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The risk of suprascapular and axillary nerve injury in reverse total shoulder arthroplasty: An anatomic study☆

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ABSTRACT

Purpose: Implantation of a reverse total shoulder arthroplasty (rTSA) places the axillary and suprascapular nerves at risk. The aim of this anatomic study was to digitally analyse the location of these nerves in relation to bony landmarks in order to predict their path and thereby help to reduce the risk of neurological complications during the procedure.
Methods: A total of 22 human cadaveric shoulder specimens were used in this study. The axillary and suprascapular nerves were dissected, and radiopaque threads were sutured onto the nerves without mobilizing the nerves from their native paths. Then, 3D X-ray scans of the specimens were performed, and the distance of the nerves to bony landmarks at the humerus and the glenoid were measured.
Results: The distance of the inferior glenoid rim to the axillary nerve averaged 13.6 mm (5.8–27.0 mm, ±5.1 mm). In the anteroposterior direction, the distance between the axillary nerve and the humeral metaphysis averaged 8.1 mm (0.6–21.3 mm, ±6.5 mm).
The distance of the glenoid centre to the suprascapular nerve passing point under the transverse scapular ligament measured 28.4 mm (18.9–35.1 mm, ±3.8 mm) in the mediolateral direction and 10.8 mm (−4.8 to 25.3 mm, ±6.1 mm) in the anteroposterior direction. The distance to the spinoglenoid notch was 16.6 mm (11.1–24.9 mm, ±3.4 mm) in the mediolateral direction and −11.8 mm posterior (−19.3 to −4.7 mm, ±4.7 mm) in the anteroposterior direction.
Conclusions: Implantation of rTSA components endangers the axillary nerve because of its proximity to the humeral metaphysis and the inferior glenoid rim. Posterior and superior drilling and extraosseous screw placement during glenoid baseplate implantation in rTSA place the suprascapular nerve at risk, with safe zones to the nerve passing the spinoglenoid notch of 11 mm and to the suprascapular notch of 19 mm.

Introduction

As the number of reverse total shoulder arthroplasty (rTSA) surgeries grows continuously each year, corresponding overall numbers of complications are increasing as a result [1–6]. Neurologic injury is a known complication of rTSA [3,4,7–9], with greater incidence of intraoperative nerve injury being reported in rTSA compared to anatomic TSA [9]. Iatrogenic neurologic injuries are mainly due to surgical exposure, implantation of prosthesis components and a subsequent lengthening of the arm [10–12]. In rTSA, several operation specific characteristics may endanger the integrity of the axillary and suprascapular nerves during surgery. It is assumed that the implantation of the glenosphere and inferior placement of the glenoid baseplate may place the axillary nerve at risk, as the correct implantation procedure calls for greater glenoid exposure and a prolonged retraction period [10,13]. Iatrogenic lesions of the nerve can lead to severe functional limitations in patients because the axillary nerve provides innervation for the essential deltoid muscle. As a result, intraoperative iatrogenic

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lesion of the axillary nerve can cause weakness, shoulder instability, impaired rehabilitation and pain in the postoperative period [13].

Additionally, the risk of a suprascapular nerve injury is increased during placement of the glenoid baseplate. It is reported that screws may pass through or perforate the glenoid, which in turn raises concerns about the proximity of such screws to the suprascapular nerve [14,15]. Reported deficiencies of the infraspinatus muscle, as well as significant postoperative pain, may result from a compression of the suprascapular nerve by implanted screws [7].

Hence detailed knowledge of the anatomy of the axillary and suprascapular nerve has become more relevant over the past years. In the course of such efforts, research to measure the position of the axillary and suprascapular nerves in relation to the glenoid and humerus, as well as possible interactions with the implants, may prove essential. Therefore, the aim of this anatomic study was to digitally analyse the location of the axillary and suprascapular nerves in relation to the bony landmarks of the glenohumeral joint in order to predict the path of these nerves and thereby help to reduce the risk of neurological complications during implantation of the rTSA components.

Methods

In the present study, 22 shoulder specimens, including 14 right and 8 left shoulders (four fresh frozen, ten embalmed cadavers) with an average age of 82 years (72–92 years) were used. The specimens belonged to the Department of Anatomy and were obtained following the legal procedures governing the donation of bodies. For all donors, we obtained written informed consent regarding postmortem scientific use. The cadavers used in this study stemmed from people who had died of natural pathologies.

