THE EFFECT OF PRONE POSITION ON RESPIRATORY MECHANICS DURING SPINAL SURGERY

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Objective: To study the effect of prone position on respiratory mechanics.

Design: Prospective study.

Setting: Spine elective surgery at a university hospital.

Patients: 12 ASA physical I & II with no coexisting cardiorespiratory disease undergoing cervical or lumbar laminectomy.

Measurements: Ten min after induction of general anaesthesia while patients were in supine position, the following measurements were taken using anaesthesia delivery unit **(Datex Ohmeda type A_Elec, Promma, Sweden)**: peak airway pressure **(Ppeak)**, peak plataeu pressure **(Pplat)**, peak mean pressure **(Pmean)** and dynamic lung compliance **(DLC)**. The same measurements were performed 10 min after changing to prone position. At the end of surgery and 5 min after turning the patients supine and before tracheal extubation, the same measurements were again performed. Statistical analysis were performed using SPSS 9.0 for Windows; SPSS Inc., Chicago, IL.

The results expressed as means ± SD. One way ANOVA was used for analysis of differences in the data before, during prone position and after turning patients supine at the end of the procedure. For all comparisons $p<0.05$ was considered significant.

Results: During prone position there was significant reduction in DLC. Also we noticed a significant increase in airway pressures compared to that in the supine position.

Conclusion: We concluded that turning the patients from supine to prone position during anaesthesia decreases respiratory mechanics variables including DLC.

Key words : Surgical positions, lung compliance,lumbar discectomy

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Introduction

During surgery, the prone position is commonly used to expose the dorsal surface of the body for specific surgical indications. In anaesthetized and paralyzed normal subjects, the prone position, if correctly performed, ensures free abdominal movement, is not associated with adverse effects on respiratory mechanics, and improves lung volume and oxygenation ***(1).***

During general anaesthesia, changing from the supine to prone position may have adverse effects on epidural venous pressure and airway pressure ***(2).*** These effects may be more pronounced in obese patients because pressure on the abdominal wall may further accentuate the restrictive nature of the pulmonary disease common in this patient population.***(3).***

To surgeons, the major problems encountered performing spine surgery are those exposure and bleeding. To anaesthesiologists, the major problems noted in those patients are difficulties with ventilation and with cardiac dysfunction if the abdomen and chest are restricted.The prone position alters respiratory dynamics by decreasing respiratory compliance ***(4).***

By compressing the abdomen and restricting the chest wall movement, prone position comprises pulmonary compliance. So, for spine surgery, placing the anaesthetized patient into the prone position increases the risk of improper ventilation ***(3).***

Patients and Methods

After written informed consent was obtained, 12 adult patients scheduled to undergo microdiscectomy under general anaesthesia were enrolled in the study. Exclusion criteria included patients with cardiorespiratory disease. The patients were ASA I&II. Their mean age, weight and height were 50.92±6.40yr, 76.42±15.13kg and 165.92±6.05cm respectively. The patients were premedicated with oral lorazepam 2 mg , 150 mg ranitidine and 10 mg plasil 2 hr preoperatively. Intraoperative monitoring consisted of: ECG lead II; heart rate; arterial oxygen saturation **(SpO_2)** measured by pulse oximeter; blood pressure measured by the non-invasive automated method; end-tidal CO_2 **($EtCO_2$)**; muscle relaxation by Myotest; and body temperature by rectal route **(Hewlett Packard, Sarno, Italy)**. After preoxygenation, induction of anaesthesia was achieved with fentanyl 1 mcg/kg and propofol 2 mg/kg followed by cricoid pressure and atracurium besylate 0.5 mg/kg to facilitate endotracheal intubation **(Reinforced one)**. The patients' lungs were ventilated with 50% O_2/N_2O and 1 to 1.5 MAC sevoflurane with the anaesthesia delivery unit **(Datex Ohmeda type A_Elec, Promma, Sweden)** using a tidal volume of 10 ml/kg of ideal body weight and a rate of 10 breaths/min, with inspiration equal to 33% of respiratory cycle time, including a 10% end-inspiratory pause. Analgesia was maintained with incremental dosages of fentanyl when required. Atracurium was used for muscle relaxation based on the reading from the Myotest to ensure zero train-of-four and low twitch height.

Upon completion of surgery atropine and neostigmine were given I.V. (1.2/2.5 mg) followed by tracheal extubation. The patients were then sent to the recovery-room and later to the ward.

The following respiratory data were obtained 10 min after induction of anaesthesia while patients in supine position, 10 min after turning to prone position and 5 min after turning the patients to supine position and before tracheal extubation (at stages 1, 2 and 3 respectively): peak, plataeu and mean airway pressures, tidal volume (inspiratory and expiratory), minute volume (inspiratory and expiratory), and dynamic lung compliance (DLC).

