Validation of A Histologic Scoring System for the Examination of Quality of Tendon Graft to Bone Tunnel Healing in ACL Reconstruction: TBTH Score (Tendon-Bone Tunnel Healing) Score

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ABSTRACT INTRODUCTION:

We aimed to develop and validate a histologic scoring system for the assessment of tendon graft to bone tunnel healing in anterior cruciate ligament (ACL) reconstruction.

METHODS:

Tendon Bone Tunnel Healing (TBTH) scoring system, comprised of 5 items, each corresponding to one histologic feature valued semi-quantitatively on either a 5-point (0–4) or 6-point scale (0–5) was developed. Items in TBTH score are listed (Table I). Another 6 histologic features (graft collagen fiber organization, fibrous tissue organization, presence of chondrocyte-like cells, presence of proteoglycan-rich matrix, graft and interface vascularity and graft cellularity) were also graded for better understanding of the mechanism of healing but were not included in the TBTH score (Figure 1).

Validation of TBTH histologic scoring system

The training dataset consisted of 15 blinded histologic slides of an on-going study representing different healing qualities at different time points (week 0, 2, 6 and 12), tunnel locations (juxta-articular region, middle region or exit region) and bone tunnels (femoral tunnel or tibial tunnel). Two observers were trained to familiarize with the usage of the scoring system. An independent dataset consisting of 89 blinded histologic slides were scored for validity and reliability tests. Two expert observers independently scored and their results were compared (inter-rater reliability). One of the observers scored the slides again within 2 weeks in order to assess the intra-rater reliability.

Histological Processing

For histological analysis, the samples were fixed in 4% neutral buffered formalin, decalcified in 9% formic acid and embedded in paraffin. Both the femoral and tibial tunnels were then dissected into 3 blocks of equal length (juxta-articular region, the middle region and the exit region).

Histologic features Score

Graft degeneration
- Severe (≥75% of graft remnant) 0
- Substantial (<75% of graft remnant) 1
- Moderate (<50% of graft remnant) 2
- Slight (<25% of graft remnant) 3
- None (0% of graft remnant) 4

Graft remodeling
- None (0% of graft remnant) 0
- Slight (<25% of graft remnant) 1
- Moderate (<50% of graft remnant) 2
- Substantial (<75% of graft remnant) 3
- Intense (≥75% of graft remnant) 4

% of fibrous tissue
- Empty space between graft remnant and bone front 0
- Massive (≥75% of healing interface) 1
- Substantial (<75% of healing interface) 2
- Moderate (<50% of healing interface) 3
- Slight (<25% of healing interface) 4
- None with 100% direct graft and bone connection (0% of healing interface) 5

Collateral connection
- None (0% of healing interface) 0
- Fair (<25% of healing interface) 1
- Moderate (<50% of healing interface) 2
- High (≥75% of healing interface) 3
- Very high (75% of healing interface) 4

Head-to-head connection
- None (0% of healing interface) 0
- Fair (<10% of healing interface) 1
- Moderate (<25% of healing interface) 2
- High (<50% of healing interface) 2
- Very high (≥50% of healing interface) or complete replacement of tendon graft by bone 3

Table I. The TBTH score for the evaluation of tendon graft to bone tunnel healing in ACL reconstruction.

SUMMARY:

The TBTH score is a reliable and valid measure for evaluating the histologic outcome of tendon graft to bone tunnel healing in ACL reconstruction.

DISCUSSION:

TBTH score is a reliable and valid measure for evaluating the histologic outcome of tendon graft to bone tunnel healing in ACL reconstruction.

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