Letters to the Editor

Can the Deadman Be Killed?

To the Editor:

When I postulated the deadman theory of suture anchors in 1995,1 I had no idea that it would ignite such a firestorm of controversy almost 20 years later. It seemed such an innocent concept. However, for the second time in the past 12 months, I find myself defending this venerable and self-evident concept against a quasiscientific diatribe. First, there was a cyclic loading study by Clevenger et al.2 that used a non-physiological methodology to “disprove” the deadman theory. Fortunately, I had the opportunity to point out the experimental misapplication3 in that study.

Now the deadman theory is under attack again, this time by Green et al.4 in their article “Biomechanical Study: Determining the Optimum Insertion Angle for Screw-In Suture Anchors: Is Deadman’s Angle Correct?” Once again, I feel compelled to explain the folly of these deadman doubters.

For starters, the study by Green et al. illustrates perfectly the principle that complexity is the greatest ally of obfuscation. These investigators placed suture anchors into polyurethane foam at 4 different angles and then loaded them to failure with loads applied at 7 different angles, only one of which was in a physiological direction. After working through the dozens of combinations of anchor angle versus load application angle, they claim that the strongest construct is one in which the load is applied in the most nonphysiological direction of all. Yes, the authors lull us into a brain-dead stupor with data for dozens of nonphysiological configurations and then proclaim that the most non-physiological of all is best.

This article also proves that study design can be manipulated to yield spurious results that only careful analysis can detect. For example, Green et al. obviously did not read my Letter to the Editor in 20095 regarding the study by Strauss et al.6 in which I suggested that “the experimental design by Strauss et al. was not appropriate for proving or disproving the validity of the deadman theory. To do so would require intracortical fixation at all angles of fixation, which would have demanded that they use fully threaded suture anchors.” In this study by Green et al., the anchors that were used were not fully threaded and did not achieve intracortical fixation. In fact the eyelet of the anchor used in this study sits on a post above the anchor body, and the top edge of the anchor body creates a fulcrum against the bone so that an artifact-producing moment is created under load; such a moment would not have been produced in a fully threaded anchor with intracortical fixation, as I had suggested in 2009.

Green et al. seem ambivalent about disagreeing with me. In writing about my formulation of the deadman theory, they state that “the mathematical principles he used are sound but did not take into account micro-movement at the bone-anchor interface.” Therefore, I must ask the authors why my analysis of the deadman theory was wrong if it was based on sound mathematical principles? Also, how does their model of catastrophic single-pull load to failure take into account “micro-movement at the bone-anchor interface”? Do they pretend to implicate micro-movement by a study using macro-failure as an end point? What am I missing here?

If you add in the other problems with this study (the use of polyurethane foam block as a “bone substitute,” the lack of a cyclic loading component to the testing, the failure to account for a constantly changing angle of load as occurs in the real shoulder, and the fact that an anchor could not actually be placed in the proximal humerus at the angle the authors recommend because the acromion is in the way), it takes a major suspension of disbelief to think that Green et al. have killed the deadman!

I rest my case. Long live the deadman!

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References

Author’s Reply

The “Deadman” Concept in Practice: Should We Believe a Mathematical Theory or Accept the Experimental Evidence?

The recent letter by Dr. Burkhart reflects his passion and belief in his deadman theorem,\(^1\) which is commendable. No doubt he agrees that it would be naive of the orthopaedic community to accept his hypotheses without experimentation. Figure 1 is extracted from his original article and is a component of his deadman theory. He defined “theta” as the angle between the deadman’s wire (suture equivalent) and the surface. Burkhart stated that pullout strength increases as angle theta is reduced. The exact opposite was found within the same experimental model in our study; a threaded suture anchor inserted perpendicular to the surface had lower pullout strength as angle theta was reduced. We also found that anchors placed at acute angles relative to the direction of pull, i.e., those closer to the deadman’s angle, failed at lower loads. Our findings were remarkably similar to those of Clevenger et al.,\(^2\) and Strauss et al.,\(^3\) which surely imparts some validation. Whether our experimental constructs are nonphysiological, as Dr. Burkhart highlights, or physiological bears no significance because it was his hypothesis that we were putting to the test not the clinical application. In any case, suture anchors are implanted all over the body, and determining the insertion angle and angle of applied load that gives greatest pullout strength is useful in this wider clinical setting. Burkhart commented that we did not achieve intracortical fixation with a fully threaded anchor and therefore have not disproved his theory. This I think highlights the main flaw in the deadman model when applied to in vitro or in vivo scenarios: It does not account for variables at the anchor-bone interface, such as poor bone quality and anchor design. Because rotator cuff pathologic characteristics increase with age and many different anchor designs are in use, these factors are common and cannot simply be ignored. True intracortical fixation, as Burkhart demands, may not be achievable in osteoporotic proximal humeral metaphyseal bone. This was the rationale behind our use of polyurethane foam blocks—to provide a constant medium that more closely represents metaphyseal cancellous bone. Polyurethane foam is widely used as a model for pullout testing and is specified as the material to use by the American Society for Testing and Materials (ASTM F1839 - 08[2012]: Standard Specification for Rigid Polyurethane Foam for Use as a Standard Material for Testing Orthopaedic Devices and

Fig 1. Extract from Burkhart’s original article on the deadman theory. Reprinted with permission.\(^1\)