

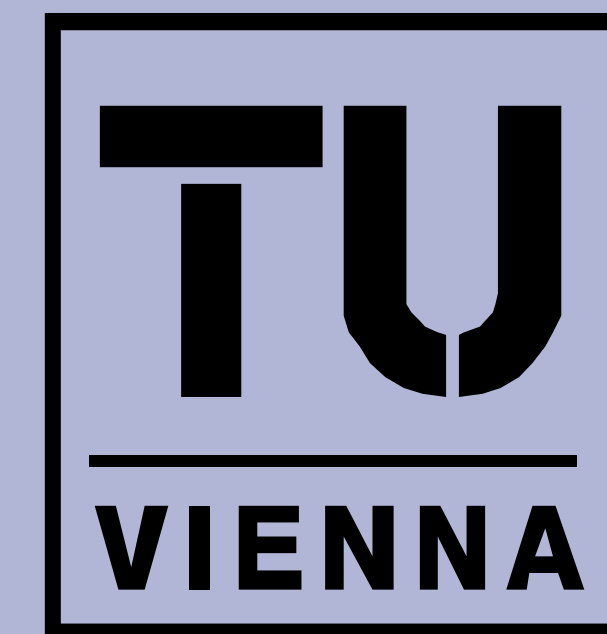
The Stability of Tendon Fixation to Bone in Surgery

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Introduction

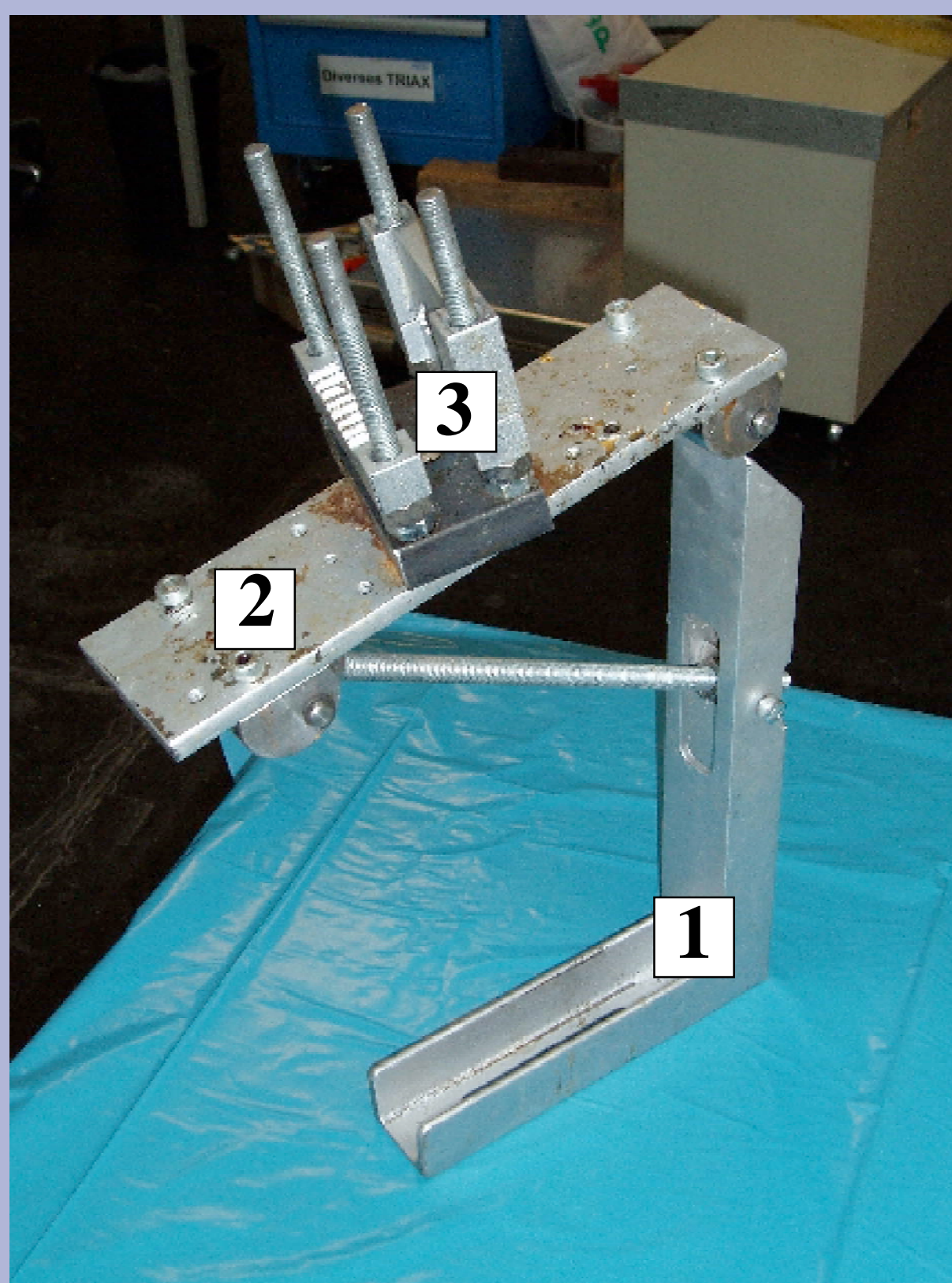
The optimal method for repair of a torn rotator cuff remains controversial [1]. Because of reduced surgical exposure and ease of insertion suture anchors have become increasingly popular for reattachment of avulsed rotator cuff tendons [2]. The object of the present study is to measure the stabilities of different anchor-suture systems when subjected to load cycling and also to compare the anchor based technique with the transosseous tunnel technique of tendon fixation.

