Obtaining Maximal Optic Nerve Length During Enucleation Procedures

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Objective: To determine optimal scissor blade design and surgical approach to facilitate obtaining a long optic nerve segment during enucleation procedures.

Methods: Two hundred mock enucleations were performed with the use of a human child skull model and a silicone sphere to simulate an eye. Temporal and nasal approaches with scissor blades with noncurved, mildly curved, or strongly curved blades were tested.

Results: Longer optic nerve segments were obtained with mildly curved scissor blades from both temporal and nasal surgical approaches. Strongly curved scissor blades uniformly produced smaller specimens.

Conclusions: Mildly curved scissors should be used for enucleation when a long optic nerve specimen is desired. Strongly curved scissors should be avoided.


Despite major advances in chemoreduction and local treatment of retinoblastoma,1,2 enucleation remains an important option for patients with extensive tumor.3 Enucleation in cases of intraocular malignant neoplasm can be lifesaving. One of the basic principles of enucleation for intraocular malignant neoplasms is to obtain a long segment of optic nerve in an effort to remove all of the tumor at the time of the enucleation. This is particularly important in eyes with retinoblastoma, because the tumor most commonly spreads via extension into the optic nerve.

Survival decreases if viable tumor cells are present at the surgical margin of the optic nerve in patients who have undergone enucleation for retinoblastoma. A variety of commercially available enucleation scissors are available to facilitate transection of the optic nerve during enucleation procedures. The purpose of this study was to compare 3 commercially available scissor blade designs and to compare nasal and temporal surgical approaches in a mock enucleation experiment to determine which approach and scissor blade design facilitated obtaining the longest optic nerve segment. To our knowledge, no published reports are available that systematically analyzed these issues. This information will be useful in the surgical treatment of patients with retinoblastoma and other intraocular malignant neoplasms.

RESULTS

A total of 200 mock enucleations were performed. Half were performed from a nasal approach and half from a temporal approach. Twenty-five enucleations were performed from each approach by means of each of the 3 scissors types. The blade shaft of the scissors was maintained flush against the orbital wall until the tips of the scissors contacted bone of the opposite orbital wall. Twenty-five additional enucleations were performed from a nasal approach and 25 additional enucleations from a temporal approach with the use of strongly curved scissors tilted to force the tips of the blades into the orbital apex.

The results are summarized in the Table. With noncurved scissors, the mean optic nerve length obtained from a temporal approach was 15.82 mm, compared with 12.39 mm with a nasal approach. Mildly curved scissors achieved a mean length of 17.08 mm with a temporal approach and 14.04 mm with a nasal approach. Strongly curved scissors achieved a mean optic nerve length of 4.89 mm with a temporal approach and 0.44 mm with a nasal approach. When the strongly curved scissors tips were angled...
MATERIALS AND METHODS

An anatomically correct child skull model (catalog No. 247172; Carolina Biological Supply Co, Burlington, NC) and a 24-mm silicone sphere were used in a simulated enucleation experiment. The left orbit was used for the study. The dimensions of the anterior orbital opening of the left orbit were 23 mm vertically and 30 mm horizontally. The distance from the anterior orbital rim to the orbital apex along the medial orbital wall was 38 mm. The distance from the lateral orbital rim to the orbital apex was 41 mm along the lateral orbital wall.

Two 6-0 silk sutures were fastened 180° apart on the silicone sphere to simulate positions of the medial and lateral rectus muscle insertions and were used to facilitate anterior displacement of the globe during enucleation (Figure 1). A cotton cord with a diameter of 0.75 mm was used to simulate the optic nerve. We found that a cord of larger caliber proved too difficult to cut, but did not simulate the human enucleation experience well, and resulted in rapid dulling of the scissors blades. The cord used, albeit of smaller caliber than a human optic nerve, very closely mimicked the “feel” of optic nerve transection during human enucleation.

To facilitate and standardize each mock enucleation, the distal end of the cord was tied securely to a metal clip (Figure 1). The proximal end of the cord was passed through a hole drilled through the silicone sphere, and then passed through the optic canal, the cranial vault, and foramen magnum. The skull was fixed in a wooden frame during testing. By pulling on the proximal end of the cord after it passed through the foramen magnum, the silicone sphere was pulled tightly into the posterior orbit. The cord was then threaded through a series of horizontally and vertically separated spacers behind the skull. After it passed around the final spacer, the proximal end of the cord was secured. The central spacer was then removed, allowing a consistent 12 mm of slack to develop in the cord.

Mock enucleations were then carried out in the following manner. The two 6-0 silk “muscle insertion” sutures were held in one hand of the surgeon and the silicone sphere was displaced anteriorly until the cord was taut. Scissors with closed blades were then passed behind the silicone sphere and the optic nerve was palpated with the scissors tips. The scissors were then opened, the blades were positioned astride the cord, and the cord was transected.

Three scissors blade curves and 2 surgical approaches were tested. The scissors blade curves used were noncurved (Codman 36-5010; Codman and Shurtleff, Inc, Raynham, Mass), mildly curved (Model E3668; Storz Surgical, St Louis, Mo), and strongly curved (Model E3652; Storz Surgical) (Figure 2). Nasal and temporal approaches with each blade curve type were evaluated. When curved scissors were used, the concave side of the scissors was always facing the silicone sphere. For each surgical approach and each scissors blade curve, the surgeon advanced the scissors along the respective orbital wall until bone of the opposite orbital wall was encountered. The cord was then palpated with closed scissors. Once the position of the cord was ascertained by palpation, the blades were opened and the cord was transected. When this method was used, the blade tips of the noncurved and mildly curved scissors were directed into the orbital apex. The tips of the strongly curved scissors were directed into the midorbit. The strongly curved scissors were further tested with the use of a secondary approach in which the surgeon attempted to place the tips of the scissors as far into the orbital apex as possible by rotating the shaft of the scissors toward the silicone sphere.

