Cutaneous Nerves at Risk During the Posterior Midline Approach to the Elbow

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Received: 13 November 2009 / Accepted: 11 February 2010 / Published online: 4 March 2010
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Abstract The purpose of this study was to investigate the cutaneous nerves at risk during the posterior midline approach to the elbow and proximal ulna. Ten fresh frozen cadaver upper extremities were used for this study. A posterior midline skin incision extending from 10 cm proximal to 15 cm distal to the olecranon tip was created. All superficial nerves were identified and preserved. Nerve diameters were measured, their distance from the olecranon tip assessed, and they were dissected proximally to confirm their nerve of origin. Point of nerve arborization to skin from the midline incision was quantified. An average of one confirmed nerve proximal and five distal to the olecranon tip were identified with an average diameter of 0.9 mm proximal and 1.3 mm distal to the olecranon. The largest nerves were typically located 2 cm proximal (range 7–46 mm) and 45 mm distal (range 9–135 mm) to the olecranon. The branches arborized into the skin an average of 5.2 mm lateral to the incision. All nerves joined the posterior medial antebrachial cutaneous nerve. The branches of the medial antebrachial cutaneous nerve are at risk with a straight posterior midline elbow incision, though the clinical significance of injury to these nerves at this location is unknown.

Keywords Nerves · Midline incision · Elbow

Introduction

The midline posterior elbow incision is commonly used for exposure of the distal humerus, proximal ulna, and elbow joint. It has been suggested that this incision reduces the incidence of injury to the medial antebrachial cutaneous nerve (MABCN) compared to more medially placed incisions [2]. However, there are few anatomic or clinical studies related specifically to the cutaneous nerves crossing the posterior midline incision. We have often clinically noted some fairly substantial appearing cutaneous nerves crossing the operative field with this incision that are usually sacrificed in order to obtain adequate exposure for the surgical procedure. The purpose of our current study was to investigate the cutaneous nerves at risk during the posterior midline approach to the elbow and proximal ulna.

Materials and Methods

Ten fresh frozen cadaver upper extremities were used for this study. None of the cadavers had visible evidence of previous upper arm and forearm trauma or surgical procedures. A posterior midline skin incision extending approximately 15 cm distal and 10 cm proximal to the olecranon tip was created directly in line with the middle of the subcutaneous border of the olecranon and proximal ulna with the elbow flexed 90° and the forearm in neutral rotation (Fig. 1). Dissection was performed under ×3.5 loupe magnification to visualize and preserve all suspected subcutaneous nerves (Figs. 2 and 3). Measurements included the diameters of all identified nerves as well as

Grant support: Cadavers purchased through a grant from the Orthopaedic Scientific Research Foundation (nonprofit)

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Figure 1 Skin incision used in study.

the distances from where each nerve crossed the incision relative to the tip of the olecranon. Each suspected nerve was then dissected proximally to identify its nerve of origin; if no definite nerve origin was found then the ‘suspected’ nerve was not considered to be a true nerve. The nerves were also dissected radial (lateral) to the midline in order to quantify their point of skin arborization from the incision. All measurements were performed with electronic calipers (Mitutoyo, Aurora, IL, USA) and repeated for accuracy.

Figure 2 Dissection preserving all suspected nerves.

Results

Proximal to the olecranon tip, there were an average of three suspected nerves and one confirmed nerve (rounded up or down to nearest whole number) which crossed the midline incision. Only 44% of suspected nerves were confirmed. All confirmed nerves joined up with the MABCN. Three specimens had no confirmed proximal nerves. The location of the nerves ranged from 7–46 mm proximal to the olecranon with an average diameter of 0.9 mm (range 0.6–1.5 mm). The largest crossing nerves were typically located about 2 cm proximal to the olecranon (Table 1).

Distal to the olecranon tip there were an average of six suspected and five confirmed nerves crossing the midline (rounded to nearest whole number). Eighty-eight percent of suspected nerves were confirmed. All confirmed nerves joined up with the MABCN. These nerves were found to be within a range of 9 to 135 mm distal to the tip of the olecranon. Nerve diameters ranged from 0.5 to 2.2 mm with an average of 1.3 mm. The largest nerves were typically located at an average of 45 mm distal to the olecranon tip with a range of 16–70 mm (Table 2).

It was found that the confirmed nerves proximal and distal to the olecranon arborized into the skin an average of 5.2 mm radial (lateral) to the skin incision (range 2–10 mm).

Discussion

The midline posterior incision is routinely used for operative exposure of the elbow and has been reported to place fewer cutaneous nerves at risk compared with medial or lateral incisions [2]. Dowdy noted an average of eight

Figure 3 Example of crossing nerve.

Table 1 Nerve branches crossing midline incision proximal to olecranon.