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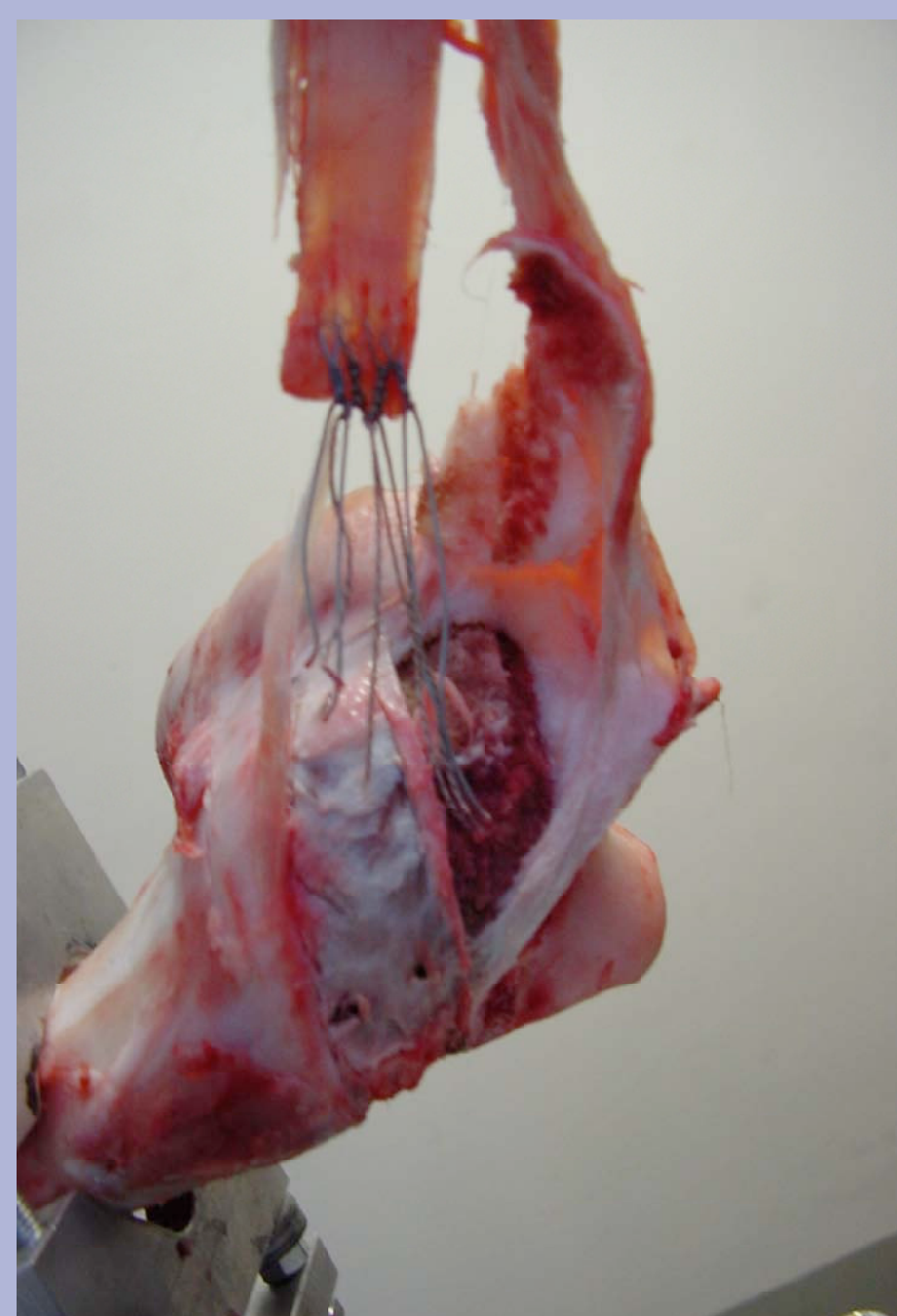
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2. S. Burkhart, J. Pagan, M. Wirth, K. Athanasiou (1997) Cyclic loading of anchor-based rotator cuff repairs: confirmation of tension overload phenomenon and comparison of suture anchor fixation with transosseous fixation. Arthroscopy: The Journal of Arthroscopic and related surgery, 13, 6: 720-724.
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Materials and Methods

