

# Bone Block Graft Fixation for Glenoid Bone Loss: A Comparative Study of Construct Tensioning Protocols Using FiberTape® Cerclage

Arthrex Research

## OBJECTIVE

Recurring anterior shoulder instability is frequently associated with glenoid bone loss.<sup>1</sup> Different techniques using autogenic or allogeneic bone block grafts have been established to address the glenoidal bone defect.<sup>2</sup> The suture-based bone block cerclage, using two interconnected FiberTape and TigerTape™ cerclage sutures, offers a metal-free fixation method, thereby avoiding screw-related complications.<sup>3</sup> To achieve sufficient stable graft fixation and minimize the risk of graft fracture, nonunion, or failure, repeatable procedures need to be established. This study compared different knot-tensioning protocols using a cerclage tensioner for an all-suture bone block cerclage. The load applied during tensioning and the initial fixation achieved after tensioning were analyzed. Three different protocols were tested (n = 5 in each group):

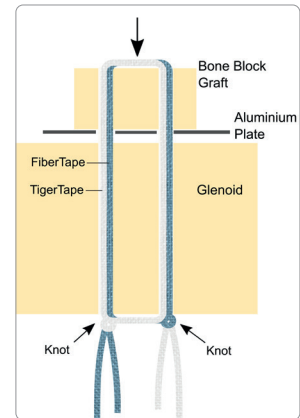
- › 3× tensioning up to the 80 mark on the tensioner and finalizing the construct with two consecutive half hitches followed by two alternating half hitches
- › 3× tensioning up to the 30 mark and finalizing the construct with two consecutive half hitches followed by two alternating half hitches
- › 2× tensioning of the hitching suture up to the 30 mark and finalizing the construct with one successive and two alternating half hitches

## METHODS AND MATERIALS

For this purpose, two 40/20 pcf Sawbones blocks, representing the glenoid (30 mm × 30 mm × 40 mm) and the bone block graft (10 mm × 10 mm × 20 mm), were prepared. Two drill holes were predrilled 10 mm apart with a diameter of 3 mm in each block. For testing, an Instron E10000 with a 1 kN/25 Nm load cell attached was used. The glenoid Sawbones block was mounted to the testing machine, enclosed in a sample holding fixture, with the drill holes axially aligned along the actuator axis. The small bone block was placed on a custom aluminum plate with corresponding drill holes and secured to the actuator of the testing machine. This allowed for measurement of the load applied onto the small bone block by tensioning the bone block cerclage construct. The two blocks were positioned a few millimeters apart, with the drill tunnels aligning axially (see Figure 1A).



**Figure 1A.** Test setup with bone blocks and cerclage.



**Figure 1B.** Schematic representation of FiberTape cerclage construct with two interconnected sutures.

For the FiberTape cerclage, two different colored cerclage tapes, FiberTape and TigerTape, were shuttled from the bottom to the top through the glenoid and bone block graft, and then vice versa back through the second tunnel, to press the bone block graft to the plate above the glenoid (see Figure 1B). To interconnect both cerclage sutures, the FiberTape cerclage suture tail was loaded through the pretied racking hitch knot from the TigerTape cerclage suture. Then, TigerTape cerclage suture tail was loaded through the pretied racking hitch knot from the FiberTape cerclage suture. The cerclage loop was then shortened by pulling alternately on the suture tails until the two knots were seated against the Sawbones block, thus reducing the slack in the construct. Afterward, 5 samples were tested for each tensioning protocol.



### Tensioning Protocol 1

The first group was tensioned 3 times in total. One of the cerclage sutures was loaded into the FiberTape® cerclage tensioner and tensioned up to the 80 mark on the tensioner. The second cerclage suture was then tensioned in the same way up to the 80 mark, followed by another tensioning step of the first suture up to 80. The suture's ends were cut to separate the two tails of the FiberTape and TigerTape™ sutures. Two consecutive half hitches followed by two alternating half hitches were made on each cerclage suture to finalize the construct.