Each cord specimen, consisting of a metal clip along with the distal end of the cord, was placed in an individually masked envelope. After completion of all mock enucleations, a single masked investigator measured the length of each cord from the clip to its cut edge. The silicone sphere diameter of 24 mm was subtracted from this measurement to obtain the specimen length. Statistical analysis was performed with a 1-way analysis of variance, analysis of variance on ranks, and the paired t test as indicated. To make this article easier to read, the silicone sphere will be referred to as the globe, and the cord will be referred to as the optic nerve.

Obtaining a long optic nerve specimen at the time of enucleation of eyes with intraocular tumors is important, particularly for eyes containing retinoblastoma. Despite major advances in the treatment of retinoblastoma with chemoreduction and local treatment measures, enucleation remains an important primary treatment modality in eyes with extensive intraocular tumor involvement. Survival increases if the cut margin of the optic nerve is free of tumor. To our knowledge, despite numerous publications on the surgical management of retinoblastoma, a systematic effort to determine the best surgical approach (temporal vs nasal) and optimal scissors blade design to obtain the longest possible optic nerve segment has not previously been reported.

Shields and coworkers reported their recommendations for enucleation of eyes in children with retino-

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blastoma based on their personal experience. They concluded that long, minimally curved scissors were the optimal tool for cutting the optic nerve near the orbital apex and obtaining long optic nerve segments. Our mock enucleation experiment confirms the experience and recommendations of these authors. Shields and coworkers\(^6\) advocated a nasal approach when cutting the optic nerve. Our study demonstrated that mildly curved scissors used from a temporal approach provided longer mean optic nerve segments than a nasal approach did. However, using these scissors from a nasal approach was subjectively easier during the experiment and has also been found to be easier in our clinical practice in the treatment of children with retinoblastoma. Interestingly, despite obtaining longer optic nerve segments from a temporal approach, we noted that multiple attempts to cut the optic nerve were often required when cutting from the temporal side, while only a single attempt was universally needed when approaching the optic nerve from the nasal side of the orbit. However, we did not tabulate the number of attempts, nor did we systematically record the surgeon's subjective impressions during the course of the experiment. The optic nerve is nasally positioned in the posterior orbit, potentially explaining why the nasal approach appeared easier.

An important finding of our study is that strongly curved enucleation scissors harvested substantially shorter optic nerve segments regardless of the approach or technique used. In fact, when strongly curved scissors were used in the manner in which they were designed, extremely short optic nerve segments were realized, and exaggerated tilting of the scissors into the apex resulted in only modest increases in the optic nerve lengths obtained. This maneuver was also subjectively difficult for the investigator to perform. We recommend against the use of strongly curved scissors when enucleation is performed in eyes containing tumors, particularly tumors that can spread via direct extension into the optic nerve, such as retinoblastoma.

The results and conclusions of this study must be viewed with several limitations in mind. First, the skull model used in this experiment approximated the size of a 6-year-old child's skull. We were unable to obtain a skull or skull model of a child less than 3 years old, the age at which retinoblastoma typically occurs. Second, no attempt was made to mimic the presence of orbital soft tissues, which can play an important role in enucleation for retinoblastoma and other intraocular tumors.\(^7,8\) Third, we attached sutures on the simulated globe and used these sutures to put forward traction on the globe. We were unable to simulate the use of hemostats on the muscle stump for traction, a technique commonly used for enucleation of eyes containing retinoblastoma. Finally, the material used to simulate the optic nerve was only 0.75 mm in diameter, substantially thinner than a human optic nerve. Despite its small diameter, the tactile experience of palpating and cutting the cord during this experiment closely mimicked the tactile experience of severing the optic nerve during human enucleation procedures. Despite these limitations, we believe that our results are valid and provide information useful in the management of intraocular malignant neoplasms by enucleation.

In conclusion, longer optic nerve specimens were obtained with the use of long, mildly curved scissors in
a mock enucleation experiment. The temporal approach uniformly provided longer segments. A nasal approach provided shorter optic nerve lengths but was subjectively easier to perform. Strongly curved scissors resulted in smaller optic nerve specimens regardless of the technique or surgical approach used and, therefore, should not be used for performing enucleations in the management of intraocular tumors.

Accepted for publication August 17, 1999.

This study was supported by The Lions Eye Bank of Texas at Baylor College of Medicine, Houston, and an unrestricted grant from Research to Prevent Blindness Inc, New York, NY.

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REFERENCES


A look at the past...

The author made many experiments in regard to the changes in corneal curvature following sections made with lances of various curvatures. He also measured the astigmatism following glaucoma and cataract operations. Sections made with the Graefe knife were not considered on account of the unavoidable irregularity in puncture and counter-puncture. Of 112 cases of glaucoma in which a lance 6-9 mm broad was used, it was found that in the meridian dividing the wound the refraction sank 0.5-2.5 D, while in the meridian at right angles it rose 0.5-3 D. On an average, the astigmatism produced was 2.76 D.