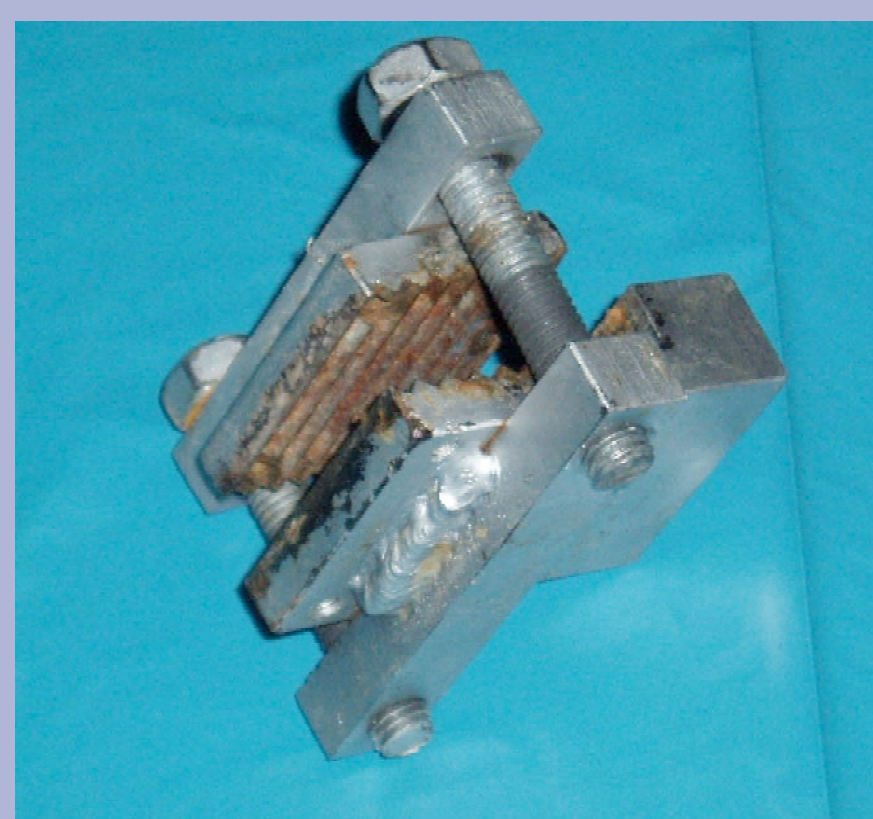
60 bone-tendon-complexes from the bovine shoulder have been used in this study, divided into 5 groups (4 anchor-suture systems, and 1 for the transosseous technique). Load cycling between the load levels of 10 N and 180 N was performed [2] with deformation rate controlled ramps of +/- 33 mm per second. The tests were limited with 2500 load cycles, each with durations of 5 s. This loading scheme was reported as to resemble the natural loading situation within the period of the initial healing phase [2,3]. Prior to the tests, each, we have a test with the virgin bone-tendon complex to compensate the overall compliance (with the applied suture) for that of the tendon-bone complex itself.



