Investigating the single incision anterior transverse approach to the antecubital fossa for distal biceps tendon repair: a cadaver study

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Abstract

Background

The aim of this study was to accurately establish the anatomy of the antecubital fossa in the context of distal biceps tendon repairs and to determine whether the leash of Henry (LoH) can be sacrificed to improve surgical exposure of the radial tuberosity.

Methods

Upper limb cadaveric specimens were dissected, and various measurements were taken to describe the positional anatomy of specific structures in the antecubital fossa. Specimens with previous injury or trauma to the antecubital fossa and gross variations of anatomical structures were excluded. Descriptive statistics were used to describe the data.

Results

A total of 20 specimens were included. The mean ± standard deviation (SD) distance from the elbow crease to the insertion of the distal biceps tendon into the radial tuberosity was 55.6 ± 8.7 mm (95% CI 51.5–59.6 mm). The distance between the elbow crease and the bifurcation of the brachial artery was 29.9 ± 9.3 mm (95% CI 25.5–34.2 mm), while the distance from the crease to the origin of the radial recurrent artery was 34.9 ± 7.9 mm (95% CI 31.2–38.6 mm). The distance from the elbow crease to the distal aspect of the deep venous plexus (LoH) was 47.4 ± 9.9 mm (95% CI 42.7–52.2 mm), with the crease to the cephalic vein anastomosis with the deep venous plexus being 27.2 ± 9.5 mm (95% CI 22.8–31.7 mm). Finally, the anterior interosseous nerve was located 9.9 ± 3.9 mm (95% CI 8.0–11.7 mm) medial to the insertion of the distal biceps tendon, while the median and radial nerves were 10.50 ± 5.2 mm (95% CI 8.07–12.93 mm) medial and 17.65 ± 3.54 mm (95% CI 15.99–19.31 mm) lateral to the insertion, respectively.

Conclusion

This descriptive cadaver study suggests that the distal aspect of the LoH may be sacrificed to increase exposure to the radial tuberosity. The radial nerve should be considered a lateral structure at risk while both the median and anterior interosseous nerves should be considered medial structures at risk during reinsertion of the distal biceps tendon. Additionally, the authors propose that the classical single transverse incision should be distalised when used for distal biceps tendon repair.

Level of evidence: 4

Keywords: antecubital fossa, surgical approach, distal biceps tendon rupture, deep venous plexus, leash of Henry

Introduction

Once thought to be an uncommon injury,[1,2] distal biceps tendon injuries are diagnosed and treated more frequently.[3] This is likely a result of increased activity levels in the middle-aged population with increasing demands being placed on the upper extremities.[4] Based on the superior function regained following surgical repair of a distal biceps tendon rupture, taken together with the known complexity of repair in the chronic setting, acute repair is recommended in most cases.[5,6]

Due to the controversy regarding the best approach and technique for repair, various approaches and repair techniques have been described: i) one-incision modified Henry approach,[4] ii) double-incision technique (initially described by Boyd and Anderson[7], later modified by Morrey et al.[8]), and the iii) one-incision transverse approach (described by Bain et al.[9]).

The single anterior transverse approach is described as a minimally invasive (5 cm) transverse incision made 2 cm distal to the elbow crease.[9] Directly in the plane of dissection lies a deep venous plexus commonly known as the 'leash of Henry' (LoH). These series of veins lie directly anterior to the insertion of the distal biceps tendon into the radial tuberosity and, in the clinical and operative setting, limits adequate surgical exposure.[3,4,10-12]

The aim of this study was to investigate the single transverse incision as a surgical approach in the setting of distal biceps tendon repair, especially with regard to the close proximity of the nerves, vascular structures and the deep venous plexus (LoH) anterior to the radius neck and tuberosity.

Methods

A descriptive cadaveric anatomical study of upper limb specimens was conducted. Institutional ethics committee approval was obtained prior to the commencement of data collection. There were no specific inclusion criteria, and exclusion was limited to previous injury/trauma to the antecubital fossa and gross variations of anatomical structures.

Both saline-preserved and fresh specimens were dissected using the classical single transverse approach as described by Bain et al.[9] Saline-preserved cadavers provided firmer tissue and well-preserved vasculature structures that were readily identifiable, allowing for easier dissection without the need for dye injection. Latex dye was injected into the distal forearm veins of the fresh cadaver specimens in order to facilitate identification of venous structures, and photographs were taken for visual effectiveness. Injecting veins with coloured latex dye proved to be an excellent method to illustrate the LoH with its surrounding vascular structures (*Figure 1*).

Measurements were taken in millimetres (mm), describing the positional anatomy of structures and their relationship to other relevant structures in the antecubital fossa. Measurements in relation to the elbow crease were taken with the elbow in 0° flexion.

Data was analysed using STATISTICA (v13.5, TIBCO Software). Considering the anatomical nature of the measurements taken, all data was normally distributed. Data is described as means ± standard deviations (SDs) with 95% confidence intervals (CI) indicated in parentheses. Categorical data is described as frequencies with the count indicated in parentheses.

