[Guest Editorial]

Isn't It Time to Stop Pretending Ligament Reconstructions Are "Anatomic"?

Historically, the closer knee ligament reconstructions resembled natural ligamentous anatomy, the better results were - but perhaps this positive effect has peaked. Many techniques, often considered state of the art, claiming to be "anatomic" are actually far from it. The term "anatomic" can be unconsciously, or consciously, used to imply the techniques concerned are "superior" to other methods, thus making the surgeon using them feel more worthy by doing the "right thing." In an effort to continually improve my surgical techniques and outcomes, I have been fortunate to work with Professor Andrew Amis in his laboratory at Imperial College, London studying knee biomechanics. In addition, I have followed many elite athletes, who put unbelievable stresses on their surgically repaired knees in their efforts to return to play at the highest levels. These elite athletes are very valuable to study: they test surgical techniques much more than the general population and so differentiate surgery options clearly defining what works and what doesn't!

With a clinical practice of nearly 30 years, caring for elite/professional athletes as my predominant patient group for 26 years, and, through clinical and basic science research, I have learned how a different philosophy - biomechanically favorable over "anatomic" techniques - may be best.

"ANATOMIC" IS NOT ALWAYS BEST

Example 1—Anterior Cruciate Ligament Reconstruction Femoral Tunnel Position

The anterior cruciate ligament (ACL) is considered to have 2 functional bundles: anteromedial (AM) and posterolateral (PL). Traditionally, ACL reconstruction placed the femoral tunnel in the AM bundle position, as this resulted in a fairly isometric graft. In an effort to improve patient outcomes, the double bundle technique was created, using 2 grafts - one each to reproduce the AM and PL bundles of the ACL. When it was realized that there was no real clinical advantage from adding the second bundle, the enthusiasts for the concept then returned to a single-bundle technique but moved their femoral tunnels to the center of the ACL "footprint" on the femur, between the AM and PL bundle insertions. Unfortunately, instead of the technique being described as "central" bundle position, it was dubbed the "anatomic" ACL reconstruction - even more confusing as the previous AM bundle reconstruction technique is also anatomic! Although placing an ACL graft in the center of the femoral "footprint" looks logical at first glance, subsequent research has shown that most of the resistance to anterior tibial translation (up to 85%) occurs from fibers attaching in the AM bundle region of the ACL "footprint."[12,17]

After some time, having been convinced to do so by some well-known friends who were proponents of the "anatomic" technique, I moved my femoral tunnel to the central footprint position. . . with disastrous results. In my professional soccer players, the ACL graft rerupture rate rose unacceptably. For cases without a lateral extra-articular tenodesis (LET) with a graft in the AM bundle position, patellar tendon grafts had 7.5% rerupture and hamstrings 10%. Those in the "anatomic position" had rates of 10.5% and 18.5%, respectively.[1] As a result, I moved my femoral tunnel back to the AM bundle position!

Example 2—Posterolateral Corner Reconstructions

Posterolateral corner (PLC) reconstructions can never be truly anatomic as the dynamic tensioning from popliteus muscle cannot be recreated with static grafts. Also, "anatomic" techniques often place grafts to appear rather like the native anatomy hoping they can reproduce natural biomechanics. For example, some authors claim a graft joining the fibular head and posterolateral tibia (as part of a complex technique) functions as a popliteofibular ligament, thereby improves control of tibial external rotation (ER). In reality, this limb of graft can only act as the posterior superior tibiofibular ligament and stabilize the tibiofibular joint.[14] In addition, in the same "anatomic" technique, the dynamic popliteus muscle/tendon unit is replaced by a static tendon graft. How is this "anatomic?" Increasingly, studies have shown no clinical or biomechanical advantage of this "anatomic" technique compared with much

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The following author declared potential conflicts of interest: K.B. serves as a speaker for Xiros Inc and J&J, is a paid consultant for Mitek, Xiros Inc, and Conmed, and has received stock from Native Orthopaedics and Skye Biologics.

DOI: 10.1177/19417381251381821

simpler fibular based reconstructions (so long as the superior tibiofibular joint is stable).[3] Using a modified Larson technique, I have found 88% return to professional sport (70% at the same or higher level) in the setting of multiligament knee injuries that require PLC reconstruction.[7,18] Furthermore, "nonanatomic" fibular head based techniques better control tibial ER, because of the longer lever arm to control axial rotation that ends in the fibular head rather than the more medial tibia.