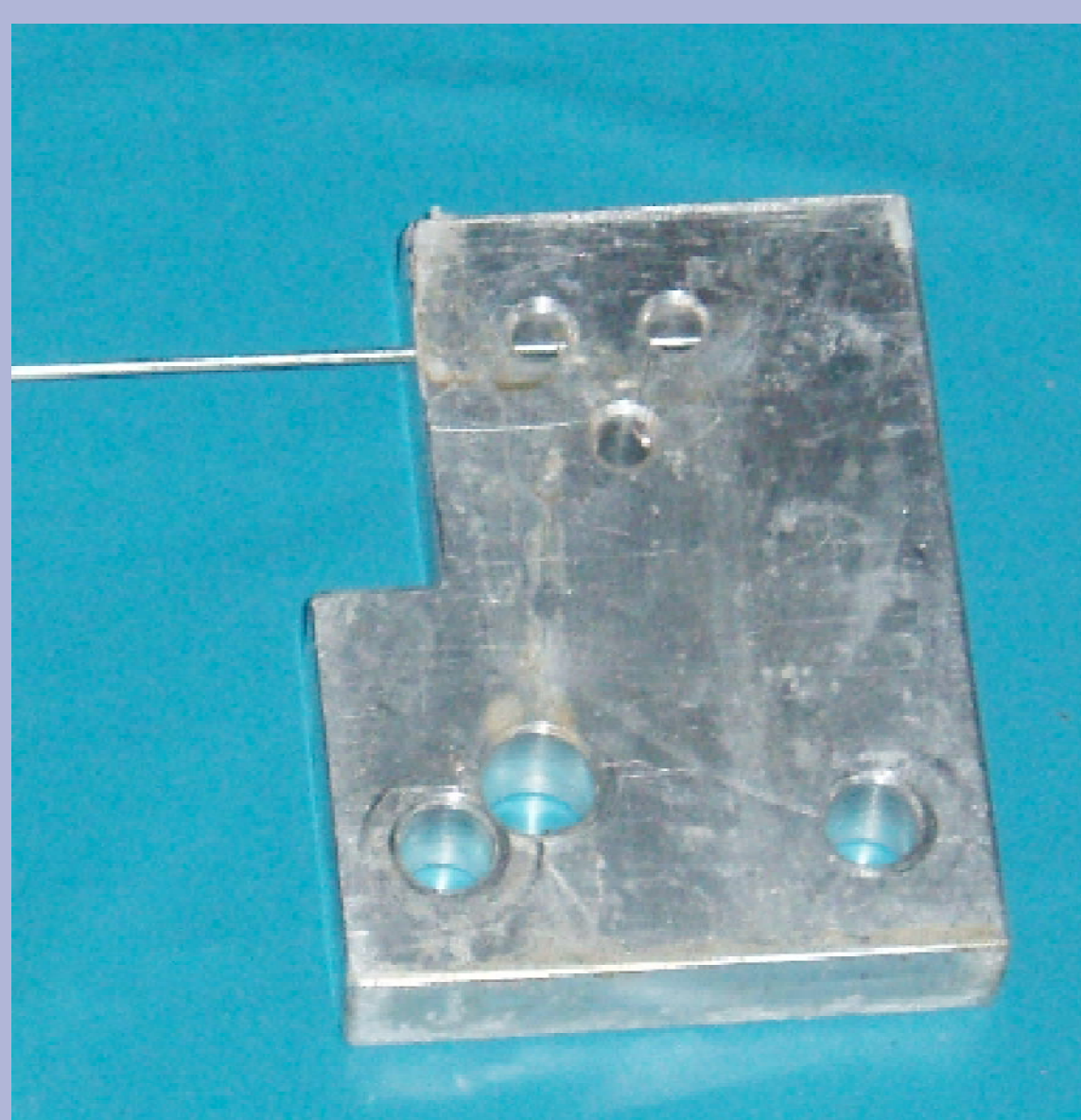
Device for the fixation of the bone-tendon-complexes. The device is mounted to the base plate of a hydraulic loading machine (Wille Geotech & Walter und Bai). The device consists of a metal rack (1), a swivel mounted platform (2), and a serrated clamp for the bone (3).