Results

A total of 12 cadavers and 21 arm specimens were dissected. Twenty specimens were included. One specimen was excluded due to gross anatomical variation where the bifurcation of the brachial artery was situated in the axilla. Of the included cadavers, five (42%) were known male and one (8%) were known female specimens, with the remainder being unknown (n = 6, 50%).

The mean distance from the elbow crease to the bifurcation of the brachial artery was 29.9 ± 9.3 mm (95% CI 25.5–34.2 mm), with the distance from the crease to the origin of the radial recurrent artery being 34.9 ± 7.9 mm (95% CI 31.2–38.6 mm) (*Table I*). In 75% of the specimens, the origin and initial course of the radial recurrent artery was lateral to the proximal radial artery, with the LoH located medially and the radial tuberosity inferior-medially to the origin. The mean distance from the elbow crease to the distal aspect of the deep venous plexus (LoH) was 47.4 ± 9.9 mm (95% CI 42.7–52.2 mm). The distance from the elbow crease to the insertion of the distal biceps tendon into the radial tuberosity (centre of the footprint) was 55.6 ± 8.7 mm (95% CI 51.5–59.6 mm). Finally, the mean distance from the crease to

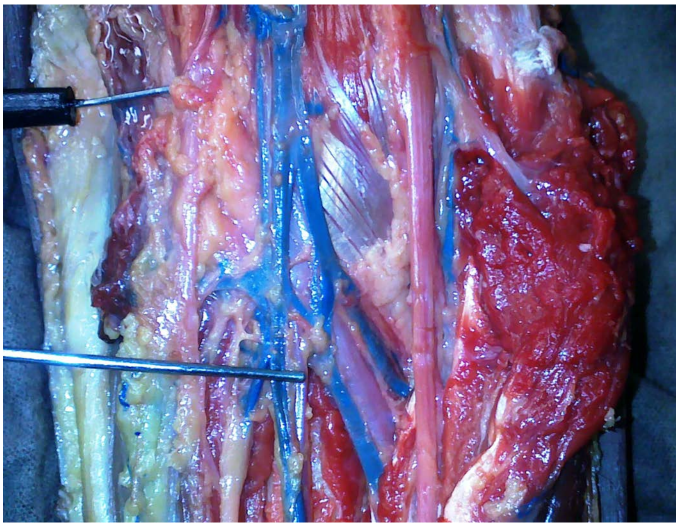

Figure 1. Leash of Henry following latex dye injection

the cephalic vein anastomosis with the deep venous plexus was 27.2 ± 9.5 mm (95% CI 22.8–31.7 mm).

Distances and relationships between the insertion of the distal biceps tendon and the various structures are reported in *Table II*, while other important anatomical relationships and measurements are indicated in *Table III*.

Table I: The anatomical measurement results as measured from the elbow crease to specific landmarks

Measurement from the elbow crease (mm)	Mean ± SD (95% CI) n = 20
Distance to bifurcation of brachial artery	29.9 ± 9.3 (25.5–34.2)
Distance to origin of radial recurrent artery	34.9 ± 7.9 (31.2–38.6)
Distance to distal aspect of deep venous plexus	47.4 ± 9.9 (42.7–52.2)
Distance to insertion of distal biceps tendon into radial tuberosity	55.6 ± 8.7 (51.5–59.6)
Distance to coronoid tip	15.6 ± 5.1 (13.2–17.9)
Distance to cephalic vein anastomosis with deep venous plexus	27.2 ± 9.5 (22.8–31.7)

SD: standard deviation; CI: confidence interval

Table II: Anatomical measurements in relation to distal biceps tendon insertion

Measurement in relation to distal biceps tendon insertion (mm)	Mean ± SD (95% CI) n = 20
Insertion of distal biceps tendon (lateral) to median nerve	10.5 ± 5.2 (8.1–12.9)
Insertion of distal biceps tendon (lateral) to AIN	9.9 ± 3.9 (8.0–11.7)
Insertion of distal biceps tendon (medial) to radial nerve	17.7 ± 3.5 (16.0–19.3)
Insertion of distal biceps tendon (distal) to distal aspect of deep venous plexus	8.5 ± 4.8 (6.2–10.8)
Insertion of distal biceps tendon (distal) to bifurcation of brachial artery	25.4 ± 7.0 (22.1–28.7)
Bare area (distal) to insertion of distal biceps tendon	37.2 ± 7.4 (33.7–40.6)

SD: standard deviation; CI: confidence interval; AIN: anterior interosseous nerve

Table III: Anatomical relationships and measurements of various important upper limb structures

Variable (mm)	Mean ± SD (95% CI) n = 20
Origin of radial recurrent artery (distal) from the bifurcation of brachial artery	5.4 ± 4.1 (3.5–7.3)
Area occupied by deep venous plexus	15.0 ± 6.2 (12.1–17.8)
Median nerve (medial) to deep venous plexus	9.9 ± 3.3 (8.3–11.5)
AIN (medial) to deep venous plexus	9.8 ± 2.9 (8.4–11.3)
Lateral antebrachial cutaneous nerve (lateral) to musculocutaneous junction of distal biceps tendon	6.9 ± 3.3 (5.3–8.4)
Coronoid tip (posterior) to median nerve (mm)	7.9 ± 3.1 (6.4–9.3)

