The Modified Racking Hitch (MRH) Knot
A New Sliding Knot for Arthroscopic Surgery

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Abstract
Sliding knots are commonly used in arthroscopic surgery and can be problematic in terms of strength and loop security. A new sliding knot for arthroscopic surgery, a modified racking hitch (MRH) knot, is described. The knot is essentially a modified cow’s hitch knot that includes two self-locking loops. By tensioning the loop strands, a snug knot is created without backward sliding and provides excellent knot and loop security. In laboratory testing, the MRH knot provided comparable strength and security to other sliding knots. Experience gained from approximately 5 years of clinical use has added to the promise of the useful application of the MRH knot in arthroscopy.

In arthroscopic shoulder surgery, arthroscopic knot tying is often needed for suture anchor repair of labral lesions, rotator cuff tears, side-to-side repair of the rotator cuff, rotator interval closure, and capsular plication. Often a blind knot is placed without direct visualization. There are many types of sliding and non-sliding arthroscopic knots described in the literature that vary with ease of tying, profile, and fixation strength. A new, secure sliding knot, the modified racking hitch (MRH) knot, is presented that is both low profile and easily locked. In addition, this new type of knot is strong and can be readily tightened, whether it is able to be directly visualized or not during tying. The MRH knot is based on a pedigree cow hitch that is tied over a post consisting of the two remaining suture strands. The result is a modification of the racking hitch knot used with the SecureStrand cable system. The MRH knot has been routinely used in our institution for rotator interval closure, side-to-side rotator cuff repair, rotator cuff repair with suture anchors and arthroscopic capsular plication for approximately 5 years.

Technique
The MRH knot technique involves passing a doubled suture through the tissue and retrieving the loop of suture through the same arthroscopic cannula. As the knot is tightened, resistance within the strands prevents “backing up” of the knot, maximizing loop security. A knot pusher may be placed on either suture end, since either suture can be used as a post (Figs. 1 and 2). No past-pointing is necessary. When the desired tension is achieved, reverse half-hitches are thrown securing the knot.

Testing
Knot and loop security of the MRH were compared to a modified Roeder knot (a sliding, locking knot) and to a second knot consisting of four reversing half hitches on alternating posts (4-RHAPs) that is equal to two square knots. Both knots have been described and tested in other studies. The MRH and the modified Roeder knots were both secured with an additional single half hitch. No. 2 Ethibond suture (Ethicon, Inc., Somerville, New Jersey) with...
a standard single-hole knot pusher (Arthrex, Inc., Naples, Florida) was used to tie the suture to two 8.5 mm diameter rods. Knot security was tested by increasing the tensile load to failure, defined as suture breakage or elongation of the loop to 3 mm.\(^7\) Loop security was measured by elongation of the suture loop under a 30 N load after a 7 N preload was applied to take slack out of the fixation.\(^6,8\) Statistical analysis was performed using analysis of variance (ANOVA). The Tukey-Kramer multiple comparisons test was applied if the F-test on the ANOVA was significant (p < 0.05).

**Results**

Knot security data showed that the MRH knot (mean load to failure = 122.94 N, SD = 20.70 N) was superior to the modified Roeder knot (mean load to failure = 41.16 N, SD = 10.03 N, p < 0.001) but not significantly different from the 4-RHAPs knot (mean load to failure = 133.79 N, SD = 21.49 N, p = 0.32). The loop security of the MRH knot (mean elongation = 0.69 mm, SD = 0.12 mm) was superior to both the modified Roeder (mean elongation = 1.45 mm, SD = 0.23 mm; p < 0.001) and 4-RHAPs knot (mean elongation = 1.75 mm, SD = 0.22 mm; p < 0.001). The mode of failure for the MRH knot was slippage, which was the same as for the modified Roeder knot. The trials of the 4-RHAPs knot resulted in suture breakage more often than slippage, which was expected.

**Discussion**

The MRH knot technique is straightforward and readily applied in the clinical situation. In laboratory testing, the MRH knot itself demonstrated excellent knot security, equivalent to two square knots in sequence (4-RHAPs), and was superior to the modified Roeder knot. The MRH knot has also been shown to have superior loop security in comparison to both of these aforementioned knots. This is striking since only one underhand throw was used to secure the MRH knot. Even though further studies of this knot are needed in order to evaluate its full clinical effectiveness, the proven mechanical strength of the knot combined with our clinical experience suggests the MRH knot has substantial promise in application.

**Disclosure Statement**

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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