

Comparison of the lateral decubitus and beach chair positions in terms of their effects on airway pressure in arthroscopic shoulder surgery

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Abstract

Aim: The aim of this study was to investigate the effects of extravasated fluid on the airway pressure of the patients in different surgical positions.

Material and Methods: This prospective observational study included 50 arthroscopic shoulder surgery patients (18-65 years) placed in lateral decubitus (Group L) and beach chair (Group B) positions under general anesthesia. Peak airway pressure (Ppeak) and internal PEEP (iPEEP) measurements were recorded after intubation. The neck, chest, and shoulder circumferences were measured before induction and after operation.

Results: The increases in Ppeak and iPEEP values were not statistically significant between the groups ($p > 0.05$). The total amount of irrigation fluid was significantly higher in Group L ($p = 0.042$), not significantly correlated with Ppeak but positively correlated with the surgery time ($r = 0.51099$; $p = 0.001 < 0.05$). The neck circumference measurements were statistically significant between the groups. No respiratory complications were observed during the follow-up period.

Conclusion: The lateral decubitus and beach chair positions do not cause a clinically significant compromise on the airway pressure in arthroscopic shoulder surgery but a longer operation duration will cause a higher amount of irrigation fluid to be used, leading to an increased circumference of the neck in the postoperative period.

Keywords: Shoulder arthroscopy; airway pressure; lateral decubitus position; beach chair position

INTRODUCTION

Irrigation solution is used in arthroscopic shoulder surgery in order to expand the joint space, to obtain a clearer visualization of the tissues, and to control bleeding. Various airway complications; such as subcutaneous emphysema, pneumomediastinum, tension pneumothorax, air embolism or airway edema may occur as a result of the extravasation of the irrigation solution to the adjacent soft tissues and systemic circulation (1). Among them, a major one is the airway obstruction due to tracheal compression resulting from tissue edema (2,3). Furthermore; prolonged duration of the surgery, larger volumes of irrigation fluid use, a higher arthroscopic pump pressure, and obesity are the other factors increasing the airway pressure (4).

The lateral decubitus (LD) and beach chair positions (BCP) are used upon the surgeon's discretion in the arthroscopic shoulder surgery. Both the ventilation and perfusion rates are equal in either of the two lungs under anesthesia in the lateral decubitus position. Compared with supine and lateral decubitus positions, beach chair position is reported to least affect the functional residual capacity during general anesthesia. The incidence of postoperative pulmonary dysfunction is comparable in both beach chair and supine positions. In both positions, there is a limited approach to the airway of the patients and the irrigation fluid used may increase airway problems. Therefore, this study aimed to investigate the effects of irrigation fluid on airway pressures during shoulder laparoscopic surgery with general anesthesia in lateral decubitus and beach chair positions.

Received: 07.08.2019 Accepted: 20.11.2019 Available online: 09.01.2020

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MATERIAL and METHODS

This study was designed as a prospective observational study to be conducted in the operating room of orthopedics department (Local ethics committee decision no: 2016/109). Patients scheduled for an arthroscopic shoulder surgery under general anesthesia, between 18 and 65 years of age, with a American Society of Anesthesia (ASA) score below 3 were informed about the study. Patients, who agreed to participate and signed written informed consent form were included in the study.

Patients presenting with any of the following conditions were excluded: neurological or psychiatric disorders, respiratory diseases, history of smoking, upper respiratory tract infection in the past ten days requiring medications, morbid obesity, pregnancy, organ failure, allergies to any of the anesthetic drugs used, dependence to alcohol or drugs, a history of bronchospasm; a history of an unpredicted, difficult or traumatic intubation; and a history of not being intubated at the first attempt by laryngoscopy. Moreover; patients with severely disordered pulmonary compliance including tracheostomy, airway anomaly, asthma or chronic obstructive lung disease were excluded from the study. Thus, two out of fifty-five patients included in the study were excluded as they did not meet the study conditions and three of them did not approve to participate in the study and, therefore, excluded. The study patients (n=50) were assigned to two groups as the lateral decubitus (group L, n = 25) and beach chair position groups (group B, n = 25) as expressed in the study flow diagram (Figure 1).

