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EXCURSION AND STRAIN OF THE BRACHIAL PLEXUS AND PERIPHERAL UPPER LIMB NERVES FOLLOWING REVERSED ARTHROPLASTY OF THE SHOULDER

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INTRODUCTION

The concept of non-anatomic reversed arthroplasty for the treatment of omarthrotic shoulders with severe destruction of the rotator cuff is becoming increasingly popular and has been shown to provide predictable improvement in pain and function. [1] The reversed prosthetic design medializes and stabilizes the centre of rotation, minimizes torque on the glenoid component, and aids in recruiting fibers of the anterior and posterior deltoid to act as abductors. The design lowers the humerus relative to the acromion, restoring and even increasing deltoid tension by lengthening the muscle up to 18% of its original length. [2] Such a surgically created global distraction of muscles is libely to affect nervous structures.

When nerves are stretched, the nerve path straightens by longitudinal sliding or excursion of the nerve within its bed. With further tension the nerve excurses by straining its undulated axons. The change in length divided by the initial length is termed nerve strain. Nerve strain of 5-10% impairs axonal transport and nerve conduction. At 8% of elongation the flow of venous blood from nerves starts to diminish and at 15% all circulation in and out of the nerve is obstructed by stretching and strangulation of the intraneural vessels. [3]

In the present study we have tried to quantify the amount of excursion and strain of the brachial plexus and peripheral upper limb nerves following reversed shoulder arthroplasty by simulation of the process on a cadaver model.

MATERIAL AND METHODS

In a formalin-embalmed female cadaver specimen, the brachial plexus was carefully dissected using an anterior approach and injected with an iodine contrast medium (visipaque), glycerine and toluïdine blue to secure proper injection and highlight the nerve tissue on CT imaging. At the same time sixteen 1.2 mm-diameter leaded markers were implanted in the plexus and peripheral nerves at topographically crucial via points for later enhanced recognition on CT reconstructions.

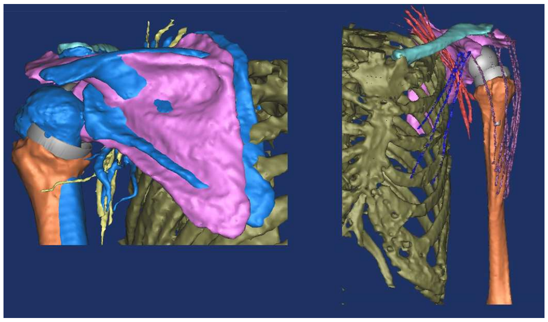
After the first session of CT scanning a plastic replica of the Delta reversed shoulder prosthesis ® (DuPuy Orthopaedics, Inc., Warsaw, IN) was surgically placed followed by re-injection of the plexus with the same solution.

The preoperative and the postoperative specimen were studied using a helical CT scan with a 0,5 mm slice increment (Siemens/ volume zoom). The Mimics ® (Materialise NV, Heverlee, Belgium) software package was used for visualization and segmentation of CT images and 3D rendering of the brachial plexus and peripheral nerves. (Figure 1)

After reconstruction the nerve segment paths were approximated using the draw nerve function. Each segment was exported in STL format. To calculate the respective lengths of the nerve segments a spline function was defined representing the exact centre of the nerve using a cluster method algorithm.

RESULTS

The starting position before reversed surgery was assigned 0% strain. The percentage change in strain was calculated from the length of the segments divided by the non-operated segment length. After surgery, there was an average increase in nerve strain below physiologically relevant amplitudes. In a few local segments of the brachial plexus an increase in nerve strain exceeding 5-10 % was calculated. The largest increase in strain (up to 19%) was observed in a segment of the medial cord.



DISCUSSION AND CONCLUSIONS

To understand nerve dynamics following reversed arthroplasty, we investigated nerve strain and excursion in a cadaver shoulder before and after surgery. Our results support the hypothesis that there can be a clinically relevant increase in strain of the neurovascular structures.

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