Statistical analyses were performed with the aid of a computer program **(SPSS 9.0 for Windows, SPSS Inc., Chicago, IL)**. The results were expressed as mean ± SD. One-way analysis of variance (ANOVA) was used for analysis of differences of the data before, during and after positioning. For all comparisons, $p<0.05$ was considered significant.

Results

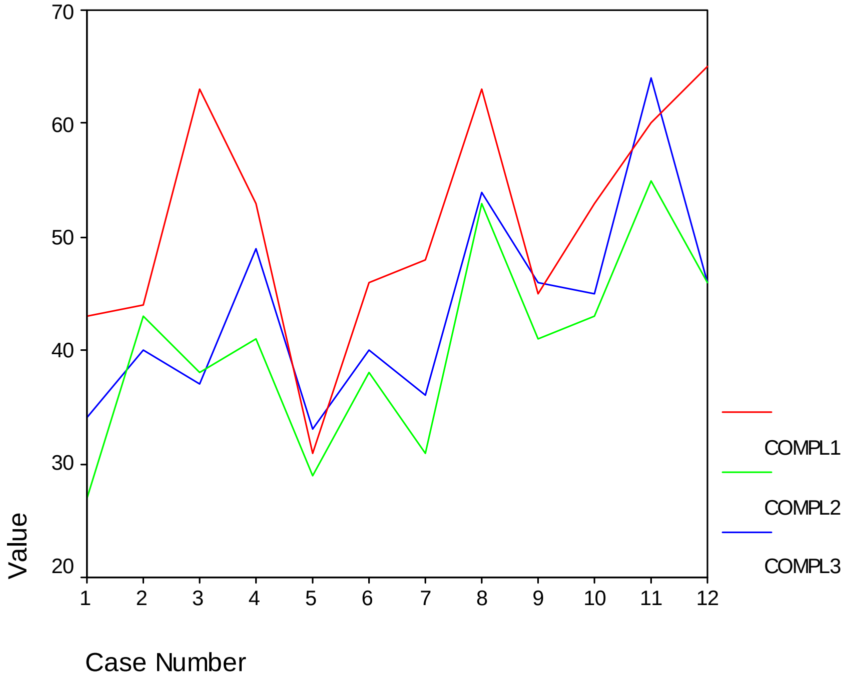
Table (1) Patient Demographic and Respiratory Mechanics

	N	Mean ± SD
AGE	12	50.92 ± 6.40
WEIGHT	12	76.42 ± 15.13
HEIGHT	12	165.92 ± 6.05
P PEAK1	12	15.42 ± 2.50
P PLAT1	12	13.42 ± 2.23
P MEAN1	12	6.33 ± 0.89
COMPL1	12	51.17 ± 10.25
P PEAK2	12	17.75 ± 2.73
P PLAT2	12	16.00 ± 2.41
P MEAN2	12	6.67 ± 0.65
COMPL2	12	40.42 ± 8.67
P PEAK3	12	17.50 ± 2.58
P PLAT3	12	15.83 ± 2.12
P MEAN3	12	6.42 ± 0.79
COMPL3	12	43.67 ± 9.04

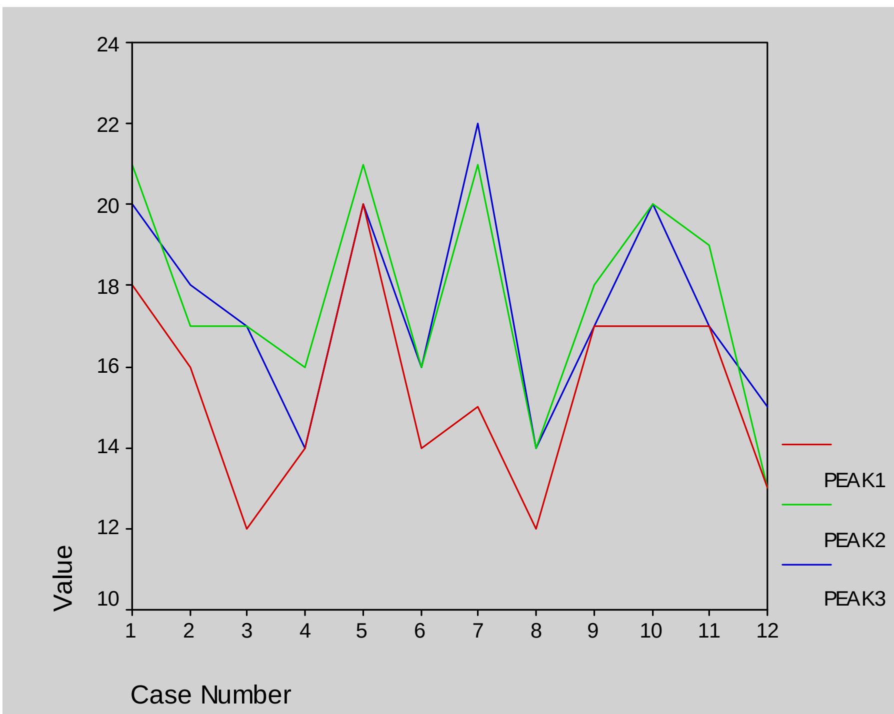
Table (2) Comparison between Respiratory Mechanics during the 3 studied periods

