Distal biceps tendon rupture operated on with the Boyd-Anderson technique

Follow-up of 9 patients with isokinetic examination after 1 year

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ABSTRACT – We operated on 9 patients for distal biceps tendon rupture using the Boyd-Anderson technique. All patients were re-examined after at least 1 year using a questionnaire, radiographs, motion measurements and isokinetic testing. 2 patients had temporary radial nerve dysfunction and 7 patients had diminished forearm rotation. Elbow flexion strength was reduced by median 13% and supination strength by 19%. We think the Boyd-Anderson technique can be recommended, but slightly reduced strength and forearm rotation must be expected.

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Only 3% of all biceps ruptures affect the distal tendon (Gilcreest and Albi 1939). The typical patient is a 50-year-old man, who injures the dominant arm by an unanticipated large load being applied to the flexed arm (Hegelmaier et al. 1992, Lintner and Fischer 1996). The classical clinical signs include an audible pop and pain in the fossa cubiti, an upper arm deformity, a palpable tendon defect and reduced strength of supination and flexion of the forearm (Dobbie 1941). Nonoperative and surgical treatment options exist (Meherin and Kilgore 1960). Anatomic reinsertion of the tendon into the bicipital tuberosity by a one- or two-incision technique has given better results than other techniques (Baker and Bierwagen 1985, Morrey et al. 1985, Pearl et al. 1998, Karunakar et al. 1999). We assessed the outcome of surgical treatment with the Boyd-Anderson technique.

Patients and methods

From 1992 to 1997, we repaired 9 traumatic distal tendon ruptures of the biceps brachii. We used the two-incision technique described by Boyd and Anderson (1961). Tendon readaptation to its origin was done by a transosseous suture which was tied over two drill holes through the tuberosity. Time from injury to repair was less than 1 week in 8 patients and 4 weeks in 1 patient. Median age was 49 (39–53) years. All patients were men and right-handed. 6 injured their right arm, 3 their left arm. Postoperative immobilization was for 6 weeks (1 patient for 2 weeks) in an above-elbow plaster cast at 90°–110° of flexion and with the forearm in slight supination. This was followed by a rehabilitation program under the supervision of a physical therapist.

All patients were available for follow-up examination after median 16 (13–72) months. They answered a questionnaire, motion was measured, radiographs were taken and muscle strength was tested isokinetically. The questionnaire included pre- and postinjury histories and an evaluation of the outcome by an analog scale (VAS) with a range from 0 (poor) to 10 (excellent) and a three-step scale with the categories of good, medium and bad. Elbow flexion-extension and forearm supination-pronation with the elbow at 90° were measured in both arms with a goniometer.

Isokinetic muscle strength and endurance were tested on a Cybex 6000 dynamometer (Cybex-Lumex Inc., Ronkonkoma, New York). Since the

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Table 1. Outcome in 9 patients with distal biceps tendon rupture operated on with the Boyd-Anderson technique

Patients	Motion deficit (°)				Calcification			VAS
	flexion	extension	supination	pronation	type 1[a]	type 2[b]	type 3[c]	
1	0	–15	–10	–45	yes	no	no	4
2	0	0	–5	0	yes	yes	no	10
3	–5	0	–10	0	yes	no	no	9.5
4	0	0	–15	0	yes	yes	yes	10
5	0	0	–40	–35	yes	no	no	7.5
6	0	0	0	0	yes	yes	no	8.5
7	0	0	0	–75	yes	yes	no	7.5
8	0	0	0	0	no	yes	yes	8.5
9	0	0	–5	–15	no	no	no	9

[a] calcification on radial tuberosity
[b] calcification on biceps muscle
[c] incomplete radio-ulnar synostosis
VAS: visual analog scale (from 0 (poor) to 10 (excellent))

biceps muscle is a strong elbow flexor and forearm supinator, we were especially interested in analyzing and determining these two movement patterns. The patients were given consistent verbal commands and they performed 4 submaximal warm-up repetitions at each angular velocity. First, elbow flexion-extension was tested with the shoulder at 45° abduction. Motion was set from 0° extension to 150° flexion. Secondly, pronation-supination was tested with the elbow at 90° flexion and from 80° of pronation to 80° of supination. The test protocol consisted of 5 repetitions at 60°/sec for strength followed by a 1 minute rest period and 20 repetitions at 180°/sec for endurance. Both arms were tested, the uninvolved side first. Correction for dominance was done according to Gallagher et al. (1997).

Results

Subjective treatment result evaluation by the patients gave a VAS score of 8.5 (4–10). 8 patients classified the outcome as good, 1 patient as medium. No patient had pain at rest, but 6 patients complained about weakness, slight pain at work or reduced motion. 1 patient had to retire from his job as a mechanic.

2 patients had postoperative dysfunction of the deep branch of the radial nerve, with reductions of extension in the MCP joints of all fingers and reduced power for abduction of the first finger. The functions were normal after 2 and 6 months, respectively.

On measurements of motion, we found a slight flexion-extension deficit in 2 patients, but reduced supination in 6 patients (median –5° (–40° to 0°)) and reduced pronation in 4 (median 0° (–75° to 0°)) (Table 1).

Radiographic examination showed heterotopic bone formation on the radial tuberosity around the presumed insertion of the reattached tendon in 7 patients. 5 patients showed ectopic ossification more proximally in the area of the biceps muscle. Finally, we found incomplete radio-ulnar synostosis in 2 patients (Figure). However, there was no

Three typical calcification sites:
1 on radial tuberosity around the presumed tendon insertion.
2 more proximally around the biceps muscle.
3 incomplete radio-ulnar synostosis.