Typical bone-tendon-complex



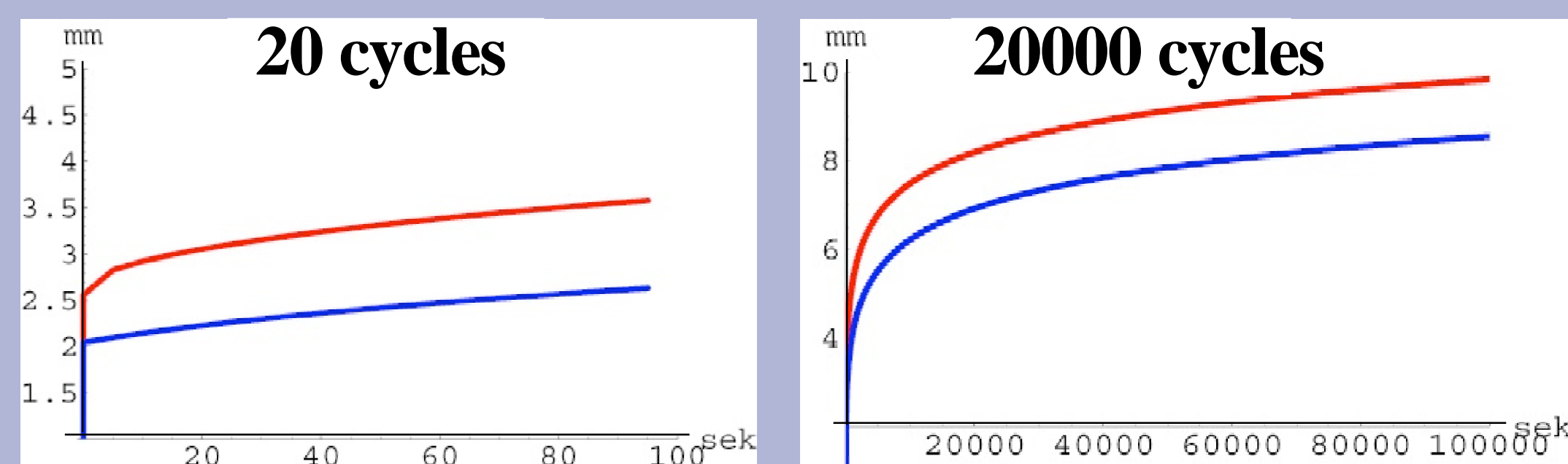
Serrated clamp for the free end of the tendon