After administering 2 mg midazolam for premedication, the study patients received routine monitorization with 3-lead electrocardiogram (ECG), peripheral oxygen saturation (SpO₂), non-invasive blood pressure measurements, and the measurements of the respiratory rate (RR) and peripheral temperature. anesthesia was induced with 1 µg kg⁻¹ fentanyl, 1 mg kg⁻¹ lidocaine, 2-3 mg kg⁻¹ propofol. Neuromuscular block was obtained with 0.6 mg kg⁻¹ rocuronium. anesthesia was maintained with a 1: 1 ratio of a mixture of oxygen/nitrous oxide and 2-3% sevoflurane gas, aiming for a BIS level of 40-60. The heart rate (HR), peripheral oxygen saturation (SpO₂), mean arterial pressure (MAP), bispectral index (BIS, Aspect Medical Systems, Inc. Newton MA 02464 USA), and the body temperature values were measured in all study patients before the induction. End-tidal carbon dioxide levels (EtCO₂), internal PEEP (iPEEP) values, and peak airway pressure (P_{peak}) were recorded in the minutes 5, 15, 30, 45, 60, 75, 90, and 105 after the intubation. Mechanical ventilation of the patients was achieved with a 6-8 mL kg⁻¹tidal volume in volume controlled mode (Avance CS2, Datex-Ohmeda Inc. USA). The circumferences of the neck, chest, and the shoulder were recorded in the study patients before the induction and after the operation.

The intraoperative fluid requirement was adjusted to a PVI (Pleth Variability Index, Pulse Oximetry Plethysmograph, Masimo® Radical-7) level between 10 and 15%. The

irrigating fluid was given to both of the groups using an arthropump (Arthropump ConMed® Linvatec Fluid Management System) at a pressure level of 40 mmHg. For both groups; the duration of the anesthesia, the duration of the surgery, total volume of the irrigation fluid administered, and volumes of intravenous fluid given during the operation were recorded separately.

At the end of the operation and at a Train of Four (TOF, Fisher&Paykel Healthcare Ltd Auckland, New Zealand.) level of 25%, the neuromuscular block was antagonized with 0.04 mg kg⁻¹ neostigmine + 0.01 mg kg⁻¹ atropine. When spontaneous respiratory effort was adequate, and BIS and TOF scores reached above 80 and 75%, respectively. The patients were extubated and taken to the postoperative recovery room when their hemodynamic findings were within normal limits and the airway stability was adequate. The patients were observed for any symptoms or signs of shortness of breath, chest pain, hoarseness, chest retractions, tachypnea, cyanosis or desaturation when they became conscious. Patients with an Aldrete score ≥ 9 were transferred to the surgical ward.

Power analysis

The power analysis of this study was performed as posthoc. The first peak measurement after intubation was 16.5 ± 2.1 in the L group and 17.4 ± 3.5 in the B group. Accordingly, in the independent samples t-test study, the power of the study was calculated as 66% when both groups had a sample size of 25 and the significance level of the differences was 2 and type 1 error was 0.05.

Statistical analysis

Statistical Package for Social Sciences (SPSS Inc., Chicago, IL) Version 23.0 was used for the statistical analysis of the data. Descriptive statistics were performed. The Chi-Square test, Fisher's Exact test, Mann-Whitney U test, Wilcoxon test, and Independent Samples t-test were used in the comparisons. The statistical significance level was accepted as p < 0.05.

RESULTS

There were no statistically significant differences between the groups in terms of ASA, age, body mass index (BMI), duration of anesthesia, duration of surgery, and the total volume of the administered fluids (p> 0.05). The mean of the total amount of irrigation fluid was significantly higher in Group L compared to Group B (p=0.042) (Table 1).

The P_{peak} values; measured in minutes 5, 15, 30, 45, 60, 75, 90, and 105 increased gradually within minutes as observed in both groups. There were no statistically significant differences between the groups for neither of the measured values (p> 0.05, Figure 2a).

