

Change in neck circumference after shoulder arthroscopy: An observational study

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ABSTRACT

Background and Aims: Shoulder arthroscopy requires fluid irrigation, which causes soft-tissue oedema around chest, neck, and arm intraoperatively, leading to postoperative airway complications. We decided to study the incidence of increase in the neck circumference in shoulder arthroscopy and its effects on the airway. **Methods:** We studied 32 cases of shoulder arthroscopies over a period of 1-year, performed under general anaesthesia with interscalene block. The neck circumference of patients before and after the procedure was measured along with other parameters. The endotracheal tube cuff was deflated at the end of surgery to determine air leak around the tube. The negative leak test suggested airway oedema. **Results:** Thirty out of 32 patients showed positive air leak test. The average change in neck circumference was 1.17 ± 1.16 cm and all could be extubated uneventfully. Two showed negative leak test with an increase in neck circumference by 4.5 and 6.4 cm and were not extubated. Multiple regression analysis for risk factors showed intraoperative hypertension as a single predictor for an increase in neck circumference. **Conclusion:** Change in the neck circumference beyond 4 cm may suggest airway compromise and below 4 cm, airway compromise is unlikely even in the presence of extensive soft-tissue oedema around the shoulder, upper arm and chest.

Key words: Airway oedema, saline extravasation, shoulder arthroscopy

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INTRODUCTION

Operative shoulder arthroscopy requires proper visualisation of the glenohumeral joint and the uncapsulated sub-acromial area. A large amount of saline irrigation, mechanically pumped into these spaces, may cause the fluid to escape into the arm and chest resulting in soft-tissue oedema.^[1,2] A rare but potentially life-threatening complication in the form of airway obstruction may be caused when this oedema extends into the neck. Although several reports have documented postoperative neck oedema resulting in delayed extubation following shoulder arthroscopies, not many studies have been conducted to study the incidence of neck oedema and its effects on the airway.^[3] Hence, we decided to study the incidence of increase in neck circumference in shoulder arthroscopies and its effect on the airway.

METHODS

Over a period of 1-year, a total of 32 patients aged between 18 and 70 years, of American Society of Anaesthesiologists physical status I and II undergoing elective shoulder arthroscopy under general anaesthesia with interscalene brachial plexus block (ISBPB) were studied after the Institutional Ethics Committee approval. Patients who refused consent or those with distorted neck anatomy were excluded from the study.

After attaching standard monitors, neck circumference was measured at the level of the thyroid cartilage in the supine position (C1). An ISBPB was administered using peripheral nerve stimulator with a total of 25 ml local anaesthetic (mixture of 10 ml 2% lignocaine and 15 ml 0.5% bupivacaine) for analgesia. The neck circumference was measured again after giving

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the block (C2). Patients were premedicated with intravenous midazolam 1 mg and fentanyl 2 µg/kg. After pre-oxygenation with 100% oxygen, general anaesthesia was induced with thiopentone 5 mg/kg or propofol 2 mg/kg. Tracheal intubation was facilitated with vecuronium (1 mg/kg) and anaesthesia was maintained with 50% nitrous oxide and oxygen in isoflurane, titrated to achieve stable haemodynamics. Intraoperative hypertension was defined as systolic blood pressure more than 20% of the baseline and was treated with additional fentanyl 1 µg/kg and titrated isoflurane of 1 minimum alveolar concentration. In case high blood pressure persisted after other causes were ruled out, nitroglycerine infusion (NTG) was added at 0.5 µg/kg/min and titrated as per response. Injection vecuronium top ups were given every 30–45 min.

All surgeries were done in lateral position with 15° head up. After the procedure, patients were turned to the supine position and the neck circumference was measured again (C3). The endotracheal cuff was deflated with the patient on volume control mode and the expiratory tidal volume was noted. A drop in the expiratory volume more than 100 ml suggested leak around the tube (positive leak test). In case of a positive leak test, the neuromuscular blockade was antagonised and the patient's trachea was extubated. The absence of leak around the tube (negative leak test) was taken as an indication of extensive airway oedema; patients were kept intubated and observed in the post-anaesthesia care unit. Next day, leak test was repeated and patients were extubated when the leak was positive indicating reduction in airway oedema.

RESULTS

Data were analysed using Microsoft® Excel® for Mac 2011 version 14.4.4 (140807). Regression analysis was done using analysis tool pack of Microsoft® Excel® 2007. Observed values were expressed as mean ± standard deviation. Of total 32 patients, 20 were females and 12 were males. Average patient age was 51.65 ± 14.0 years with an average body mass index of 25.45 ± 4.84. Change in the neck circumference was calculated as C3–C2.

Thirty out of 32 patients showed positive leak test and hence, were extubated uneventfully. The average increase in their neck circumference was 1.17 ± 1.16 cm. Only 2 out of 32 patients showed negative leak test and hence were kept intubated.

The increase in their neck circumference was 6.4 cm and 4.5 cm, respectively. Both patients remained haemodynamically stable and were extubated next morning when the leak was positive indicating reduction in airway oedema.

In our case series, all the patients were given a score as per the presence of known risk factors responsible for airway oedema after shoulder arthroscopy. The six risk factors that were considered were sub-acromial procedures, prolonged duration of surgery, high pump pressures (beyond 150 mm off Hg), intraoperative hypertension, loose connective tissue (subjective finding), and lateral decubitus position. One point per risk factor, with a maximum possible score of six, was determined for each patient [Table 1].