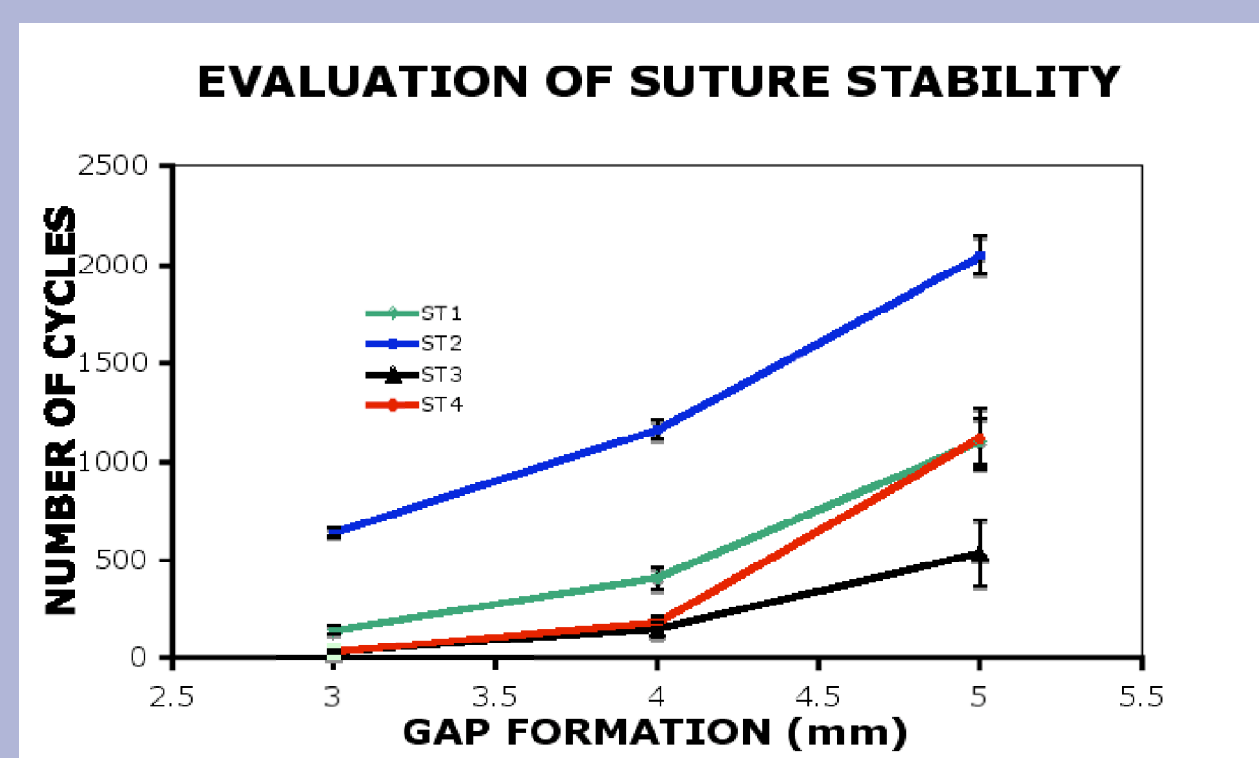
Alternative method for tendon fixation using a metal plate with drilled holes and a wire for the suture application.

