Relevant Insertion Site Anatomy of the Conventus Distal Radius System

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Abstract

Background: The Conventus Distal Radius System (DRS) is an intramedullary fixation scaffold inserted into the lateral aspect of the distal radius. The purpose of this study was to identify insertion site anatomy to illustrate risks associated with the minimally invasive nature of radial-sided implant application. **Methods:** Ten cadavers were utilized. Using fluoroscopy, the 1.1-mm Kirschner wire and template was introduced per manufacturer's guidelines, access guide assembled, and dissection carried out to the superficial radial nerve (SRN) with preservation of the native location. The access guide marked the insertion location for the side-cut drill. This point was measured in relationship to structures nearby, including the SRN, brachioradialis (BR), lateral antebrachial cutaneous nerve (LABCN), and radial styloid (RS). **Results:** The large guide contacted the SRN in 4 of 10 cadavers and was volar to it in 6 of 10. When volar, the mean distance was 1.7 mm. The tip of the RS to the large access guide averaged 44.5 mm. The small guide contacted the SRN in 2 of 10, was volar to it in 4 of 10, and between the bifurcation in 4 of 10. When volar, the distance averaged 3.25 mm. When bifurcated, the distance from the small guide to both the dorsal and volar branches was 3.5 mm. The distance from the RS to the small guide averaged 37.8 mm. The LABCN was found in the field of dissection in 4 of 10 cadavers. **Conclusions:** Several structures are at risk during insertion of the Conventus DRS; thus, knowledge of the relevant anatomy of this minimally invasive approach is crucial to optimize outcomes and patient satisfaction, and to avoid nerve injury.

Keywords: Conventus Distal Radius System, radial sensory nerve, lateral antebrachial cutaneous nerve, distal radius fracture, cadaver

Introduction

Distal radius fractures are a common injury, representing more than 200 000 fractures per year in the United States.^{1,4,13,17} There is a predilection for elderly individuals and females in the postmenopausal period, but these injuries can occur at any age and may be secondary to low- or high-energy mechanisms.² Treatment options are numerous and encompass variable results, most of which can be considered successful.¹² Since the advent of anatomic contoured osteosynthesis, fixed-angle locking devices, and fragment-specific fixation, many of the previously described complications of internal fixation have been reduced.³ Despite these improvements, reoperation rates remain approximately 11% and are performed most commonly for complications related to hardware impingement.^{5,8,16}

The Conventus Distal Radius System (DRS; Conventus Orthopaedics, Maple Grove, Minnesota) is an intramedullary nitinol fixation scaffold that is inserted into the medullary canal of the radius from its radial aspect (Figure 1). It was designed to provide rigid internal fixation through a

small radial-sided incision, thus minimizing biologic insult.¹⁵ The intramedullary position of the implant is thought to theoretically decrease tendon and nerve irritation in the postoperative period, thus avoiding potential reoperation.

The purpose of this study was to identify the anatomy of the insertion site of the Conventus DRS as it relates to the superficial radial nerve (SRN), lateral antebrachial cutaneous nerve (LABCN), brachioradialis (BR) tendon, and radial styloid (RS) to illustrate potential pitfalls of utilizing a minimally invasive technique so that surgeons may optimize successful outcomes when utilizing this particular implant.

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Materials and Methods

Ten fresh-frozen cadavers were utilized for dissection, 5 of which included the elbow and 5 of which included the shoulder. There were 7 right and 3 left specimens in 9

females and 1 male. Average age of the cadavers was 71 years (range, 66-88 years). No cadaver had a known distal radius/wrist pathology or surgical intervention that otherwise would interfere with the native position of the local anatomy. Each specimen was placed at room temperature for 24 hours to allow for complete thaw prior to initiation of dissection.

