurcation of a single nerve into separate fascicular bundles. This study was undertaken to quantitatively compare the nerve fiber counts of normal and duplicated abducens nerves to better characterize the nature of this anatomic variation.

Figure 1: Cadaveric skull base specimen demonstrating the cranial nerves. A typical abducens nerve is indicated by the right arrow, while a duplicated variant is identified by the left arrow.[1]

Methods

Ten duplicated abducens nerves and five non-duplicated (normal) abducens nerves were identified and harvested from adult human cadaveric specimens. All specimens were dissected at the level of the nerve's entrance into the dura overlying the clivus. Harvested nerve segments were fixed, processed, and submitted for histological evaluation using standard paraffin-embedding techniques. Quantitative nerve fiber counts were performed on each specimen to determine the total axonal content. In duplicated nerves, each fascicular bundle was analyzed individually, and combined fiber counts were calculated. Comparative analyses were conducted to evaluate differences in total nerve fiber counts between duplicated and non-duplicated nerves, as well as across laterality and sex.

Results

Histological analysis demonstrated that the total nerve fiber count was comparable between duplicated and non-duplicated abducens nerves. In specimens with duplication, the nerve consisted of two distinct fascicular bundles, each individually encased within its own connective tissue sheath. No statistically significant differences in fiber counts were identified when stratified by laterality or sex.

Figure 2: Cadaveric skull base specimen demonstrating a right-sided abducens nerve dividing into two distinct bundles prior to penetrating the dura mater (white arrows) along the floor of the posterior cranial fossa.[1]

Conclusions

Based on our cadaveric study, the term "duplication of the abducens nerve" should not be used. Our findings demonstrate that the combined total fiber content of split abducens nerves is comparable to that of a normal abducens nerve. This suggests that the phenomenon represents a variation in fascicular organization rather than true duplication with increased neural content.

This distinction carries important surgical implications for skull base approaches involving the clivus, cavernous sinus, and petroclival region. Surgeons should recognize that each fascicular bundle contributes to the overall functional integrity of the nerve, and injury to either component may result in abducens dysfunction. Further study is warranted to better understand the impact of these nerve variations on muscle innervation and strength. Collectively, these findings enhance our understanding of regional microsurgical anatomy and anatomic variation, and may inform safer operative planning in areas where the abducens nerve is at risk.

References

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