SD: standard deviation; CI: confidence interval; AIN: anterior interosseous nerve

Discussion

Potential injury to the radial nerve during the one-incision anterior Henry approach and possible injury to the lateral antebrachial cutaneous nerve during surgical dissection, as well as when attempting to locate the retracted distal end of the tendon, are well described in the literature.[4,6] Little, however, is described regarding the intraoperative management of the surrounding vascular structures. In practice, it is usually these vessels – in particular the deep venous plexus (LoH) that limits exposure to the radial tuberosity for reattachment of the ruptured tendon. Some authors have advocated that the radial recurrent artery should be addressed by suture ligature, coagulation or retraction and that special attention was to be given to the deep venous plexus without further detail.[13,14] The aim of this study was to accurately establish the anatomy of the antecubital fossa in the context of distal biceps tendon repairs and to determine if the LoH can be sacrificed to improve surgical exposure of the radial tuberosity.

The presence of Henry's leash was a consistent finding around and distal to the bifurcation of the brachial artery, and can be considered its venae comitantes. The superficial and deep venous systems of the hand and forearm frequently anastomosed with each other, which is in agreement with reported literature.[15] This finding was even more evident after injecting blue latex dye into a superficial vein in the forearm distal to the antecubital fossa, and exploring the venous structures by anatomical dissection. Therefore, it is unlikely that ligation of specific veins would result in distal venous congestion, and it can be surmised that the distal aspect of the LoH may be ligated to improve surgical exposure to the radial tuberosity.

Distal to the bifurcation of the brachial artery, the proximal radial and ulnar arteries are in close relation to the insertion of the distal biceps tendon into the radial tuberosity.[13,15] Both structures are, therefore, to be considered 'at risk' during dissection and reinsertion of the tendon, and care should be taken around this location during surgery (*Figure 2*).

The mean distance of the radial recurrent artery from the elbow skin crease was 34.9 mm with its origin 5.4 mm distal to the bifurcation of the brachial artery. In 75% of the specimens, the origin and initial course of the radial recurrent artery was lateral to the proximal radial artery, with the LoH located medially and the radial tuberosity inferomedially to the origin.

The mean distance of the distal biceps tendon insertion was 55.6 mm distal to the elbow crease. Therefore, the origin of the radial recurrent artery is, on average, 20 mm proximal to the distal biceps tendon insertion and likely not a structure at significant risk during surgical exposure.

Figure 2. Close proximity of the bifurcation of the brachial artery, and insertion of the distal biceps tendon (marked by yellow markers)

The mean distance from the elbow crease to the insertion of the distal biceps tendon was 55.6 mm. This observation challenges the literature and especially leads to the scrutinisation of the location of the classic transverse incision originally described to be made 2 cm distal to the elbow skin crease[9] for distal biceps tendon repair. According to the findings of the present study, it is, therefore, a credible suggestion to distalise the incision to 5 cm distal to the elbow crease. Another practical suggestion would be to identify the radial tuberosity intraoperatively with an image intensifier, regardless of the distance between the elbow crease and the distal biceps tendon insertion. This could, however, make the retrieval of the tendon more problematic and may require an additional proximal incision. Even with this caveat, the more distal approach still has better exposure to the anatomy and may be safer.

The anterior interosseous nerve was, on average, 9.9 mm medial to the insertion of the distal biceps tendon, while the median and radial nerves were an average of 10.5 mm medial and 17.7 mm lateral to the insertion. The radial nerve was, on average, 17.7 mm lateral to the insertion. If the literature suggests that the radial nerve is a lateral structure at risk during the one-incision technique,[4,6] then it should also be acknowledged that the anterior interosseous nerve and median nerves are important medial structures at risk.

The safety of sacrificing the distal aspect of the LoH in order to improve surgical exposure of the radial tuberosity cannot be confirmed in a cadaveric study and will require investigation in future clinical studies.

Conclusion

This descriptive cadaver study suggests that the distal aspect of the LoH may be sacrificed to increase exposure to the radial tuberosity. In addition to the radial nerve being a lateral structure at risk, the median and anterior interosseous nerves should be considered medial structures at risk during repair due to their close proximity to the distal biceps tendon insertion. Both the proximal radial and ulnar arteries are possible structures at risk during the approach and reinsertion of the tendon, while the radial recurrent artery is not at risk. The findings challenge the literature regarding the location of the classical single transverse incision, and although retrieval of the ruptured tendon may be more difficult, the authors propose that the incision should be distalised under guidance of intraoperative fluoroscopy for distal biceps tendon repair.

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Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010. Prior to commencement of the study ethical approval was obtained from the following ethical review board: Stellenbosch University Health Research Ethics committee (N11/06/193).

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this study, formal consent was not required.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

JDK: data analysis, first draft preparation, manuscript revisions and final draft preparation

IP: study conceptualisation, data capture, data analysis and final draft review

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