Cadaver no.	No. suspected	No. confirmed	Position (mm) proximal to olecranon tip	Size (mm)	Largest nerve location (mm)
1	2	1	13	0.6	13
2	3	1	13	1.0	13
3	3	1	46	0.7	46
4	1	0	NA	NA	NA
5	3	2	19–36	0.8 both	19 and 36
6	3	2	7–12	1.0–1.5	7
7	6	3	15–35	0.6–1.0	31
8	3	0	NA	NA	NA
9	1	1	26	1.0	26
10	0	0	NA	NA	NA
Avg (range)	2.5	1.1 (0–3)	(7–46)	0.9 (0.6–1.5)	23

nerve branches crossing the medial elbow incision, seven crossing the lateral, and only two crossing the posterior incision [2]. In Dowdy's study, the nerve branches crossing the midline posterior incision were typically branches of the posterior cutaneous nerve of the arm, the intercostobrachial nerve, or the medial cutaneous nerve of the arm. Distal to the olecranon, 19% of crossing nerve branches arose from the medial antebrachial cutaneous nerve and the remainder from the posterior cutaneous nerve of the forearm or lateral cutaneous nerve of the forearm. It was not specifically noted whether the crossing nerves were traced back to their nerve of origin; however, selected nerve biopsies revealed that up to 20% of suspected nerves were not nerves. In our study, we noted an average of one crossing nerve proximal to the olecranon and five nerves crossing distal to the olecranon tip. Eighty-eight percent of suspected nerves distal to the olecranon were confirmed, though only 44% of suspected nerves proximal to the olecranon were con-

firmed. All confirmed nerves in our study joined up with the MABCN.

Dellon and Mackinnon [1] in 1985 called attention to injuries of the MABCN occurring during cubital tunnel surgery and noted that the MABCN posterior branches may cross the incision anywhere from 6 cm proximal to 6 cm distal to the medial epicondyle [2]. Masear et al. in 1989 noted posterior branches of the MABCN from 6 cm proximal to 4 cm distal to the medial epicondyle, with 90% crossing posteriorly at or near the ME. The number of posterior branches ranged from one to four, with 40% having multiple branches [4]. Lowe et al. in 2004, noted that MABCN branches crossed at or proximal to the medial epicondyle 61% of the time at an average of 1.8 cm proximal to the ME in a clinical study of 97 patients undergoing cubital tunnel surgery via an incision directly over the cubital tunnel [3]. The larger number of crossing nerve branches seen in our study may reflect the more distal

Table 2 Nerve branches crossing midline incision distal to olecranon.

Cadaver no.	No. suspected	No. confirmed	Position (range; mm) distal to olecranon tip	Size (mm)	Largest nerve location (mm)
1	3	3	13–49	1.0–1.7	30 and 49
2	5	4	18–40	0.5–2.0	18
3	4	4	32–64	1.0–1.7	42, 48, 64
4	8	5	20–54	0.5–1.6	35
5	6	6	22–135	0.7–1.3	39 and 61
6	4	4	9–62	0.6–1.6	16
7	10	8	11–84	0.5–1.8	36
8	11	10	27–103	0.5–1.9	52
9	3	3	34–70	1.0–2.0	70
10	6	6	26–65	1.0–2.2	65
Avg (range)	6 (3–11)	5.3 (3–10)	(9–135)	1.3 (0.5–2.2)	45 (16–70)

arborization of the MABCN nerve branches as they fan out over the posterior aspect of the elbow and forearm.

Race and Saldana in a 1991 anatomic study of the MACN and MBCN, concluded that placing the standard cubital tunnel incision more posteriorly would prevent injury to these cutaneous nerves. They noted one MABCN branch 4–6 cm proximal to the ME in 60% of 20 cadavers and five to eight branches beginning 2 cm proximal to the ME. One of seven patients undergoing cubital tunnel decompression via the posterior incision was noted to have a sensory deficit, and this was attributed to a technical error [5].

The present study was undertaken not to compare the posterior incision with respect to any other incision with respect to ‘nerve safety’, but to establish that there is no truly ‘safe’ incision with respect to the MABCN posterior branches which do cross even the midline posterior incision. These nerve branches arborize into the skin shortly after crossing the posterior incision and it is possible that placing the incision more radially (laterally) would avoid the MABCN branches entirely, but the nerve branches emanating from the lateral side would likely then be more at risk. A more anteriorly placed incision could allow easier identification of MABCN branches before they arborized; however, this type of incision is generally not practical in the clinical situations where the surgical exposure afforded by a midline posterior incision is required.

The results of this study, as well as the aforementioned studies, demonstrate that some cutaneous nerves will be sacrificed if a posterior midline incision is carried down through all layers of skin and subcutaneous tissue to the fascia and bone. What is surprising is that these nerve injuries are usually clinically inapparent. Incisional tenderness with a Tinel-like quality to it might be blamed on these transected nerves, though significant cutaneous deficit is

rare, likely due to the fact that these nerves are close to their arborization point in the skin when they are coagulated with the electrocautery or transected with the scalpel. An additional clinically significant angle to the nerves in this region is that occasionally, patients present following a closed injury or blow to the subcutaneous border of the proximal ulna with a neuritic type painful component associated with a Tinel’s sign: this has likely been a contusion to these small nerve branches of the MABCN if the olecranon bursa does not seem to be the culprit.

In conclusion, cutaneous nerve branches of the medial antebrachial cutaneous nerve are at risk with a straight posterior midline elbow incision. Preservation of these nerve branches may limit adequate operative exposure. Surgical transection of these nerve branches is likely quite common and the clinical significance of injury to these nerves in this anatomic zone is unknown at present.

Conflict of interest The authors declare that they have no conflict of interest.

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