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ORIGINAL RESEARCH ARTICLE

ENT SURGERY & ET CUFF PRESSURE-EFFECTS & MEASURES A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

BACKGROUND

ENT surgeries necessitate endotracheal general anaesthesia for airway protection and prevention of aspiration. Sister rose position and head up with neck flexion are the 2 position commonly used for functional nasal endoscopic surgeries and tonsillectomy. Significant variation in endotracheal cuff pressure was noted in altered position. The increase in cuff pressure could after tracheal mucosal blood flow. This study focuses on changes in cuff pressure before and after positioning and stresses need for endotracheal cuff pressure monitoring.

AIMS AND OBJECTIVES

- To evaluate endotracheal cuff pressure before and after positioning in ENT surgery.
- To compare the effect of extension and flexion of neck on endotracheal cuff pressure.
- To correlate airway pressure and cuff pressure during altered position in ENT surgeries.
- To offer recommendations on ET cuff pressure monitory

MATERIALS AND METHODS

Patients who presented to pre anaesthetic clinic for tonsillectomy and endoscopic sinus surgery along with other surgeries.

RESULT

BMI and PAW have P value of 0.072 cuff pressure before and after positioning have P value of 0.249 Et CO_2 and airway pressure were unaffected by rise in airway pressure. Both the postures for tonsillectomy and endoscopic sinus surgery showed rise in endotracheal cuff pressure. Significant increase was in head up and flexed position probably due to the effect of gravity on the endotracheal cuff. Significant association between BMI and airway pressure predict a raised

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airway pressure in an obese patient (P= 0.072). The following relation with cuff pressure were statistically significant namely with airway pressure (0.027) and cuff pressure before and after positioning (P=0.001) needing similar position for surgical access were included in the study. Airway pressure, cuff pressure before and after positioning along with patient demographic descriptive data were collected and analyzed.

CONCLUSION

Endotracheal cuff pressure increases due to altered position of head and neck and influenced by gravity and nitrous oxide. In this study, sister rose and head up neck flexed positions were studied. Both showed increased in cuff pressure more so in head up and neck flexed position. Periodic monitoring and correction of endotracheal cuff pressure to normal limits (20-30cm.H_2O) is recommended.

KEYWORDS

ET Cuff Pressure, Position of Head and Neck, ENT Surgery.

BACKGROUND

Endotracheal general anaesthesia is mandatory in nose and throat surgeries to protect airway and prevent aspiration. Endotracheal cuff offers proper seal, prevents gastric contents from entering the airway and pools secretions and blood preventing them to enter the tracheal during positive pressure ventilation.

The normal tracheal wall capillary is pressure is 5-8mmHg. Prolonged pressure on the tracheal mucosa could jeopardize the blood supply. Hence constant monitoring of endotracheal cuff pressure between 20-30 cm water is important.

More over different surgical positions effect endotracheal cuff pressure. Neck extension and flexion increase the cuff pressure and prolonged surgical duration reduce the cuff pressure.

An excessive cuff pressure has been attributed to the post operative throat discomfort following endotracheal general anaesthesia.

In this study we intend to evaluate the changes in endotracheal cuff pressure following position for tonsillectomy (neck extension) and for FESS surgery (neck extension & flexion) and offer recommendations for vigilant, monitoring

Aims and objectives

- To evaluate endotracheal cuff pressure before and after positioning in ENT surgery.
- To compare the effect of extension and flexion of neck on endotracheal cuff pressure.
- To correlate airway pressure and cuff pressure during altered position in ENT surgeries.
- To offer recommendations on ET cuff pressure monitoring.

MATERIALS

Study: Retrospective observational study
Study Period: February 2024 to June 2024
Study Sample: All cases presenting for tonsillectomy and FESS to PAC for assessment.
Parameters: Ht, Wt, BMI, Type of airway pressure, cuff pressure and $ETCO_2$ before and after positioning.

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Methods

The patients referred by ENT surgeon for tonsillectomy and endoscopic sinus surgery underwent a through pre anaesthetic check and those under ASA I,II category were included in the study.

Pre operative vitals were recorded a long with BMI from the chart. All patients were induced with fentanyl, propofol and vecuronium after endotracheal intubation, the cuff pressure was checked using cuff pressure monitor and corrected to be within normal limits – standardized to 30 cm, H_2O

Airway pressure and endotracheal cuff pressure were again noted after positioning for the surgery and corrected to normal limits 30 cm, H_2O.

The values were tabulated and analyzed.