Under fluoroscopic guidance, the distal apex of the Conventus DRS template was positioned approximately 2 to 4 mm proximal to the subchondral surface of the distal radius, between Lister's tubercle and the center of the lunate facet, according to the manufacturer's technique guide. A 0.045" (1.1 mm) target Kirschner wire (K-wire) was then driven from dorsal to volar into the area that corresponded to this location, perpendicular to the radial shaft. The scaffold template was again introduced over the target K-wire through the distal hole to confirm adequate placement for the future intramedullary implant (Figure 2a-2c). Following removal of the template, the access guide was assembled on the target K-wire to mark the skin overlying the insertion site (Figure 3). Conventus offers 2 sizes of intramedullary implants, a small and large. The scaffold template (Figure 2c) is utilized to select the "best-fit" size between the two, as the remainder of the procedure, including dissection and side-cut drilling location, is dictated by the tolerances of either the small or large access guide.

Dissection was carried down to the level of the SRN with careful attention paid to preserving the native anatomic location of the nerve and its branches. We again introduced the access guide and marked the future insertion location for the side-cut drill. This point was measured in relationship to relevant anatomic structures nearby, including the SRN, BR, LABCN, and distance from the RS tip. This technique was duplicated for both the large and small access guides. All measurements were performed by

Figure 1. (a, b) Anteroposterior and lateral radiographs of injury. (c, d) Anteroposterior and lateral radiographs after Conventus Distal Radius System fixation.

Figure 2. (a-c) Target wire and scaffold template for access guide placement.

Figure 3. Assembled target wire with access guide for future dissection site.

Figure 5. Small access guide, distal to bifurcation, straddled by dorsal and volar branches of superficial radial nerve.

Figure 4. Large access guide volar to bifurcation of superficial radial nerve and overlying the brachioradialis.

the senior author using a calibrated digital caliper (iGaging IP54; China).

Statistical Analysis

Mean distances (mm) were calculated for both the large and small access guides as they related to each anatomic structure recorded.

Results

The large access guide landed on the SRN in 4 of 10 cadavers and landed volar to the SRN in 6 of 10. When volar, the distance to the SRN averaged 1.7 mm (Figure 4). The distance from the tip of the RS to the insertion site of the large access guide averaged 44.5 mm.

Figure 6. Variable presence of the lateral antebrachial cutaneous nerve.

The small access guide landed on the SRN in 2 of 10 cadavers, landed volar to the SRN in 4 of 10, and landed distal to and between the SRN bifurcation in 4 of 10 (Figure 5). When volar, the distance to the SRN averaged 3.25 mm. When the SRN bifurcated, the distance from the small access guide to the both the dorsal and the volar branches was 3.5 mm.

The distance from the RS to the insertion site of the small access guide averaged 37.8 mm.

The LABCN was found in the field of dissection in 4 of 10 cadavers (Figure 6). It was consistently found dorsal to the small and large access guides at a distance of 8.5 and 9 mm, respectively. For those in which the LABCN was not found, its location was significantly outside the field of dissection for this implant.

Table 1. Results.

Cadaver	ID #	Sex	Arm	RS to small	RS to large	SRN, small	SRN, large	BR, small	BR, large	LABCN, small	LABCN, large
1	LI40066	F	R	35	42	3 D	5 D	3 V	3 V	NA	NA
2	LI40285	F	R	40	48	0	0	1 V	1 V	NA	NA
3	LI40717	F	R	40	48	3 D	2 D	0	0	8 D	10 D
4	LI40334	F	L	34	41	7 D; 4 V	0	0	0	NA	NA
5	LI40720	M	R	40	48	4 D; 3 V	0	0	0	9 D	8 D
6	CI4048	F	R	39	44	4 D; 2 V	2 D	0	0	NA	NA
7	CI41541	F	L	38	44	1 D; 5 V	4 D	2 V	2 V	NA	NA
8	CI41512	F	R	35	41	1 D	3 D	2 V	4 V	10 D	8 D
9	CI41177	F	R	41	47	0	0	0	0	6 D	10 D
10	CI41512	F	L	36	42	5 D	2 D	0	0	NA	NA
Mean (mm)				37.8	44.5	3.5 D; 3.5 V	1.7 D	1.75 V	2.5 V	8.5 D	9 D

Note. RS = radial styloid; SRN = superficial radial nerve; BR = brachioradialis; LABCN = lateral antebrachial cutaneous nerve; D = dorsal; V = volar.