The specimens showed no clinical signs of previous shoulder surgery or trauma or radiological evidence of bony deformation. Bone quality of the shoulders was not measured. The fresh frozen specimens were deep frozen at −40 °C. Thawing of the shoulder specimens at room temperature (23 °C) was started 24 h before preparation.

The same sequence of dissection was used in each specimen, and great care was taken not to mobilize the nerves from their original path. First, the axillary nerve was exposed. The posterior cord of the brachial plexus was located posterior to the clavicular shaft and followed distally to the origin of the axillary nerve. The course of the nerve was carefully followed through the axilla. A Judet approach to the posterior aspect of the scapula was then performed. The trapezius muscle and the posterior aspect of the deltoid were released. While the trapezius was reflected medially, the posterior aspect of the deltoid was carefully reflected anteriorly until the axillary nerve could be identified again. The course of the nerve around the humeral head was then followed by longitudinal splits of the respective aspects of the deltoid muscle. A fine, radiopaque thread with a diameter of 0.3 mm was subsequently sutured onto the axillary nerve of each specimen (Fig. 1).

Second, the suprascapular nerve was dissected. Through the already established Judet approach with elevation of the trapezius and triceps, the nerve was identified beneath the superior transverse scapular ligament anterosuperior to the supraspinatus muscle. The supraspinatus muscle was carefully released from the scapula and mobilized laterally to expose the suprascapular nerve to its course around the spinoglenoid notch (Fig. 2a). Next, the infraspinatus muscle was mobilized from the scapula to identify the course of the nerve along the infraspinatus fossa (Fig. 2B). Similar to the axillary nerve, the suprascapular nerve was marked with a radiopaque thread (0.3 mm diameter).

Subsequently, 3D X-ray scans of the specimens were performed using an ARCADIS Orbic 3D (Siemens Healthcare Diagnostics GmbH, Eschborn, Germany) with the shoulder being placed in a neutral position. The implanted threads marked the anatomic path of the nerves. Three-dimensional reconstructions and measurements in a sagittal, axial and coronal plane were built by use of the software Impax EE (Agfa Healthcare GmbH, Bonn, Germany).

First, the inferior edge of the glenoid rim was marked in the coronal, axial and sagittal planes, and the closest distance of the axillary nerve to the inferior glenoid rim was measured (Fig. 3). Then, the inferior and superior edge of the humeral head were depicted in the coronal, sagittal and axial views and the distances to the crossing points of the axillary nerve at the medial and lateral borders, as well as the shaft centre of the humerus, were measured in superoinferior (longitudinal, sagittal) and anteroposterior (horizontal, axial) directions.

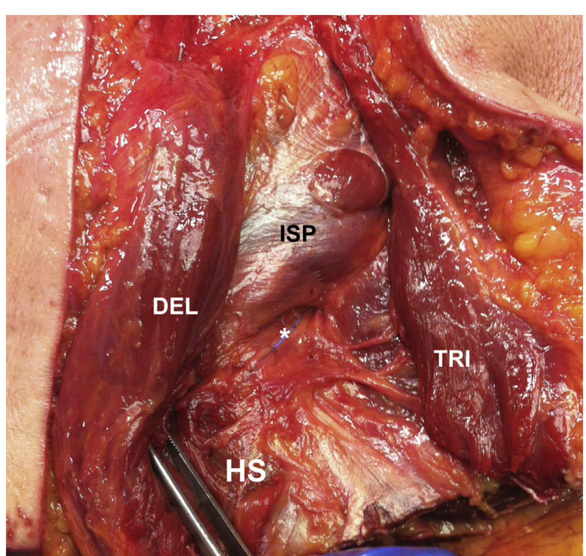

Fig. 1. Posterior view of a left shoulder depicting the dissection of the axillary nerve. The axillary nerve was marked with a radiopaque wire (*) along its course through the axilla. The triceps (TRI) has been released, and the posterior aspect of the deltoid muscle (DEL) has been carefully reflected anteriorly to show the course of the nerve from underneath the infraspinatus (ISP) around the proximal humerus. HS = Humeral shaft.

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