Eighteen patients were rotator cuff repairs, which are a sub-acromial procedure, 12 were Bankart's surgeries while 2 were combination surgeries. The average duration of surgery was 146.90 ± 44.25 min. The average volume of irrigating fluid used was 39.66 ± 20.8 L. Irrigating pump pressures were always maintained between 30 and 65 mm of Hg. Three out of 32 patients required NTG infusion for treatment of intraoperative hypertension. Multiple regression analysis for risk factors done on 32 patients showed hypertension as a single most direct predictor for an increase in the neck circumference ($P = 0.002$, $r = 0.49$). Other factors by themselves or all six factors taken together did not predict an increase in neck circumference.

DISCUSSION

Amongst the various complications of operative shoulder arthroscopy, soft-tissue oedema extending into the neck causing airway compromise is well-documented. Hynson *et al.* have reported extra-articular dissection of arthroscopic irrigation

Table 1: Table of risk factors based on 6 point score

Risk factor	Number of patients with each risk factor	Total number of risk factors (score out of 6)	Total number of patients having each score
Sub-acromial surgeries	21	1	3
Lateral decubitus	32	2	11
Hypertension	6	3	12
Prolonged duration of surgery	16	4	3
Loose subcutaneous tissue	5	5	1
High irrigation pressure	0	6	0

solution causing complete airway obstruction and even suggested monitoring of neck circumference through the procedure.^[2] The six contributing factors responsible for airway oedema are sub-acromial procedures, prolonged duration of surgery, high pump pressures (beyond 150 mm of Hg), intraoperative hypertension, loose connective tissue around the neck and lateral decubitus position.^[1,2] Administration of general anaesthesia with endotracheal intubation can facilitate uninterrupted surgery even in the event of massive extravasation of irrigation fluid but may call for reintubation if careful examination of neck and leak around the endotracheal tube is not performed prior to extubation.^[3,4]

Operations in the sub-acromial space are particularly susceptible to extravasation because this space is not enclosed in a capsule like the glenohumeral joint.^[5-7] The majority of the surgeries in our study were rotator cuff repairs (18), a sub-acromial procedure. Others were Bankart's surgery (12), which is a stabilisation surgery in the glenohumeral joint while 2 were a combination of above.

The prolonged duration, which is the next risk factor, was defined as surgical time above 150 min. Previous studies have mentioned times of occurrence of airway compromise from 85, 108, 110, 120, 150, 240 min of surgical time.^[8] 150 min is the closest to the average duration of surgery in our study. The presence of visible wrinkles over neck and chest were suggestive of loose connective tissue, which is another high-risk factor for fluid extravasation. This was a subjective observation by the attending anaesthesiologist who was not participating in the study. Studies indicate that modest elevation in pump pressure in combination with induced hypotension gives appropriate pressure differential for better visualisation of joint spaces. Excessive pump pressures may lead to fluid extravasation into soft-tissues. High pump pressures up to 100–150 mm of Hg have been associated with excessive fluid extravasation and a pressure difference of 49 mmHg between the systolic blood pressure and sub-acromial space pressure has been advocated.^[9] In our study, all the surgeries used mechanical pumps with pressures set between 30 and 65 mmHg (much lower than the maximum permissible) and flow rates between 50 and 150 ml/min with continuous outflow conduit. A low flow continuous outflow theoretically provides a conduit for irrigation fluid to preferentially exit rather than dissecting into soft-tissues.^[10] In our study, interscalene block given prior to induction of

general anaesthesia resulted in stable haemodynamics and clear surgical field in most patients (26).^[11] Intraoperative hypertension leads to poor arthroscopic visualisation due to bleeding, which may prompt the surgeon to increase the irrigation pressure, which may lead to increased extravasation of saline and risk of airway oedema. In our study, moderate hypertension was treated with additional fentanyl 1 µg/kg and titrated inhalational agent. Only 3 out of 32 patients required additional NTG infusion to maintain stable haemodynamics.

It was postulated by Hynson *et al.* that lateral position may contribute to the accumulation of fluid in soft-tissue of the neck due to gravity.^[2] In our study, only 2 out of all 32 surgeries that were conducted in lateral decubitus position had extensive neck oedema making it a weak association. Whether the 15° head high position that was given to all the patients to reduce the incidence of gravity-induced accumulation of oedema fluid made any difference is a moot point. Almost all patients in our study had extensive soft-tissue swelling of shoulder, upper arm and chest on the operative side compared to the contralateral side with minimal change in the neck circumference (1.17 ± 1.16 cm.) Three patients developed excessive neck oedema (4 cm and above). Two out of those three patients had negative leak test and hence were not extubated. They had 3 and 4 risk factors positive out of the six factors that we discussed above. Multiple regression analysis done over 32 patients for risk factors showed hypertension as a single most direct predictor for an increase in the neck circumference ($P = 0.002$, $r = 0.49$). The three patients with intraoperative hypertension had an increase in the neck circumference beyond 3 cm. Other factors by themselves or all six factors taken together did not predict an increase in neck circumference. A possible weak association with a higher sample size cannot be ruled out. Edwards *et al.* have reported a rare case of an anatomical variant with abnormal communication amongst the shoulder joint, infrapinnous fossa, thorax and neck leading to massive airway oedema and obstruction.^[8] Such associations are rare and we did not encounter any of them.

In our view, multiple risk factors especially hypertension may increase the risk of airway oedema after shoulder arthroscopy, although the absence of them may not eliminate its possible occurrence. Air leak test, though advised by many authors in the past should be accompanied by careful examination and measurement of the neck circumference after

shoulder arthroscopy.^[12] It would be an additional test to improve the negative predictability of a leak test. A future clinical study with respect to high-risk factors for the increase in the neck circumference post-shoulder arthroscopy is recommended.

CONCLUSION

The measurement of neck circumference can be a clinical predictor for airway oedema following shoulder arthroscopy. Amongst all the possible risk factors, intraoperative hypertension is a single most direct predictor for this increase. In patients with multiple risk factors especially with hypertension, measurement of neck circumference and cuff leak test should be done before extubation.

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