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Editorial commentary: The acrid bioscrew in anterior cruciate ligament reconstruction of the knee

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EDITORIAL COMMENTARY: THE ACRID BIOSCREW IN ACL RECONSTRCUTION

ABSTRACT
Bioresorbable screws have been widely adopted for graft fixation in ACL reconstruction on the promise of screw resorbtion and replacement by bone. When considering the value of bioresorbable screws it is imperative to understand that the 'A' in PGA and PLA, the base ingredient of all bio screws, is for ***Acid***. All resorb by a process of hydrolysis, the speed and extent of resorbtion is determined by both the acidity of the screw and the environment in which it is placed. Regrettably, the promise of reliable, predictable screw resorbtion and replacement by bone remains elusive, despite the addition of 'osteoconductive' materials. For the most part bioresorbables are associated with good clinical outcomes for ACL reconstruction, they are not 'dangerous', just disappointing with respect to bony replacement. We propose that non-resorbing inert plastics such as PEEK may be better suited for the purpose of graft fixation devices for ACL reconstruction.

I read with interest the article "Radiographic tibial tunnel assessment after anterior cruciate ligament reconstruction using hamstring tendon autografts and bio composite screws: a prospective study with five-year follow-up" by Dr Karikis, Ejerhed, Sernert, Rostgård-Christensen, and Kartus[1]. The authors examined the radiological appearance of tibial tunnels 5 years after ACL reconstruction with a bio composite screw, and concluded that no tunnel widening had occurred over time.

This leads me to opine regarding the value of 'bio composite', 'osteoconductive' and 'resorbable' materials for fixation in current ACL reconstruction techniques and ligament repair to bone. Why do we have these Bio screws?

The advantages and disadvantages of metal screws are well described and understood by surgeons. 'Bio screws' were designed with the goal of creating a screw that is radiologically friendly, able to provide strong fixation until the graft incorporates, and then fully undergo resorbtion to be replaced by bone. Although most studies have shown that 'bio screws' are associated with good clinical outcomes, which may be equivalent to metal screws [2-12], there is also evidence that these screws are not readily absorbed by the body, nor replaced with bone[13-17]. The literature is scattered with reported complications and adverse events, including cyst formation, sterile abscess formation, inflammatory reaction, breakage, intra-articular migration, transcutaneous migration, tunnel widening and osteolysis[9 18-20]. One of the early 'osteoconductive bio screws' was recalled from the market by the manufacturer after unpredicted inflammatory reactions in the first year after implantation, which gave the then editors of Arthroscopy Journal cause to consider "we don't know as much biology as we thought"[21].

It is far more enlightening to examine the chemistry of PGA and PLA based bio screws than biology. It is imperative to understand that the 'A' in PGA and PLA, the base ingredient of all bio screws, is for ***Acid***. These are solid acids that resorb by 'hydrolysis', i.e. dissolve in water forming liquid acid. In areas of good blood supply the acid is well buffered and then metabolised (such as resorbable sutures). However, in areas of poor blood supply such as bone, the pH can be so low that acidic tissue damage occurs, resulting in bone destruction. For this reason, and because of it, manufacturers have added buffers to increase pH, as well as osteoconductive materials such as

Hydroxyapatite and Tricalcium Phosphate to stimulate bone formation. Despite various screw formulations, bone formation is only observed late in the reabsorption process, and only then in bio screws with a composition that are slowly resorbed in excess of 5 years[17 22].

The composition of ingredients, size of the acidic crystals, and method of manufacture (annealing the surface slows hydrolysis) will determine how the material will behave in a given location. Thus, not all 'bio screws' are equal, nor behave in the same way.

Tunnel widening was not found by Dr Karikis, Ejerhed, Sernert, Rostgård-Christensen, and Kartus with a PLDHA, tricalcium phosphate composite screw[1], but has certainly been reported in other series[9 10]. MRI and CT was not available in this study so the extent of ossification or screw degradation could not be determined. Furthermore, the study examined only the tibial tunnel, and we should remember that a screw made of the same material may behave differently in the femoral tunnel[22]. Surgeons should consider each screw on their own merits. To my mind, tunnel widening may not occur as seen in the study by Dr Karikis, but if the screw is also still present after 5 years, this may be a moot point to the surgeon.

It is worthwhile re-examining the reasoning for bio screws.

- Easier revision, no need to remove an osteointegrated titanium device.
- The implied promise of bone tunnel reformation.

In my experience the majority of revision ACL surgery occurs within the first 5 years[23-25]. In bioscrew fixation cases, the surgeon does not encounter healthy bone, rather a partially decomposed bio screw in soft bone, which is definitely not an advantage in revision surgery.

The material properties of 'bio screws' may change and evolve subtly, but for the most part resorption of 'bio screws' is, at best, unreliable and replacement by bone is rare. As the promise of reliable screw resorption and bone formation remains elusive with 'bio screws', my personal preference is now to use a non-resorbing inert plastic interference screw for fixation of ACL grafts. This offers the same advantages as a resorbable bioscrew, but without the risk of unpredictable biologic reactions, and easier revision surgery.

The goal of bio screws was lofty, the animal science was encouraging, the manufacturers were heralding the 'age of biologics', and we adopted bio screws with gusto, myself included. Sadly, the experience has disappointed. Perhaps simpler designs such as a non-reactive plastic such as PEEK is a better base for screw production.

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