	N	CORRELATION	SIGNIFICANCE
P PEAK1 & P PEAK2	12	0.787	0.002
P PEAK1 & P PEAK3	12	0.641	0.025
P PEAK2 & P PEAK3	12	0.897	0.000
P PLAT1 & P PLAT2	12	0.641	0.025
P PLAT1 & P PLAT3	12	0.552	0.063*
P PLAT2 & P PLAT3	12	0.887	0.000
P MEAN1 & P MEAN2	12	0.681	0.015
P MEAN1 & P MEAN3	12	0.560	0.058*
P MEAN2 & P MEAN3	12	0.293	0.355*
COMPL1 & COMPL2	12	0.708	0.010
COMPL1 & COMPL3	12	0.605	0.037
COMPL2 & COMPL3	12	0.913	0.000

* not significant : $P>0.05$



70
60
50
40
30
20
Value
1
2
3
4
5
6
7
8
9
10
11
12
Case Number
COMPL1
COMPL2
COMPL3



24
22
20
18
16
14
12
10
Value
1
2
3
4
5
6
7
8
9
10
11
12
Case Number
PEAK1
PEAK2
PEAK3

The demograghic data of the patients as regard age, weight and height are represented in ***table1***, also with the respiratory mechanics parameters. All the patients are within normal range of body weight and height . The average surgical time was ranged between 1.5 –2hr (mean 1.8±0.6). All haemodynamic parameters as regard heart rate, blood pressure and ECG were within normal values, also O2 saturation and etCO2.

There was a significant increase ***(P<0.05)*** in Ppeak, Pplat and Pmean after turning the patients to prone position***(Table 1&2)***

The most affected parameter was DLC. The mean values of DLC were 51.17±10.25, 40.42±8.68 and 43.67±9.04 ml/cmH2O during supine (compl1), prone (compl2) and before extubation in supine position (compl3) respectively. Comparing DLC mean values in these 3 stages revealed a significant decrease ***(P<0.05)*** when the patients were in prone position ***(Table 1&2).***

Discussion

There are several studies of respiratory dynamics in nonobese surgical patients in the prone position ***(5,6)***. Kaneko and colleagues***(7)*** placed patients in prone position and discovered that pulmonary blood flow in the prone and supine positions was similarly homogenous. Stone and Khambatta ***(4)*** showed that no changes in the magnitude of pulmonary shunting occurred from the supine to prone position in patients positioned prone on parallel rubber bolsters with the abdomen allowed to hang free. Douglas et al***.(8)*** studied patients in the intensive care unit with respiratory failure and discovered that pronating these patients with the abdomen hanging freely improved arterial oxygen values. Pelosi et al***.(9)*** showed that, in anaesthetized, paralyzed, obese patients positions prone with their abdomens hanging freely, lung volumes, lung compliance, and oxygenation increased.

On the contrary to the above studies we observed in our study that there was a significant difference in the respiratory mechanics when turning the patients from supine to prone position and these parameters. There was increase in airway pressures (peak, plataeu and mean) in the prone position.The most significant observation was related to the DLC as it was significantly decreased after turning patients to prone position. This may be explained by restriction of chest expansion and decreased chest wall elasticity, muscle relaxation and abdominal wall compression when moving to the prone position. This compression may be responsible for the decrease in compliance in the prone position.

Our results in this study were in consistent with that of Palmon et al.***(3)*** who observed that by compressing the abdomen and restricting chest wall movement, the prone position compromises pulmonary compliance and for spine surgery, placing the anaesthetized patient into prone position increases the risk of improper ventilation.
Also another study evaluated DLC with various surgical positions in non-obese patients and concluded that compliance decreased in the lateral and prone positions and that the kneeling position was preferable for prone cases ***(10).***

Conclusion

We concluded that turning the patients from supine to prone position during anaesthesia in patients undergoing spine surgery increase in airway pressure and decrease respiratory mechanics variables including DLC.

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