### Tensioning Protocol 2

Tensioning protocol 1 was adapted by tensioning 3 times up to the 30 mark on the tensioner instead of 80. Based on pretesting, 30 was identified as the ideal value for further investigations.

### Tensioning Protocol 3

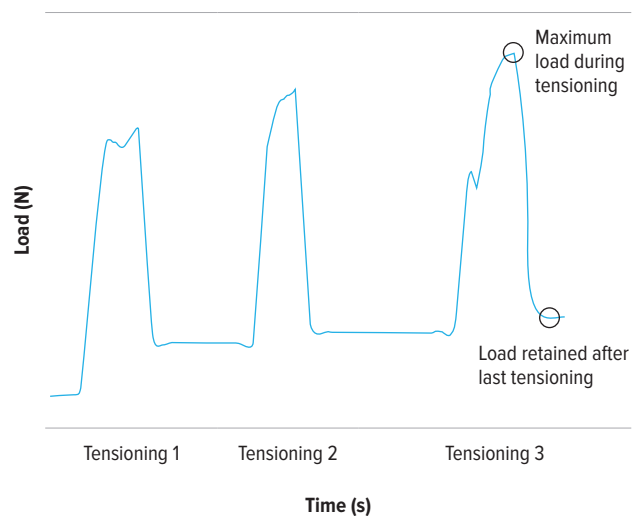
For the third tensioning protocol, the suture's ends were cut and a half hitch was applied to the first cerclage. The hitching suture tail was loaded into the FiberTape cerclage tensioner and tensioned up to the 30 mark, while holding the other suture tail aside. One successive and two alternating half hitches were applied. The procedure was repeated for the second cerclage suture. The loads acting on the bone block were recorded during tensioning. The maximum load during tensioning and the load retained after the last tensioning (initial fixation after tensioning) were evaluated as depicted in Figure 2.

All 3 groups were tested for equal variances and normality using the Brown–Forsythe and Shapiro–Wilk tests, respectively. To analyze the effect of the tensioning protocol on the maximum load during tensioning and the load retained after tensioning, a test was performed, followed by a Tukey/Steel-Dwass post hoc test (depending on the normality of the data). Statistical analysis was performed using JMP (Version 15, SAS Institute). *P* values  $\leq .05$  were considered statistically significant.