It was found that the iPEEP values measured in minutes 5, 15, 30, 45, 60, 75, 90, and 105 showed a tendency to decrease in the patients in Group B, however, the values were stable in Group L. There were no statistically significant differences between the groups for neither of the measured values (p> 0.05, Figure 2b).

The neck circumference in Group L and B was significantly increased in the postoperative period ($p = 0.018$ and 0.002 , respectively).

The percentage of change in the neck circumferences was significantly different between the two groups ($p = 0.014$). There were no significant differences between the groups in terms of the chest and shoulder circumferences measured neither in the preoperative

nor in the postoperative periods ($p > 0.05$). (Table 2).

A moderate positive correlation was found between the duration of surgery and the total amount of irrigation fluid ($r = 0.51$; $p = 0.0001$) (Figure 3).

A significant positive correlation was found between total amount of irrigation fluid and the increase in the neck circumference ($r = 0.372$; $p = 0.008 < 0.05$).

Table 1. Demographic and surgical features of patients

	Group L (n=25) Mean±SD	Group B (n=25) Mean±SD	p
ASA I/II (n)	8/17	11/14	0.382
Gender (Female/Male) (n)	6/19	14/11	0.021
Age (years)	44.0±15.9	43.3±15.0	0.900
BMI (kg/m ²)	26.8±2.5	25.3±2.8	0.055
Duration of the anesthesia (min.)	113.2±19.8	103.2±26.4	0.090
Duration of surgery (min.)	82.2±19.7	76.2±17.5	0.257
Total irrigation fluid amount			
(crystalloid, mL)	10936±5398	8180±6464	0.042
Total intravenous fluid (crystalloid, mL)	1350±336	1324±421	0.615

Our data are expressed in mean ± sd and in numbers.

ASA: American Society of Anesthesia; sd: Standard Deviation, Group L: Lateral Decubitus group, Group B: Beach Chair Group

Table 2. Comparison of the Percentages of Change in the Preoperative and Postoperative Values of Neck, Chest, and Shoulder Circumferences by the Groups

	Neck Circumference (cm)	Chest Circumference (cm)	Shoulder Circumference (cm)
Group L			
Preoperative	40.3 ± 3.4	101.2 ± 8.1	44.0 ± 5.5
Postoperative	43.5 ± 4.3	106.1 ± 9.3	52.5 ± 6.6
Difference	3.2 ± 2.1	4.9 ± 5.4	8.4 ± 5.3
Percentage of change *	7.9 ± 5.2	4.9 ± 5.3	19.7 ± 13.3
Group B			
Preoperative	38.1 ± 2.8	100.4 ± 10.0	42.3 ± 4.2
Postoperative	39.8 ± 3.4	103.7 ± 10.8	50.0 ± 5.8
Difference	1.7 ± 1.5	3.2 ± 2.5	7.7 ± 5.4
Percentage of change *	4.5 ± 3.8	3.2 ± 2.3	18.9 ± 14.2
p-value*	0.014	0.156	0.833

