Snare Technique for Enucleation of Eyes With Advanced Retinoblastoma

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Retrospective analysis of surgical outcomes for enucleation in pediatric retinoblastoma stage 5B using the snare wire loop (n=55) and standard curved enucleation scissors (n=22) revealed that a statistically significant longer mean optic nerve length was obtained with the snare (13.35 mm) compared with scissors (11.05 mm; P=.005). Four scissor cases had prolonged bleeding and required thrombin (18.2%), but no snare cases had difficulty with hemostasis (P=.005). More crush artifact was seen with the snare than with scissors (P<.001), but this did not affect the ability to determine tumor involvement at the surgical margin. The enucleation snare should be considered a valuable surgical instrument in the small pediatric orbit since obtaining the longest optic nerve segment has prognostic implications in retinoblastoma.

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Although treatment for retinoblastoma has markedly improved over the last few decades, morbidity and mortality continue to be of great concern for children who have advanced disease. A main cause of mortality is intracranial tumor extension via the optic nerve. If the optic nerve is involved with a positive margin at enucleation, the mortality risk has been estimated at 65%. It has been well established that eyes requiring enucleation for advanced retinoblastoma not amenable to other treatment modalities should have the longest optic nerve section removed, even if the optic nerve appears without gross tumor involvement, to avoid potential microscopic tumor remnants within the optic nerve stump. Poor prognostic factors include an optic nerve length of less than 5 mm at enucleation and optic nerve tumor involvement.

Traditionally, enucleation scissors are used to cut the optic nerve. However, the enucleation snare may provide several advantages over scissors for retinoblastoma cases. We investigated the hypothesis that the snare more consistently obtains a longer optic nerve length than enucleation scissors. We postulated that this advantage may be related to the snare's thinner and straighter dimensions and hence its ability to transect the optic nerve more posteriorly than the wider, curved enucleation scissors (Figure 1).

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Other theoretical advantages have been proposed, although reports in the literature are rare and anecdotal. Myers noted excellent hemostasis with the wire loop of the snare that crushes rather than cuts the central retinal artery and vein. Buss and Tse discussed the advantages of the snare for orbital exenteration, including a more posterior transection, less bleeding, less iatrogenic damage to the orbital fissures, and the ability to clamp and transect the tissues in the same plane. In this study, we investigated whether the enucleation snare provides better hemostasis and fewer intraoperative adverse events than scissors.

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Of major significance in retinoblastoma enucleation is the ability to evaluate the surgical margin for tumor involvement. Because the wire loop of the snare has a blunt rather than a sharp edge, crush artifact was analyzed to determine whether the snare causes difficulty with histopathologic interpretation of the surgical margin.

**METHODS**

All cases of children undergoing enucleation for advanced retinoblastoma by the same surgeon (T.G.M.) at Bascom Palmer Eye Institute between March 1994 and March 2005 were retrospectively reviewed. Data was collected from the medical record, operative report, pathology requisition form, and pathology report. The following were recorded: the patient’s age at enucleation, sex, stage of retinoblastoma, type of enucleation instrument used (snare or scissors), length of optic nerve obtained prior to fixation in formalin as measured in the operating room, and intraoperative adverse events. Only fresh optic nerve length measurements were used since formalin fixation has been shown to produce approximately 30% shrinkage. In addition, 20 histopathologic specimens (10 snare cases and 10 scissors cases) were randomly selected and reviewed in blinded fashion with the ocular pathologist for analysis of crush artifact at the surgical margin. Study approval was obtained from the University of Miami’s institutional review board.

**RESULTS**

Seventy-seven eyes of 76 children underwent enucleation by the same surgeon (T.G.M.) for stage 5B retinoblastoma from March 1994 to March 2005 at the Bascom Palmer Eye Institute and had fresh optic nerve length data recorded. One child underwent bilateral enucleation. There were 41 girls and 35 boys. The average age was 25 months (age range, 1 month to 10 years). Twenty-two eyes were enucleated with scissors from March 1994 to June 1996. Fifty-five eyes were enucleated with the snare from August 1996 to March 2005.

The mean optic nerve length for the scissors cases was 11.05 mm (range, 6-19.5 mm). For the snare cases, the mean optic nerve length was 13.35 mm (range, 8-20 mm). This was a highly statistically significant difference \( \text{P} = .005 \) by unpaired \( t \) test).