Both the large and small access guides landed either on or just dorsal to the BR tendon in all specimens. Results are summarized in Table 1.

Discussion

Management of distal radius fractures is rapidly evolving, with dorsal and volar plating being versatile options for most simple and complex fracture patterns.^{6,7,11,14} Despite these advances in implant technology, reoperation rates remain approximately 11% with a significant proportion of those reoperations secondary to hardware-related complications, including tendon irritation/rupture, nerve irritation, and screw placement.^{5,8,16} The Conventus DRS has been shown in early biomechanical studies to be as stiff or stiffer than nonlocking and locking volar plate options when subjected to in vitro physiologic loads, yet it offers a biologically respectful approach that does not violate tendon compartments or employ extensive periosteal stripping.^{9,10}

Comprehensive knowledge of the relevant anatomy of this “minimally invasive” approach is crucial to optimize outcomes and patient satisfaction, and to avoid preventable nerve injury. In an international clinical study of 60 closed distal radius fractures managed with the Conventus DRS implant, 4 SRN injuries occurred, all of which the authors attributed to an attempt to place radial-sided hardware through too small an incision or percutaneously without direct visualization of the SRN.¹⁵ As this current study demonstrates, the SRN is in close proximity to the entry sites for both the small and large Conventus DRS devices. Based on this study, it is advised that the SRN and/or its branches be directly visualized and retracted dorsally along with the LABCN when exposing the radial shaft for implant insertion and placement of hardware. The small access guide portends a greater chance of being in a location distal to the

bifurcation of the SRN, with a theoretical increased risk of SRN violation during side plate application if left unprotected. In addition, if no BR tenotomy is intended, volar retraction of the BR tendon should be considered.

As with all techniques, there will be variation in implant positioning from one surgeon to another. Per the manufacturer’s guidelines, the Conventus DRS target K-wire should be placed 2 to 4 mm proximal to the subchondral surface of the distal radius, between Lister’s tubercle and the center of the lunate facet. Placement of this K-wire is the only surgeon-dependent placement variable through the entirety of this procedure, and the subsequent steps are dictated by the Conventus DRS instrumentation. Understandably, small variability in the location of the target K-wire may manifest as minor variability in the location of the incision or instrumentation. The significance of this variability could certainly be an area of future study. As such, it should be clear that the above recommendations are general guidelines and should not replace surgeon discretion. Again, comprehensive knowledge of the anatomy of the radial-sided wrist is of the utmost importance to avoid potential pitfalls of a minimally invasive approach.

There are several limitations to this study. First, in light of the potential desiccation of tissue in cadaveric dissection, it is possible that the position of the relevant structures studied may be altered in their native in vivo position. In addition, cadaveric dissection in an uninjured limb may not represent the position of relevant structures in the presence of injury deformity or soft tissue trauma. Next, dissection was carried out by both authors (J.D. and M.T.), with meticulous care taken to leave the structures in their native position, although it is impossible to entirely avoid moving them. Finally, variation in the implant insertion site based on the position of the initial target K-wire is possible, of which subsequent changes on the location of the entry site are possible.

Despite these limitations, this cadaveric dissection does shed light on the importance of identification and protection of the SRN when utilizing this device.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

Each author certifies that his institution approved or waived approval for the use of human subjects for this investigation and that all investigations were conducted in conformity with principals of research.

Statement of Informed Consent

Informed consent was obtained when appropriate and all living subjects involved in the study signed a general research consent allowing usage and sharing of their data.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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