Group L; Lateral decubitus position, Group B; Beach chair position

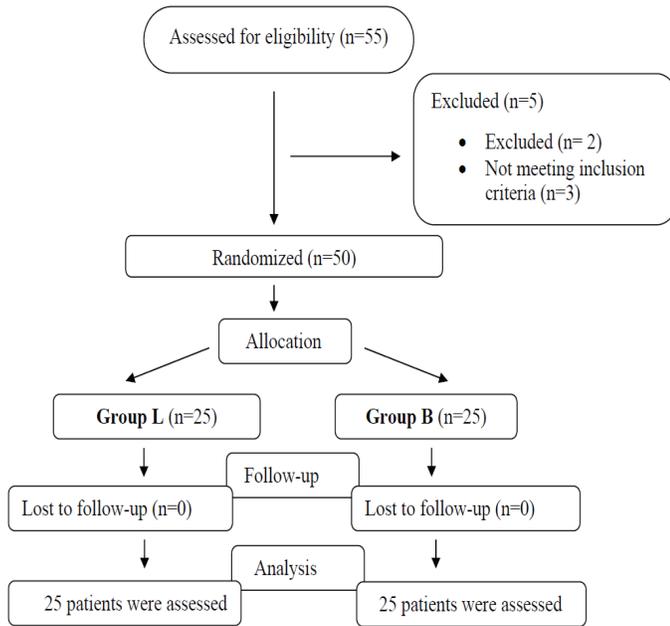


Figure 1. Study flow diagram, Group L; Lateral decubitus position, Group B; Beach chair position

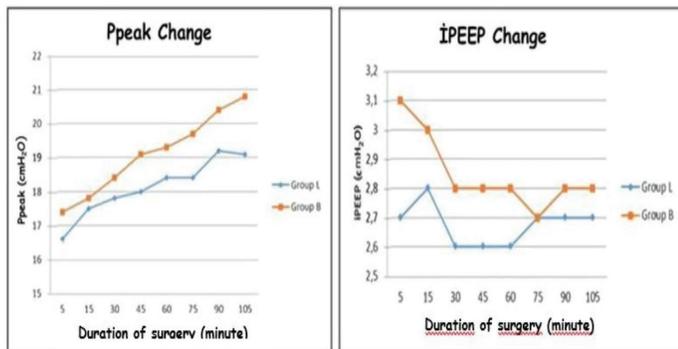


Figure 2a and 2b. Changes in Ppeak and iPEEP by the groups after intubation of the trachea

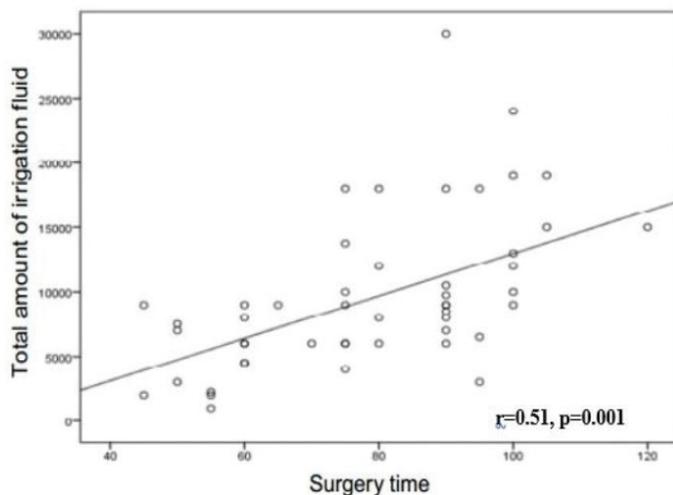


Figure 3. The relationship between the total amount of the irrigation fluid and the duration of surgery

DISCUSSION

Although it is known that the lateral decubitus position potentially compromises pulmonary compliance and causes ventilation-perfusion mismatch, our study has found that neither the lateral decubitus nor the beach chair positions have led to clinically significant changes on the airway pressure. However, we are of the opinion that an increased duration of operation will result in an increased volume of the irrigation fluid; and extravasation of the irrigation fluid may cause an increase in the neck circumference.

The two positions that are commonly used during shoulder arthroscopy are the lateral decubitus and beach chair positions. The position to be preferred is mainly based on the surgeon's discretion as neither of these positions has been shown to be superior to the other (3). Risk factors associated with the upper airway functioning during shoulder arthroscopy include the duration of the operation, the anatomical structure of the subacromial area, increased arthroscopic pump pressure, amount of irrigation fluid, lateral decubitus position, and obesity (1).

It is reported that there is a predisposition to fluid extravasation in the lateral decubitus position and in obese patients during shoulder arthroscopy. Excess fluid may accumulate especially in the neck and chest. Fluid accumulation in the laryngeal and tracheal tissues may cause external compression and may lead to full or partial airway obstruction due to the developing edema in these structures (5).