Example 3—Medial Collateral Ligament Reconstruction

A commonly used contemporary medial collateral ligament (MCL) reconstruction technique that claims to be "anatomic" has now been shown in multiple studies not to be effective in restoring either coronal or rotational stability.[6,19]

Recent anatomical and biomechanical work from Imperial College, London raises important points: current popularized views of MCL anatomy may not be correct, e.g., the superficial MCL (sMCL) is attached to the central medial epicondyle and not posterior to it, and that the understanding of the role of the components of the MCL is inaccurate, e.g., the most important medial restraint to ER in the range 0° to 30° is the deep MCL (dMCL) and not the sMCL as commonly thought. Contemporary "anatomic" MCL reconstruction techniques frequently include a limb for the posterior oblique ligament (POL), even though the POL is rarely injured in the setting of an ACL plus MCL injury, and ignore the dMCL component completely.[2] Our laboratory testing shows that, although the grafts in such techniques may control valgus near extension, they do not control ER.[15,16] A short isometric construct reconstruction technique that does not claim to be anatomic is better than an "anatomic" procedure in controlling ER throughout full knee range of motion.[20]

Example 4—Anterolateral Reconstruction

The arguments above reflect that "anatomic" procedures do not mimic real anatomy and these techniques are "pseudo-anatomic" at best. An anatomic compromise producing more "true" biomechanical function is often best. Another good example is a lateral extra-articular tenodesis (LET). Studies from our laboratory showed LET to be effective,[11] and able to be performed without deleterious effects from "overconstraint."[10] Also, there is now clinical outcomes proof that LET is effective in reducing ACL graft rerupture rates.[9] In a study of 232 professional footballers, the addition of an LET reduced rerupture rates. A combination of a patellar tendon graft, placed in the AM bundle position on the femur with a LET had only 2% graft rerupture rate.[1] Furthermore, in a study of 455 elite/professional athletes, the ACL graft rerupture rate was 3.4% for those with a LET and 9.5% for those without.[8]

A LET is certainly not "anatomic" as the iliotibial band graft is taken deep to the LCL. But it is effective! How can this paradox be explained? The main restraint to internal rotation in angles >0° is the deep capsulo-osseous layer of the ilio-tibial band (ITB), which is curvilinear, passing proximally from Gerdy's tubercle on the tibia to the femur just proximal to the lateral condyle via Kaplan's fibers.[13] Since the LET graft is a linear strip of ITB, it can only mimic the deep capsular-osseous layer by being taken deep to the LCL. Indeed, not doing this, and passing the graft superficial to the LCL, makes the operation ineffective and potentially harmful.[11]

Can a Reconstruction *Become* the Native Ligament?

Another fundamental issue to consider is how reconstructions function. Many surgeons place and fix grafts hoping for them to function as the original ligamentous structures would. There is no attempt to restore native anatomy, be it acutely injured or chronic deficiency. In ACL deficiency, arguably the only option is to place a graft hoping for it to function as a native ACL (albeit not normally so). However, for the collateral ligament complexes, successful repair offers the possibility of restoring proprioception as well as normal ligamentous restraint to translation and rotation, versus reconstruction, which can only work as a restraint to load. Therefore, philosophically, we always do our best to restore anatomy with suture repairs, then add a reconstruction simply to protect the restored anatomy until it has healed. In the context of the MCL complex, in acute cases needing surgery, all injured MCL components are repaired before adding a short isometric construct MCL reconstruction.[5] In the chronic setting, a layer by layer exposure allows retensioning of the lax structures with sutures before adding a protective reconstruction.[4]

Therefore, we would humbly and respectively suggest:

(1) Anatomic compromise in properly biomechanically evaluated techniques may be preferable to "anatomic" techniques (that are not truly anatomic and not biomechanically sound).
(2) It is time to stop using the misleading term "anatomic" to describe surgical techniques, as most are "pseudo-anatomic."
(3) Good science wins! "Road-testing" in the laboratory to fine-tune procedures that are then followed up in clinical studies is the way to go.

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