Table 2. Isokinetic measurement of flexion strength and endurance of the elbow

			Flexion			
Patients	Side[a]		Strength[b] (Nm)	Strength[c] (%)	Endurance[d] (Nm)	Endurance[c] (%)
p1	+	r	57/39	39	739 / 293	68
p2	+	r	50/47	13	694 / 692	8
p3	+	r	39/42	0.1	698 / 555	28
p4	+	r	58/72	-17	1140 / 1037	17
p5	–	l	33/19	36	359 / 506	-47
p6	+	r	75/69	15	861 / 1277	-41
p7	+	r	60/60	7.1	755 / 731	11
p8	–	l	56/35	31	1155 / 578	43
p9	–	l	85/79	0.9	921 / 906	–5
Median				13		11
Range				-17– 39		-47–68

[a] Dominant (+) / non-dominant (-), right (r) / left (l) arm injured
[b] Peak torque, 5 repetitions at 60°/sec, uninjured/injured side
[c] Percentage of difference between the extremities. Corrected for dominance. Positive values: uninjured side is stronger than the injured side.
[d] Total work, 20 repetitions at 180°/sec, uninjured/injured side

Table 3. Isokinetic measurement of supination strength and endurance of the elbow

			Supination			
Patients	Side[a]		Strength[b] (Nm)	Strength[c] (%)	Endurance[d] (Nm)	Endurance[c] (%)
p1	+	r	14/8	43	287 / 98	66
p2	+	r	12/12	0	251 / 286	–13
p3	+	r	9/8	12	240 / 164	32
p4	+	r	9/11	-22	245 / 187	24
p5	–	l	8/5	38	161 / 73	55
p6	+	r	11/9	19	282 / 174	39
p7	+	r	14/14	0	274 / 248	10
p8	–	l	11/7	37	239 / 140	42
p9	–	l	15/9	40	244 / 190	23
Median				19		32
Range				-22–43		-13–66

[a] Dominant (+) / non-dominant (-), right (r) / left (l) arm injured
[b] Peak torque, 5 repetitions at 60°/sec, uninjured/injured side
[c] Percentage of difference between the extremities. Positive values: uninjured side is stronger than the injured side.
[d] Total work, 20 repetitions at 180°/sec, uninjured/injured side

connection between size and location of the calcifications and the degree of mobility limitation (Table 1).

Isokinetic measurement after correction for dominance showed a loss of 13% for flexion strength and of 11% for flexion endurance in the operated extremity (Table 2). For supination of the forearm, we found a loss of 19% for strength and of 32% for endurance (Table 3).

Discussion

Isokinetic measurements indicate better outcome after tendon reinsertion in the bicipital tuberosity (Baker and Bierwagen 1985, Morrey et al. 1985, Karunakar et al. 1999). Nonoperative treatment leads to significant loss of flexion and supination strength and endurance (Baker and Bierwagen 1985). Reattachment of the tendon to the brachialis muscle gives poor results, especially for supination strength (Catonné et al. 1995).

Tendon reinsertion in the bicipital tuberosity can be done with different approaches. Both one (Henry 1957) and two incisions have been used (Boyd and Anderson 1961, D'Alessandro et al. 1993, Strauch et al. 1997). Strength and endurance results seem to be equally good with these techniques (5–6% loss of flexion strength, 24–30% loss of flexion endurance, 14–15% loss of supination strength and 7–20% loss of supination endurance) (Baker and Bierwagen 1985, Catonné et al. 1995).

Complications like postoperative radial nerve palsy (Sleebom and Regort 1991, Bak et al. 1992) and motion-limiting soft-tissue calcification (Failla et al. 1990, Karunakar et al. 1999) have led to technical modifications with use of bone anchors (Verhaven et al. 1993, Le Huec et al. 1996) and limited dorsal exposure (Failla et al. 1990, D'Arco et al. 1998).

Comparisons of earlier investigations with one another and with our results are difficult because of a lack of generally accepted standards for follow-up. We found considerable variations in testing procedures used for isokinetic strength measurements in earlier studies. Further, our values for correction of dominance, which are

based on the recent extensive study by Gallagher et al. (1997), are lower than those used by several other investigators (Baker and Bierwagen 1985).

Our findings confirm the view that, in cases of distal biceps rupture, reinsertion of the tendon in the bicipital tuberosity gives better results than other treatment options. We used the Boyd-Anderson technique, using a second dorsal incision to avoid radial nerve damage. Nevertheless, 2 of our patients had dysfunction of the deep branch of the radial nerve. We believe that this complication is caused by compression of the nerve between the Homann retractor and the radius in the dorsal incision. This should be avoidable by taking care that no tissue is interposed between the retractor and bone.

Motion-limiting ectopic ossification may be caused by damage to the proximal portion of the interosseous membrane, hematoma formation between radius and ulna, bone debris in the operation area and stimulation of the ulnar periosteum (Failla et al. 1990). Even by using a limited dorsal exposure, this complication does not seem to be avoidable in all cases (Leighton et al. 1995). 3 of our patients had substantial postoperative motion-limitation (Table 1, patients 1, 5 and 7) and we found three types of calcification. We do not consider the spot-like calcification on the radial tuberosity as pathological, but more as a sign that the tendon has grown into the tuberosity. Proximal radio-ulnar synostosis has been shown to limit supination-pronation and has been treated successfully by resection and fat-graft interposition (Failla et al. 1990, Davison et al. 1996). In our study we found only incomplete radio-ulnar synostosis in 2 patients and none of them had severe motion-limitation.

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