Comments on Single-Pass Four-Throw Knot Mechanics

We read with interest the Letter to the Editor by Narang and Agarwal printed in the March issue. In our opinion, the authors have done themselves a disservice by saying that they borrowed their technique from the theory of hitches. This theory is based on the static friction force that appears between a rope and a hub (Figure 1A). In an iris suture knot, the phenomena are completely different: the rope is a 0.02 mm monofilament, with practically zero extensibility and a smooth surface, and there is no hub. In these conditions, the almost nil friction coefficient, multiplied by the almost nil length of arc of contact with an almost nonexistent core, should result in almost nothing.

However, the single-pass four-throw (SFT) knot holds if the iris is not excessively pulled. To understand why this knot holds although it should not, according to the theory of hitches, we reproduced it in dry-lab conditions and found that it has more to do with the theory of knots. Here, the static friction intervenes, but not against a core. After knot construction (Figures 1B-1C), when it was tightened, its length decreased to minimum (Figures 1D-1H) and some spires were forced to enter below others, on several layers. All of these were facilitated by the 180° knot torsion (Figures 1C-1D) and 900° filament twist, which are always associated with SFT knot construction. In the end, a ball of successive tight crossings distributed on several layers was formed (Figures 1I-1J). The static friction force acts inside this ball.

In our opinion, the authors did not borrow from another theory, but found a way to put the theory into practice in surgery. Patents are granted precisely for finding practical ways of putting theories into practice. That is why we think that “the single-pass four-throw pupilloplasty knot” should be named “the Narang-Agarwal knot.” Besides being a shorter name, it represents a small reward for the months or years of study, and the doubts and risks always related to the application of a new procedure in human medicine.

In their place, we would be more concerned by the solidity of this knot in case of a slightly rigid iris or a larger defect. Moreover, in cases of floppy iris, the membrane may herniate again during ophthalmic viscosurgical device evacuation, which may submit the knot to tensions in front of which it could not resist, as in one of our recent cases. It seems that the capacity of polypropylene to undergo plastic deformity when tied with sufficient tension has been overestimated. A recent revision of that article clearly specifies that “an additional throw is needed for adequate (Prolene) knot security.”

In the Narang-Agarwal knot, at least one throw is missing. Furthermore, the 180° iris torsion (Figure K)
1) ceases when the tightening force ceases. The iris elasticity/tension usually brings the iris defect margins in their natural position; this may add a latent source of knot weakness, as we will prove in a future study. In our opinion, these are the real problems with this technique, not the borrowing from another theory.

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REFERENCES

The authors have no financial or proprietary interest in the materials presented herein.

Reply
We are glad to read the analysis done by Bordeianu and Bordeianu. The reference to the “timber hitch” by Ashley in our letter was to illustrate the single pass and four throws that are taken during the surgical procedure of the single-pass four-throw (SFT) technique.1 We agree that the difference in the mechanics of a log and iris might be different, but we cannot overlook various clinical aspects. First, the authors state that the SFT technique is based on the “theory of knots.” A surgical knot essentially comprises an approximation loop followed by a securing loop. The SFT knot comprises only the approximation loop2; therefore, we wonder if the theory of knots actually works for the SFT technique.

Second, the authors reproduced the scenario in a dry-lab setting. We would be glad to know the details of this dry-lab setting because in cases of loss of toxicity (in an enucleated/animal model eye), the sutures are bound to crumple on each other (Figures 1G-1H) when tightened excessively. The authors state that “some spires were forced to enter below others.” This situation stated by the authors should be reviewed critically and interpreted with caution because, when the iris tissue is being apposed, the peripheral iris offers some resistance toward the central pull of the iris. Additionally, with excessive tightening there is a risk of inducing an iatrogenic iridodialysis.

The authors propound there is a 900° filament twist in the SFT technique. This is practically possible for the first throw only because it would get twisted all over again every time a throw is taken. This does not seem to be applicable to all of the throws taken in the SFT technique.

The authors express their concern over the applicability of the SFT knot for larger iris defects or with fibrosed iris tissue. We have also applied the SFT technique in cases with iris coloboma; nevertheless, if the iris defect is too large, then all techniques of pupilloplasty will probably fail because the scenario in all likelihood demands an artificial iris implant. In a special situation such as floppy iris syndrome associated with herniation of the iris, the authors probably came across opening up of the SFT knot. Here the outcome clearly depends on the method of handling the iris tissue and undue stress induced due to the constant endeavor to place the iris back inside the eye.

Clinically, four throws have been found to be optimal to prevent the SFT loop from opening.2,3 The authors suggest adding an additional throw to the SFT loop, but this just adds to the bulk of the suture material.2,4 Figure 1G in our letter focuses mainly on the forces that prevent the loop from opening and the suture pathway is clearly mentioned in our original study on the technique.2

The authors state “the 180° iris torsion ceases when tightening force ceases” and believe this may add a latent source of weakness that they intend to prove in a future study. We have yet to see an SFT loop that opens up and we would wait for the clinical study rather than a theoretical one, because our concept is sound and functional clinically and not a borrowed one.

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