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EDITORIAL

New trends in ACL research

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ACL research has driven ACL surgery and, through extensive work over the past 10 years, clearly established "anatomic ACL reconstruction". At the recent Panther Global Summit (Pittsburgh, PA, USA, August 25–27, 2011), 24/28 (85%) experts utilized anatomic techniques for ACL reconstruction. In contrast, 70% of a global expert panel in the year 2000 preferred the transtibial technique for ACL reconstruction [8].

While the past 10 years in ACL research were dedicated to the rediscovery of double-bundle ACL reconstruction, the more recent past research is dedicated to identifying criteria for anatomic single bundle versus anatomic double-bundle ACL reconstruction. An important part of the rediscovery is the treatment algorithm for anatomic ACL reconstruction by Fu et al. [14]. The most commonly listed indications for double-bundle ACL reconstructions are (1) large insertion sites (>18 mm tibial ACL anteroposterior diameter), (2) wide notch width (>12 mm), (3) high-grade pivot shift, and (4) revision ACL reconstruction. There are established contraindications for double-bundle ACL reconstruction, such as (1) multi-ligament injuries, (2) open physes, (3) degenerative OA, (4) small insertion sites (<12 mm tibial anterior–posterior diameter), and (5) small notch width (<12 mm). It is noteworthy that there are no contraindications for anatomic ACL reconstruction.

A considerable amount of research is being done in the field of ACL remnant preservation. In contrast to the 1990s, when non-anatomic guides were most commonly used for tunnel placement, it is now widely recognized that anatomic ACL reconstruction demands adequate identification of anatomical landmarks, such as the femoral ridges and the footprints on the tibia and femur, respectively [6, 15]. Preservation of the native ACL remnants is furthermore shown to enhance biomechanical knee stability [11], as well as provides mechanoreceptors that potentially improve proprioceptive function following ACL reconstruction [1]. At the recent Panther Global Summit, 20/28 (68%) experts preserve remnants during ACL reconstruction surgery.

Musculoskeletal imaging has improved in many ways. MRI is not only used for diagnosis and pre-operative planning purposes, but it can be used post-operatively for the assessment of ACL graft healing and development of osteoarthritis. MRI can also assist in accurately identifying ACL injury patterns [2, 13]. The utilization of post-operative radiographs is still the most common modality to assess adequate tunnel placement. However, 3-D CT is superior to radiographs and more clearly reflects the intra-operative perspective of the arthroscopic surgeon. 3-D CT provides a critical assessment of accurate tunnel placement [7, 10].

There is, and has been, much hype about biological enhancements for ACL healing and/or reconstruction. However, hardly any treatments have made a clinical impact beyond in vitro- and animal research. One of the few approved treatments is growth factor therapy in the form of autologous fibrin clots or platelet-rich plasma (PRP). A fibrin clot between the two grafts for double-

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bundle ACL reconstruction can enhance healing in a large animal model [9]. PRP was shown to enhance ACL cell viability and function in vitro [5]. Even "ACL healing" and primary repair of the injured ACL are being explored. Recent research has employed PRP combined with collagen to modulate growth factor release from platelets to stimulate ACL healing [16].

Female ACL research is still evolving. We know that the risk of an ACL injury is up to 10 times higher in women compared to men. We know there are risk factors, such as anatomic factors (e.g., morphology, notch width, lower extremity valgus), hormonal factors, and biomechanical factors (e.g., hamstring weakness, jump-land pattern). Could there be a genetic predisposition for higher ACL injury rates for female athletes? A specific genetic risk factor (CC genotype of BstUI restriction fragment length polymorphism within the COL5A1 gene) was found to be associated with the risk of ACL ruptures in female athletes. [12].

Criteria for returning athletes to sport following ACL reconstruction surgery have not changed; (1) time from injury, (2) absence of pain/swelling, (3) full ROM, (4) restored ligamentous laxity, (5) quadriceps strength, and (6) one-leg hop test. However, at the recent Panther Global Summit, 70% of the experts consider graft healing in making return to play decisions. From the literature of early graft failure following allograft ACL reconstruction, we have learnt that time from surgery may be the most important factor. In the future, MRI may provide valuable information on healing graft tissue.

Does ACL injury inevitably result in osteoarthritis? New research strategies are investigating this question, involving MRI, functional joint assessment with dynamic stereo radiography (DSX), and joint fluid marker analysis. Utilizing DSX, it is demonstrated that knee joint kinematics of the ACL reconstructed knee are significantly different from those of uninjured controls during functional tasks of single-legged hop landing. This may in turn contribute to long-term joint degeneration [4]. The 2010 AOSSM/NIH u-13 post-joint injury osteoarthritis conference concluded that there is a strong consensus for approaching the development of disease-modifying treatments for osteoarthritis through study of "pre-osteoarthritic" cohorts [3].

In summary, we are now more anatomic than ever, which includes the study, preservation, and reconstruction of ACL footprint anatomy. "Dare" to use advanced postoperative imaging to enhance your own ACL reconstruction technique and ultimately improve patient outcome. Biological treatments are still evolving, yet a simple and cheap fibrin clot may deliver desired growth factors to healing sites. We expect lots of new data from studies that investigate bony morphology as well as genetic predisposition, and its influence on the prevalence of instability and ACL injury. We also need to better understand what happens after the ACL reconstruction, the patient-related outcomes are vital. And we must always remember that the patient is the one who can best judge the functional status of the knee. It is also of great importance to be able to better evaluate the surgical techniques that are used today. Standardized techniques (scoring systems) that can assess and compare different surgical techniques are evolving.

The ultimate goal of ACL reconstruction surgery is to prevent the development of osteoarthritis. This may involve measures, such as anatomic surgery, possibly disease-modifying treatments, and longer time to return to play following ACL reconstruction surgery to allow for adequate healing of the reconstructed ACL.

Conflict of interest The authors declare that they have no conflict of interest.

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