In this study, the mean preoperative and postoperative neck circumference values were significantly higher in Group L compared to Group B. The maximum increase in the neck circumference was 7 cm in 3 patients, which were all placed in the lateral decubitus position. There were no significant differences between the groups in terms of the preoperative and postoperative values of the chest and shoulder circumference measurements. However, the increase was significant in the neck, shoulder and chest circumferences in both groups when the preoperative and postoperative measurements were compared. The correlation analysis revealed a 37.2% positive and significant relationship between the total volume of the irrigation fluid used and the increase in the neck circumference.

Manjuladevi et al. published a case-control study in patients, who underwent shoulder arthroscopies under general anesthesia, reporting that the airway was compromised in the patients placed in the lateral decubitus position. The problematic findings reported in this study were associated with excessive volumes of irrigation fluid used depending on the prolonged duration of surgery (1). Restricting the fluid extravasation may minimize the occurrence of potential complications (6). A prolonged duration of surgery may increase the volume of irrigation fluid used and therefore may increase the risk of edema in the surrounding tissues (7).

Hynson et al. reported that complete airway obstruction was caused by the gravity based on the results of their study. Lateral decubitus position may contribute to fluid accumulation in the soft tissues of the neck due to the effects of gravity. A sitting position may be preferred to reduce fluid migration and airway edema. In this study, biggest increases in neck circumference were observed in patients in lateral decubitus position group (8).

Chellam et al. suggested that the neck circumference might be a clinical indicator of airway edema following shoulder arthroscopy (9).

A study conducted by Gupta et al. reported a significant increase in the neck, chest, and mid-arm circumferences in the patients indicating a regional and systemic absorption of the irrigation fluid. They reported that the increase in the neck circumference was positively and significantly correlated with the duration of surgery and the volume of irrigation fluid used. Increases of up to 5 cm in the neck circumferences were reported after routine shoulder arthroscopies. Those studies reported that the increase in neck and chest circumferences did not compromise any airway functions in the patients after the operation (10).

In this study, there was an increase in the neck, chest and shoulder circumferences in both groups although the intraoperative fluid requirement of the patients was adjusted to a PVI level of 10-15% and the administration of irrigation fluid was maintained at a constant pressure using an arthropump. Although standardization was achieved in the duration of surgery and anesthesia, the amount of total irrigating fluid was higher in lateral decubitus position group. However, a significant increase in peak airway pressures was found compared to the baseline values in both groups.

Operations in the sitting position cause increases in the functional residual capacity (FRC), however, any decreases in perfusion outweigh the anticipated benefits in oxygenation (11).

A study by Salihoğlu et al., including 9 patients undergoing esophageal surgery, reported reduced dynamic compliance and an increased peak inspiratory pressure and airway resistance when the patients were moved from the supine to the lateral position (12).

Courington and Little reported that the sitting position imposes a minimal restriction on the movements of the rib cage, ribs, and sternum; based on a broad literature review (13). Özhan et al. published the first case report of tracheal compression during arthroscopic shoulder surgery in the beach chair position under general anesthesia, reporting that the value of peak airway pressure was elevated from 18 to 35 H₂O within 4 minutes and bronchospasm developed in the right lung (2).

Limitations

The major limitation of this study is the limited number of patients. Further research with a larger size of patients would give more precise analysis in terms of

the parameters studied. Complete standardization of the duration of surgery and the amount of total irrigating fluid was another limitation.

CONCLUSION

In conclusion, this study showed that both groups had increased airway pressures compared to baseline values, with no significant differences between the two groups in terms of P_{peak} and iPEEP measurements. The volumes of the irrigation fluid and the airway pressure levels were not correlated.

Acknowledgements: We thank Prof. Dr. Turan Set for his contributions in the statistical analysis phase of our study.

Competing interests: Written informed consent was obtained from each patient included in the study.

Financial Disclosure: No financial support was received.

Ethical approval: KTÜ Tıp Fakültesi Bilimsel Araştırmalar Etik Kurul Başkanlığı, 18/07/2016 tarih, Sayı: 24237859-430.

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