Four (18.2%) of 22 scissors cases had prolonged intraoperative bleeding at the optic nerve stump, requiring more than 20 minutes of pressure and thrombin. No difficulties with hemostasis were encountered with the 55 snare cases, and this was a statistically significant difference \( \text{P} = .005 \) by Fisher exact test. In 2 of the snare cases (3.6%), a single extraocular muscle was inadvertently ensnared and cut. Although this did not happen with any of the scissors cases and did not represent a statistically significant difference, the muscle was able to be recovered and resutured to the ocular implant with no subsequent motility problems.

For histopathologic analysis of the surgical margin, the ocular pathologist was given uncoded slides in random order and blinded to enucleation technique. All 10 randomly selected scissors cases were graded as having mild crush artifact (Figure 2). Of the 10 snare cases, 6 were graded as having moderate crush artifact and 4 had severe crush artifact (Figure 3). This was a highly statistically significant difference \( \text{P} < .001 \) by Mann-Whitney test). However, none of these 20 cases had tumor involvement of the surgical margin. Two other cases did have retinoblastoma extending diffusely along the optic nerve and were positive for tumor at the surgical margin (Figure 4 and Figure 5). One underwent enucleation with scissors and had a fresh optic nerve length recorded as 15 mm. The other case underwent enucleation with the snare and had an optic nerve length of 14.5 mm. In neither case was the histopathologic determination of tumor involvement hindered.

**CONCLUSIONS**

The enucleation snare obtained longer optic nerve sections than traditional enucleation scissors in the small pediatric orbit of children with advanced retinoblastoma. Orbital bony growth occurs rapidly over the first 3 years of life and continues at a slower rate until the early teens. Because the dimensions of the pediatric orbit are small, it seems plausible that a narrower enucleation instrument such as the snare could be inserted deeper into the apex and thereby obtain a longer optic nerve (Figure 1). In contrast, scissors are curved and must be opened within the orbit to engage the optic nerve. Whereas the snare can be easily pushed deep into the orbital apex as...
the loop is tightened, the opening of the scissors around the optic nerve requires more space and presumably restricts how far posterior the instrument can be advanced.

While scissors are often straightforward to use, learning to use the enucleation snare may take some practice, as with any new instrument. The wire loop is tightened around a ratcheting mechanism but cannot be released and must be replaced after each use. Thus, loop closure must be performed in 1 continuous movement. If attachments to the globe are not completely severed, the loop may catch some of these tissues and cause globe retraction while tightening the loop. Therefore, it is imperative to cleanly sever the oblique muscle attachments as well as Tenon capsule. Careful attention must be paid to avoid ensnaring the rectus muscles.

This is simplified by clamping the muscle sutures to the drape with a hemostat. In addition, leaving a medial rectus muscle stump on the globe aids in proptosing it with a hemostat (Figure 6). This maneuver puts the optic nerve on stretch and allows the snare to transect it more posteriorly.

Another advantage of the snare is the almost bloodless transection of the optic nerve (Figure 7). Some children with retinoblastoma have been treated with chemotherapy or radiation prior to enucleation. Radiated orbital tissues in particular can be more prone to bleeding. In eyes enucleated with the snare, there were no difficulties encountered with hemostasis while there was a significant number of scissors cases with prolonged bleeding. Theoretically, as noted by Buss and Tse, the tightening of tissues within the loop and blunt transection within the same plane may account for this fairly bloodless procedure. Uncomplicated hemostasis can save valuable intraoperative time.

All the surgical advantages of the enucleation snare would be negated if crush artifact were to hinder the ability to detect retinoblastoma at the surgical margin. The sharp cutting edges of scissors resulted in less crush artifact, but additional histopathologic cuts were necessary to view the entire surgical margin and get to a full perpendicular view of the optic nerve. This was due to the curved scissors edges cutting an oblique plane through the nerve. For the snare cases, the surgical margins were much more perpendicular and fewer slides were required to view the entire margin. Tumor involvement was readily identifiable at the surgical margin in both scissors...
and snare cases despite the varying degrees of crush artifact (Figure 4 and Figure 5).

In experienced hands, the snare provides several surgical advantages over enucleation scissors. We found that it consistently obtains a longer optic nerve length, provides an almost bloodless nerve transection, and despite crush artifact does not impair the ability to detect tumor at the surgical margin. In view of these findings, the enucleation snare should be considered a valuable instrument in retinoblastoma pediatric patients in whom obtaining a long optic nerve is of vital importance.

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