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## Author's Reply

Thank you for the opportunity to respond to this letter. We appreciate and are sensitive to the concerns of the patient expressed in her letter. We also share her interest in avoiding the complication described in our case report in the future. We apologize that we mischaracterized her outcome to note that "she had returned to full activities" and appreciate that she has taken the time and effort to point that out. In fact, we have recently initiated a formal evaluation of functional and strength testing after ACL reconstruction at our university, and this patient showed major quadriceps deficits when she was tested (after the article was published). Interestingly, the majority of patients we have tested so far have also shown quadriceps deficits, and we are becoming increasingly aware that this should be an area of increased focus in rehabilitation after ACL reconstruction. This patient's rehabilitation has been slowed by delayed union necessitating prolonged weight-bearing precautions and pain, but she continues to work on quadriceps strengthening, and it is our sincere hope that she will indeed return to full activities in the near future.

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## Graft Size Affects Graft Tension

To the Editor:

The recent review by Kirwan et al.<sup>1</sup> entitled "Initial graft tension and the effect on postoperative patient functional outcomes in anterior cruciate ligament

reconstruction" has drawn our attention. First, we would like to compliment the authors on systematically assessing the literature to determine whether a particular initial graft tension results in a superior functional outcome of the knee after anterior cruciate ligament reconstruction (ACLR). Although initial graft tension has been proved to significantly contribute to the optimal functional outcome, there is a great variability in the amount of tension applied by surgeons during ACLR.<sup>1</sup> That is why we very much appreciate the investigation and interest of Kirwan et al. in assessing the optimal initial graft tension applied during ACLR.

A high initial tension of the graft may result in limited knee motion, tissue damage, and graft failure, whereas a lack of tension may lead to instability.<sup>1</sup> Other important factors influencing clinical outcome after ACLR described by Kirwan et al.<sup>1</sup> are graft choice, fixation technique, tunnel motion and placement, graft biologics, and postoperative rehabilitation. Unfortunately, they did not search for the effect of graft size on the optimal initial graft tension.

In ACLR, especially when using hamstring tendons, large variations in the diameters of harvested ACL grafts are measured. We are unaware of any human, animal, or cadaveric trials that have evaluated the influence of graft diameter on the optimal initial tension and physical outcome after ACLR. A computer-based experiment indicated that even small changes in graft size resulted in large variation in joint stability of the knee and soft-tissue stresses.<sup>2</sup> Whether this impact of graft size affects clinical outcome is unknown. Hooke's law ( $F = kx$ ) calculates the force ( $F$ ) needed to stretch a structure by some distance ( $x$ ), which is affected by a structure-dependent constant factor ( $k$ ). This constant factor is directly proportional to the cross-sectional area of a structure.<sup>3</sup> According to this law, a 6-mm-thick graft requires a different amount of traction than a 10-mm graft to obtain similar tension of the reconstructed ACL. Therefore we believe that graft size is another factor that is of importance to the outcome of ACLR and that graft diameter should be accounted for when assessing the optimal initial tension applied during graft fixation.

To our surprise, none of the studies included in the systematic review accounted for graft size. Furthermore, we could not find any trials that specifically assessed the impact of graft size on the optimal initial tension. In our opinion, the conclusion of the review by Kirwan et al.<sup>1</sup> of a trend toward an optimal initial graft tension of 78.5 to 90 N could not be drawn without any knowledge of the potential impact of the size of the graft. Therefore more research is required assessing the relation between graft size and initial graft tension and their combined effect on the outcome after ACLR. This will lead to a more optimal tension, which is hypothesized to positively affect

clinical outcome and to further reduce the significant number of ACLR failures.<sup>4</sup>

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### Author's Reply

We would like to acknowledge the important contribution from Sorel and colleagues on this topic and thank them for their interest in our review. As discussed by Sorel et al., the correlation among graft size, graft tension, and patient outcomes has yet to be established in the literature. Indeed, the effect of either graft size or graft tension has received little attention. Our review focused specifically on graft tension and highlighted the lack consensus regarding optimal tension. The little work that has examined the effect of graft size on patient outcomes has conflicting results.

For example, Mariscalco et al.<sup>1</sup> reported that a reduction in graft cross-sectional area resulted in a poorer outcome on the Knee Injury and Osteoarthritis Outcome Score, whereas Kamien et al.<sup>2</sup> reported that graft size did not affect outcomes based on the Tegner score and failure rate after ACLR. However, neither of these studies discussed tension, much like the studies on tensioning fail to discuss graft size.

On the basis of a theoretical model as proposed by Sorel et al., we agree that graft size and tension are likely to be correlated. On the basis of the currently available clinical evidence, it is reasonable to conclude that 78.5 to 90 N may result in less side to side difference in anterior stability. It is vital, however, that further research is conducted in this field to elucidate the relation between graft size and tension and how this affects outcomes after ACLR. We believe our review has taken the first step to establish an argument for optimal tension, although further work on how this tension is achieved and the relation to graft size is required.

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