Does angiogenesis after arthroscopic superior capsule reconstruction result from graft healing or pain-related inflammation? A longitudinal study using Power Doppler sonography

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INTRODUCTION:

Arthroscopic superior capsule reconstruction (SCR) using a fascia lata autograft has been developed as a joint-preserving surgery for patients with irreparable rotator cuff tears. Previous studies have reported that graft healing is essential for achieving favorable postoperative clinical outcomes. Additionally, a few studies have reported that angiogenesis has been observed in the graft after SCR. However, it remains unclear 1) when and where angiogenesis occurs after SCR and 2) whether angiogenesis after arthroscopic SCR results from graft healing or pain-related inflammation. This study therefore aimed to investigate serial changes in angiogenesis and blood flow volume after SCR, and to evaluate whether there is any association between angiogenesis and pain-related clinical outcomes.

METHODS:

We prospectively studied 28 patients who underwent SCR using a fascia lata autograft with an intermuscular septum between 2021 and 2023. Two of 28 patients developed post-operative graft tears until 1-year follow-up and were therefore excluded from this study. Consequently, 26 patients (13 men and 13 women; mean age: 67.0 years) with irreparable rotator cuff tears were included in this study. All patients underwent Power Doppler sonography at 6 weeks and at 3, 6, and 12 months postoperatively (Figure 1). Power Doppler sonography was used to examine three regions: the periphery of the bursal-side graft, the graft itself on the greater tuberosity, and the graft on the humeral head. The presence or absence of angiogenesis in each region was evaluated throughout the graft within the delineated area. The blood flow volume in each region was evaluated on a 1 cm posterior long-axis view to the bicipital groove using the Fealy's scoring system (0: absence; 1: presence of a few scattered vessels; 2: thin [<2 mm in width] and long segments [>5 mm] of vessels that were not engorged; 3: presence of larger vessels in continuity or the presence of a frank blush). Shoulder pain was assessed using the visual analog scale (VAS) score at the same time points. Additionally, the Neer's and Hawkins' impingement tests were performed at 6 and 12 months postoperatively. For statistical analyses, the McNemar test and Wilcoxon rank-sum test with Holm adjustment were used to examine serial changes in the rates of angiogenesis and blood flow score. The Spearman's rank correlation was used to examine the correlation between blood flow and VAS scores. The Fisher's exact test was used to examine the correlation between the rate of angiogenesis and the positive rates of the Neer's or Hawkins' impingement tests.

RESULTS:

Angiogenesis in the periphery of the bursal-side graft was observed in 92% of the patients, and the highest blood flow score was noted at six weeks postoperatively. The rate of patients with angiogenesis and blood flow score in the periphery of the bursal-side graft significantly decreased at 12 months postoperatively (both $P < 0.05$). Regarding the graft itself, the rate of patients with angiogenesis on the greater tuberosity and humeral head significantly increased at three months postoperatively ($P = 0.011$ and 0.035, respectively), and was maintained at 12 months postoperatively. In contrast, the blood flow score in the graft on both the greater tuberosity and humeral head peaked at six months postoperatively (Tables 1 and 2).

VAS scores and positive rates of the Neer's and Hawkin's impingement tests are shown in Table 3. No statistically significant correlations were noted between blood flow and VAS scores (periphery of the bursal-side graft: $\rho = -0.26$ to 0.09, $P = 0.20$-0.70; graft on the greater tuberosity: $\rho = -0.28$ to -0.004, $P = 0.16$-0.99; graft on the humeral head: $\rho = -0.08$ to -0.003, $P = 0.69$-0.99) at any time point or region. Similarly, no statistically significant correlations were noted between the rate of patients with angiogenesis and positive rates of the Neer's and Hawkins's impingement tests ($P = 0.24$-1.0) at 6 and 12 months postoperatively.

DISCUSSION AND CONCLUSION:

Angiogenesis initially occurred in the periphery of the bursal-side graft and then progressed into the graft after SCR. Blood flow volume in the graft were maximal up to 6 months postoperatively, decreasing thereafter. Furthermore, this study revealed that the blood flow did not correlate with shoulder pain nor the results of subacromial impingement tests, suggesting that angiogenesis after SCR resulted from the healing process but not pain-related inflammation.

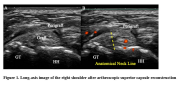

Figure 1. Long axis image of the right shoulder after arthroscopic superior capsule reconstruction

(A) The graft was attached to the GT. (B) Angiogenesis within the graft on the HH.

Periperh, the periphery of the bursal-side graft; GT, greater tuberosity; HH, humeral head.

Table 1. Summary of the patients with angiogenesis

Region	6 weeks	3 months	6 months	12 months
Periphery of the bursal-side graft	24 (92%)	22 (85%)	22 (85%)	11 (42%)*†‡
Graft on the greater tuberosity	12 (46%)	20 (77%)*	22 (85%)*	19 (73%)
Graft on the humeral head	10 (34%)	21 (81%)*	19 (69%)	25 (58%)

Values represent the number of patients and (%).

*Significantly smaller than that at six weeks postoperatively. †Significantly smaller than that at three months postoperatively. ‡ Significantly smaller than that at six months postoperatively. § Significantly larger than that at six weeks postoperatively.

Table 2. Summary of blood flow score

Region	6 weeks	3 months	6 months	12 months
Periphery of the bursal-side graft	1.2 ± 1.0	0.8 ± 1.0	1.0 ± 1.2	0.6 ± 1.1*
Graft on the greater tuberosity	0.3 ± 0.7	0.8 ± 1.2	1.5 ± 1.3*	0.6 ± 0.8†
Graft on the humeral head	0.3 ± 0.9	0.7 ± 0.8	0.9 ± 1.3	0.7 ± 1.1

Values are represented as mean ± standard deviation.

*Significantly smaller than that at six weeks postoperatively. †Significantly larger than that at six weeks postoperatively. ‡Significantly smaller than that at six months postoperatively.

Table 3. VAS score and impingement tests

	6 weeks	3 months	6 months	12 months
VAS score	2.8 (7.1, 0	2.3 (7.1, 0	0 (5.7, 0	0 (7.3, 0
Neer's impingement test	NA	NA	1 (3.8%)	0 (0%)
Hawkins's impingement test	NA	NA	4 (15.3%)	3 (12%)

Values are represented as means ± standard deviation and the number of patients and (%).