The Deadman Theory Is Alive and Well

To the Editor:

I think it is essential that I respond to the study by Clevenger et al.,[1] which is the second in a series of articles authored by largely the same investigators[2] that attempt to discredit or disprove the deadman theory of suture anchors, a concept that I introduced in 1995 in an article in *Arthroscopy*.[3] That concept was based on theoretical, yet highly intuitive considerations of trigonometry, classical mechanics, and free body analysis.

There is nothing high-tech about the deadman rationale for inserting suture anchors, in which the anchors are angled away from the direction of the anticipated load. We do the same for the "deadman" of a corner fence post; for a tent peg; or for a nail that is used to hang a picture on a wall. Would we consider reversing the direction of insertion of these common, everyday fixation devices? No—because the fence post would lean; the tent would fall down; and the picture would fall from the wall.

So, how is it that Clevenger et al.[1] were able to conduct a biomechanical study that "proves" (in their minds) the counterintuitive notion that placing a suture anchor in the reverse direction in bone (with an angle that is obtuse relative to the load) is stronger than placing it in the usual deadman direction (with an angle that is acute relative to the load)?

First, one must blow past all the smoke and recognize that biomechanical testing of suture anchors can be misapplied such that non-physiological mechanisms are magnified to cause failure in a way that never would have occurred in an actual surgical patient. Specifically, Clevenger et al.[1] applied their loads to the suture anchors with the eyelets sitting "proud," above the surface of the bone (as shown in Figs 1 and 2 of their article). Apparently, they did not read my letter to the editor in 2009 in which I suggested that the experimental design of their first experiment was not appropriate for proving or disproving the validity of the deadman theory and that "to do so would require intracortical fixation at all angles of insertion, which would have demanded that they use fully threaded suture anchors."[4] This advice was not heeded by Clevenger et al. in this second study, and it has led to erroneous conclusions.

If one watches the video of the biomechanical testing that accompanies the article by Clevenger et al.,[1] it is plain to see that, for the anchor placed at an acute angle with the eyelet above the level of the bone, the eyelet naturally migrates progressively further from the bone surface as toggling occurs and the anchor's position approaches the perpendicular to the surface of the bone. This creates an ever-increasing moment with each load application because the moment arm (the distance of the eyelet from the bone) progressively increases. However, the testing setup does not reproduce what we do clinically. In repairing the rotator cuff, today's surgeons do not leave the eyelet above the level of the bone; they typically use fully threaded anchors in which intracortical fixation is obtained and the eyelet is at or below the level of the bone. So, the Clevenger et al. testing construct is not what surgeons use clinically. To paraphrase a popular television commercial, "That's not the way this works... that's not the way any of this works."

If Clevenger et al.[1] had used fully threaded anchors with intracortical fixation, there would have been no moment arm to create progressive toggling, and I suspect the results would have been entirely different.

The authors correctly point out another shortcoming of their conclusions: specifically that, even though they recommend inserting the anchor at an obtuse angle of 135°, it would be very difficult to achieve that angle for a supraspinatus repair because the acromion would be in the way. So, even if one were to buy into their conclusions, they would have no clinical application.

So, where does that leave us? First, I have not seen any biomechanical data to cause me to change my angle of insertion from the standard acute deadman angle to a reverse obtuse angle. Suture anchors and suture anchor configurations have become more and more sophisticated over the past 20 years so that we now commonly see fully threaded biocomposite anchors used in linked double-row configurations,[5] as well as self-reinforcing load-sharing rip-stop techniques,[6-8] to compensate for poor-quality soft tissues.

I am not sure why someone would spend so much time and effort trying to disprove such an intuitively obvious mechanical concept as the deadman theory. But then I also don't understand why Don Quixote spent so much time casting at windmills.

Stephen S. Burkhart, M.D.
San Antonio, Texas

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Critical Comments and Questions Regarding the Article "Serial Assessment of Weight-Bearing Lower Extremity Alignment Radiographs After Open-Wedge High Tibial Osteotomy"

To the Editor:

It was with great interest that we read the article "Serial assessment of weight-bearing lower extremity alignment radiographs after open-wedge high tibial osteotomy" by Lee et al.[1] in the March 2014 issue of *Arthroscopy*. We have some comments and questions regarding the methods, figures, discussion, and conclusions.

The authors described in the Methods section how they used the TomoFix plate (DePuy Synthes Raynham, MA) and 6.5 mm screws for fixation. First, all figures (Figs 1, 2 and 3 in their article) show different plates. We think that Fig 1 in their article shows a 4.5/5.0 T-plate with nonlocking screws; Figs 2 and 3 in their article show a totally different plate, which is not a TomoFix plate (it has 4 holes in the proximal part and 4 in the distal part, and the shape of the proximal T-part is straight). Second, if one uses the TomoFix plate, using a 6.5 screw would not be possible in holes A through C and holes 3 and 4 (Fig 1). These holes are locking holes for a 5.0 locking screw. The TomoFix plate was developed for a special biplanar surgical open-wedge HTO technique. Why did Lee et al.[1] perform a single-plane technique? Which plates did they use in their study? Different plates? Again, they described the TomoFix for fixation, and in the figures, they showed 2 different plates. Can the authors explain that? They described a

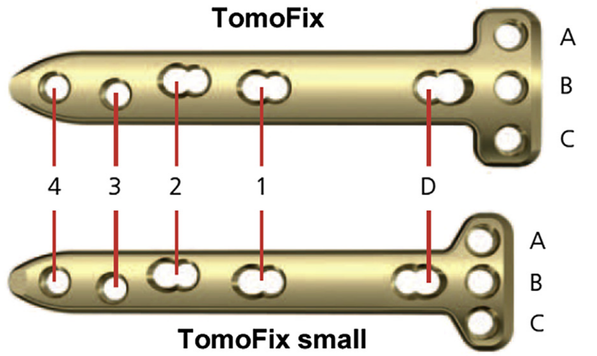

Fig 1. Top, TomoFix plate. Bottom, TomoFix small. Holes A through C and 3 and 4 are for 5.0 locking screws. Holes D, 1, and 2 are locking compression holes for 4.5/5.0.

Fig 2. Anteroposterior-view radiograph of left knee after open-wedge HTO without bone graft in a biplanar technique at 6 months' follow-up.