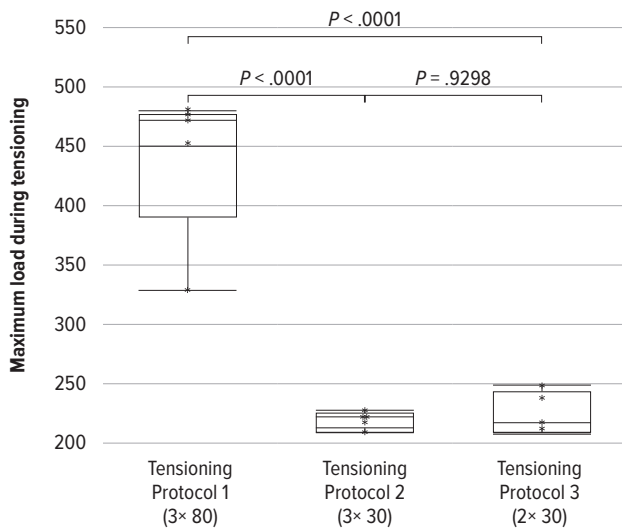
## RESULTS

The maximum loads during tension and the loads retained after tensioning are shown in Figures 3 and 4. Tensioning 3 times up to the 80 mark on the tensioner resulted in the highest loads during tensioning ( $475.1 \pm 78.2$  N) and loads retained after tensioning ( $172.6 \pm 73.4$  N). Those loads were significantly higher compared to tensioning protocol 2, tensioning only up to the 30 mark ( $232.8 \pm 13.6$  N,  $P < .0001$ ;  $77.5 \pm 17.0$  N,  $P = .0326$ ). Protocol 3 revealed significantly lower maximal loads ( $243.8 \pm 21.6$  N,  $P < .0001$ ) on the construct while tensioning, but similar initial fixation loads ( $115.0 \pm 11.8$  N,  $P = .5488$ ) compared to protocol 1. Compared to protocol 2, loads retained after tensioning were significantly higher ( $P = .0326$ ) without increasing the maximal load on the construct ( $P = .9298$ ). An analysis of the variances of the loads retained after tensioning revealed significantly higher variances when tensioning up to the 80 mark compared to tensioning up to 30 after tying one knot ( $P = .0483$ ). All other pairwise comparisons of variances showed no significant differences.<sup>4</sup>

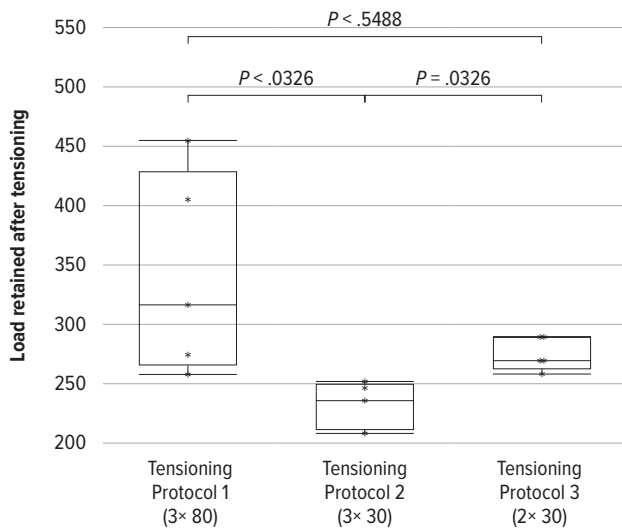
**Figure 2.** Schematic load-time graph time for a construct tensioned 3 times. The maximum load during tensioning and the load retained after the last tensioning are marked.



**Figure 3.** Maximum load during tensioning with corresponding *P* values for pairwise comparison (n = 5).



**Figure 4.** Load retained after tensioning with corresponding *P* values for pairwise comparison (n = 5).



## CONCLUSIONS

Tensioning only up to the 30 mark instead of 80 on the tensioner resulted in significantly decreased loads on the construct during tensioning but also significantly lower initial fixation after tensioning for protocol 2. Tensioning the hitching sutures up to after tying one knot down (tensioning protocol 3) also resulted in significantly lower loads on the construct during tensioning compared to tensioning up to 80. However, the initial fixation achieved after tensioning was comparable to the stability achieved for tensioning up to the 80 mark. Additionally, this procedure resulted in significantly decreased variances, therefore achieving higher repeatability.

The tensioning protocol involving the tensioning of the hitching sutures up to 30 after tying a knot down resulted in a repeatable and stable initial fixation while decreasing loads on the construct during tensioning.

## References

1. Moya D, Aydin N, Yamamoto N, et al. Current concepts in anterior glenohumeral instability: diagnosis and treatment. *SICOT J.* 2021;7:48. doi:10.1051/sicotj/2021048
2. Zhang JA, Lam PH, Beretov J, Murrell GA. A review of bone grafting techniques for glenoid reconstruction. *Shoulder Elbow.* 2022;14(2):123-134. doi:10.1177/17585732211008474
3. Hachem A-I, Del Carmen M, Verdalet I, Rius J. Arthroscopic bone block cerclage: a fixation method for glenoid bone loss reconstruction without metal implants. *Arthrosc Tech.* 2019;8(12):e1591-e1597. doi:10.1016/j.eats.2019.08.014
4. Arthrex, Inc. Data on file (APT-05727). Naples, FL; 2022.