Results

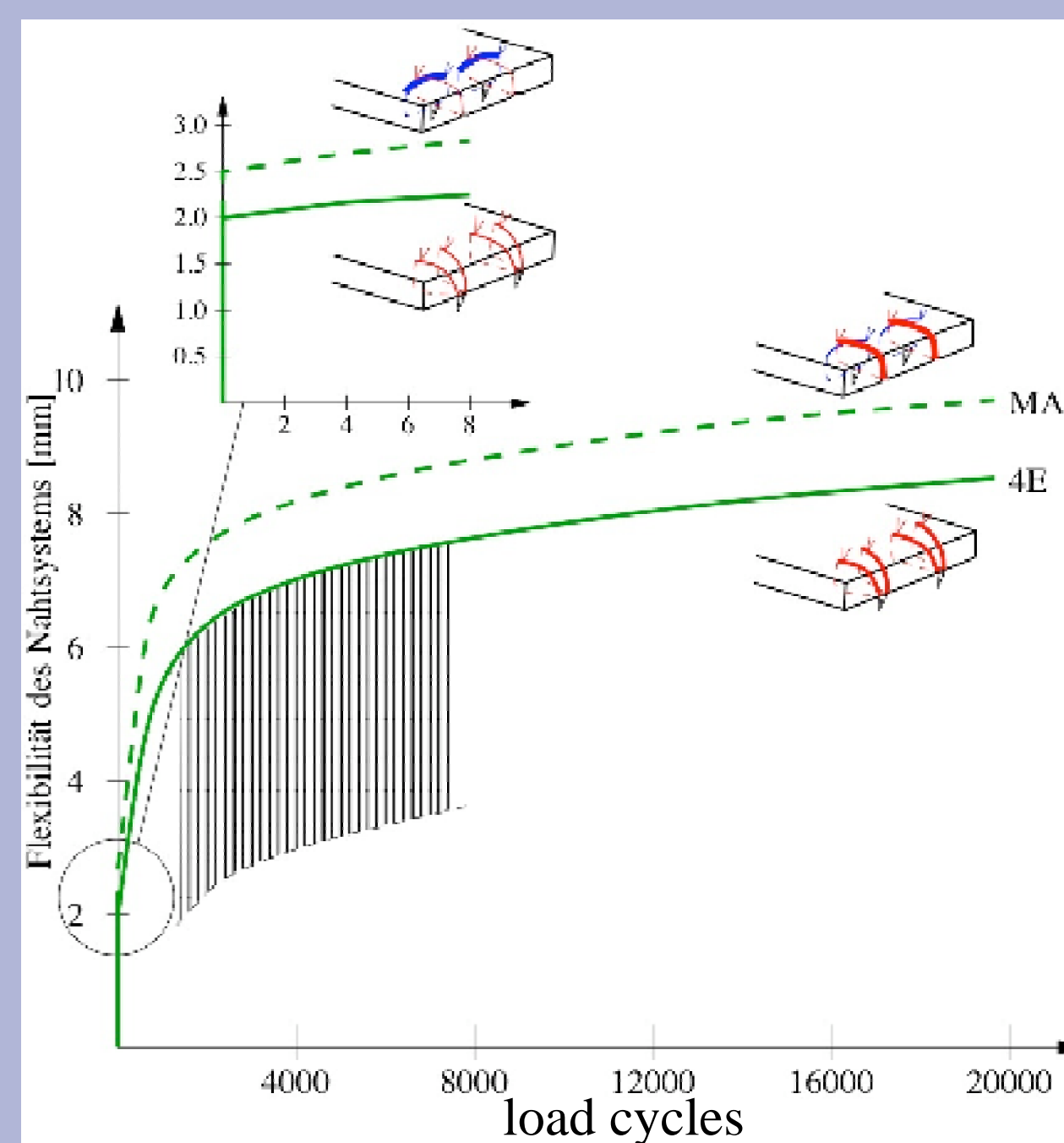
Typical results showing the response to the first few cycle and an overview for the most stable suture technique (ST2) compared to the ST4 ("mattress" suture). The deformations at 180 N are shown by the connecting lines. An overview is given by the table below: number of tests and mean (SEM) cycle number necessary for gap formation of 5 mm.



	ST1		ST2		ST3		ST4	
	n	gap	n	gap	n	gap	n	gap
bone-tendon	9	1098 (117)	5	2047 (352)	5	536 (167)	8	1114 (152)
metal plate	5	1067 (185)	5	2570 (837)	10	310 (75)	5	944 (374)
together	14	1086 (96)	10	2309 (437)	15	386 (77)	13	1048 (164)



Number of load cycles necessary to achieve a gap formation of 3, 4, and 5 mm. The ST3 (Mason Allen) was the weakest, the ST2 (double row) the most stable suture. The ST3 with the transosseous method gives: 2150 (1115) load cycles to form a gap of 5 mm



The stability of sutures applied in parallel (ST1, red loops) to tendon fibers equals that made across fibers (ST4, blue loops), both being superior to the "Mason Allen" technique (ST3, combined).

The lower part shows the response to load cycling as fitted by an exponential function.

Conclusions

In other studies [2,3] a crescent-shaped defect and one anchor-suture system for surgical repair was used. This experimental procedure may be more close to surgical practice with only partial loss of attachment of tendon to bone. However, the interpretation of results may be more difficult. The load applied splits into contributions borne by the naturally attached section of the tendon and by the reattached section by the anchor-suture system. The proportions of the load contributions remain unknown.

In our study we dissected free the complete tendon (2 cm width). Thus load is borne completely by the anchor-suture system, which consisted in the present study of 2 anchors (ST1, ST3, and ST4) or 3 anchors (ST2). Performing the pre-tests to single out the compliance of the suture-anchor system only the present data are the basis for a comparison of the different techniques irrespective of the individual biomechanical quality of the used bone-tendon complexes.