ESSR Sports Imaging Subcommittee - The interesting Paper 2022 Q4

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Anterior cruciate ligament autograft maturation on sequential postoperative MRI is not correlated with clinical outcome and anterior knee stability

Patricia M. Lutz; Andrea Achtnich; Vincent Schütte; Klaus Woertler; Andreas B. Imhoff; Lukas Willinger. Knee Surg Sports Traumatol Arthrosc. 2022 Oct;30(10):3258-3267.
https://pubmed.ncbi.nlm.nih.gov/34739559/

Background:

After Anterior cruciate ligament (ACL) reconstruction, the transplant undergoes a maturation process. The early ligamentization process causes a decrease of mechanical strength rendering the transplant particularly vulnerable for reinjury during the early postoperative period. Between 3 and 9 months postoperatively, histological findings suggest a high vascularity and cell proliferation process. This is assumed to be the histological correlate for the increasing T2 hyperintense signal of the ACL graft on MRI during the first 6 months after surgery, with a subsequent signal decline. The clinical relevance of a high T2 signal of the graft remained unclear.

Manuscript summary:

In their article in published in the October 2022 issue of the journal "Knee Surgery, Sports Traumatology, Arthroscopy", Lutz PM et al. prospectively examined 17 male patients with ACL reconstruction and 22 male control patients at the time-points 6 weeks and 3, 6, 12 and 24 months after surgery using MR imaging, clinical examination including laxity measurements and clinical outcome scores (IKDC, Lysholm, Tegner activity scale). The MR signal on sagittal intermediate weighted was evaluated by the use of two ratios: quantitative MR signal intensity of the ACL devided by (i) quantitative MR signal intensity of the posterior cruciate ligament (PCL) or devided by (ii) quantitative MR signal intensity of skeletal muscle. For the quantitative measurements, ROIs were placed on (i) the proximal, (ii) the middle and (iii) the distal ACL. The authors found the lowest ACL graft signal intensity at the 6 weeks time-point. The signal subsequently increased to the highest values at the 6 months time-point, representing the ligamentization process. In the following months the ACL signal decreased to values comparable to native ACL values. The ACL graft signal did not correlate with clinical outcomes. Only lower mid ACL signal at 1 and 2 years was associated with return to preinjury sports level.

Plus:

- Well structured and presented manuscript with a good study design

- Longitudinal, prospective study with both ACL reconstruction and control group with 5 follow-up time-points over 2 years.
- Combination of MRI, clinical examination and outcome scores
- Standardized MR protocol for all patients at all time-points at one MR scanner.

Limitations:

- Many patients of the ACL reconstruction group and of the control group had concomitant meniscus injuries that were treated; however, the exact number of patients is not provided. the exact concomitant injuries are not reported. No adjustment had been performed.
- No absolute P-values are provided (only <0.05 or <0.001)
- No standard deviations are provided in figure 2
- The orientation of the sagittal plane was not in line witht the ACL. The ACL runs not within a single MR slice. Therefore ROIs may have major partial volume effects.
- No quantitative mapping sequence such as T2 or DTI was used, but only normal TSE sequences. In addition, it seems that fat saturation was applied but is not mentioned. The authors made an effort to provide ratios as quantitative values, however these should only be interpreted with caution. Particularly, because the authors report varying background noise in their images (despite identical sequences in all patients at all time-points)
- Only males were included.
- The figure legend in fig. 3 describes "a more hyper-intense signal compared to the proximal and mid-substance ACL", but actually it is more hypointense.
- The finding that the signal of the ACL mid-substance were significantly lower (hypo-intense) in patients who could return to the preinjury sports level compared to those who did not achieve the same sports level ($p < 0.05$) has to be interpreted with caused, since it is the only correlating parameter and it is hard to imagine that the signal intensity played a role in this context. There is only little information on this parameter and one would need to know more details on this finding. Even the proper P-value is not provided.

Comment:

Although the findings of the study by Lutz PM et al. were described earlier and the actual signal intensity measurements are questionable the study systematically and nicely demonstrates the ligamentization process after ACL reconstruction from 6 weeks post surgery till 2 years after surgery. All radiologists should keep in mind the changing signal intensity to not misinterprete the findings: On proton density/ T2 images, the lowest ACL graft signal is found 6 weeks after surgery, the highest signal is found 6 months after surgery and it subsequently decreases to normal values at 1 and 2 years after surgery. Although it was shown earlier, that the graft is vulnerable during the ligamentization

process (the time period with high ACL graft signal on MRI), the signal intensity does not seem to correlate with clinical knee stability/ findings.