RESULT

Age	Gender	Height (cm)	Weight (kg)	BMI	Diagnosis	Surgery	NF/NE	Paw	CP	Etco2	Paw	CP	Etco2
55	F	158	65	26	B/l sinonasal polyposis	FESS	NF	19	30	32	26	38	37
31	M	165	78	28.7	chronic rhinosinusitis	FESS	NF	20	32	38	22	39	30
41	M	171	58	19.8	B/L Sinonasal polyposis	FESS	NF	18	40	28	20	42	34
14	M	142	38	18.8	chronic adenotonsillitis	adenotonsillectomy	NE	14	34	36	17	38	39
24	F	152	56	24.2	sino nasalpolyposis	FESS	NF	20	28	33	21	35	35
12	F	137	28	14.9	chronic adenotonsillitis	adenotonsillectomy	NE	15	36	28	18	32	33
36	M	148	52	23.7	Thyroid nodule left	hemithyroidectomy	NE	22	34	33	19	40	30
37	M	165	74	27.2	sino nasalpolyposis	FESS	NF	18	32	36	16	40	38
28	F	154	60	25.3	DNS to left with ITH	turbinoplasty	NF	16	38	37	18	42	34
48	M	160	70	27.3	papillary CA thyroid	total thyroidectomy	NE	20	35	32	22	40	30
54	F	148	52	23.7	multinodular goitre	total thyroidectomy	NE	18	28	36	20	33	34
30	F	150	40	17.8	DNS to right	septoplasty	NF	22	26	37	23	38	34
24	F	143	50	24.5	sino nasalpolyposis	FESS	NF	24	25	32	20	39	30
32	M	160	63	24.6	right lobe thyroid nodule	hemithyroidectomy	NE	20	26	30	22	30	33
35	F	142	63	31.2	Chronictonsillitis	tonsillectomy	NE	24	28	32	28	32	35
17	M	160	56	21.9	DNS to left with ITH	turbinoplast,septoplasty	NF	18	24	35	20	32	36
50	F	154	68	28.7	papillary CA thyroid	total thyroidectomy	NE	20	37	36	18	42	34
11	F	130	35	20.7	chronic adenotonsillitis	adenotonsillectomy	NE	19	26	30	20	32	33
23	M	152	49	21.2	DNS to left with ITH	septoplaty,turbinoplasty	NF	20	30	32	24	39	39
39	F	150	48	21.3	multinodular goitre	total thyroidectomy	NE	22	31	40	20	35	32
44	M	161	70	27	sino nasalpolyposis	FESS	NF	19	30	35	23	46	33
32	F	154	61	25.7	hashimotos thyroiditis	total thyroidectomy	NE	20	26	37	18	28	34
34	M	163	72	27.1	DNS to right	septoplasty	NF	20	35	36	24	44	38
43	F	154	64	27	B/Lsinonasal polyposis	FESS	NF	18	29	355	20	40	38
17	F	150	52	23.1	chronic adenotonsillitis	adenotonsillectomy	NE	22	25	30	20	29	32

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Table 1

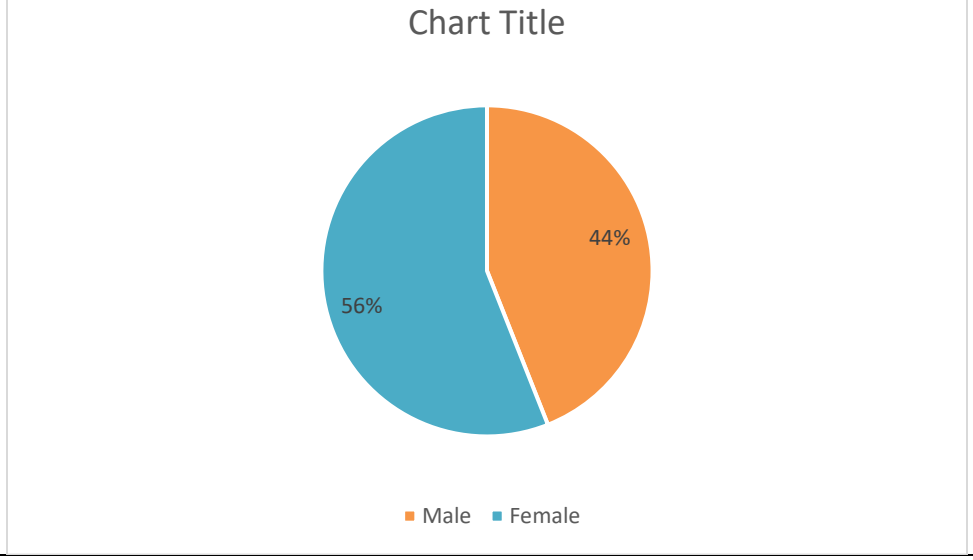

Figure 1 – Gender Distribution

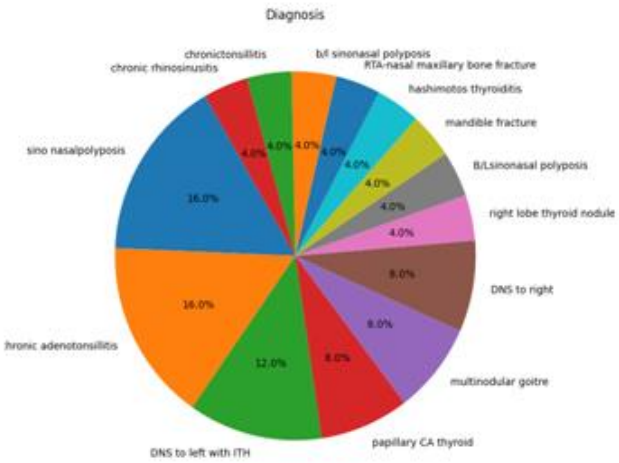

Figure 2 - Diagnosis

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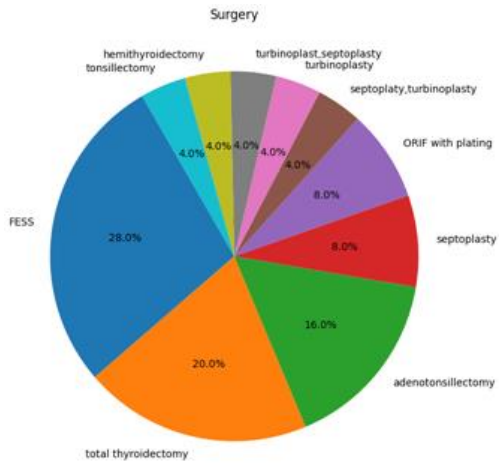


Figure 3: Surgery

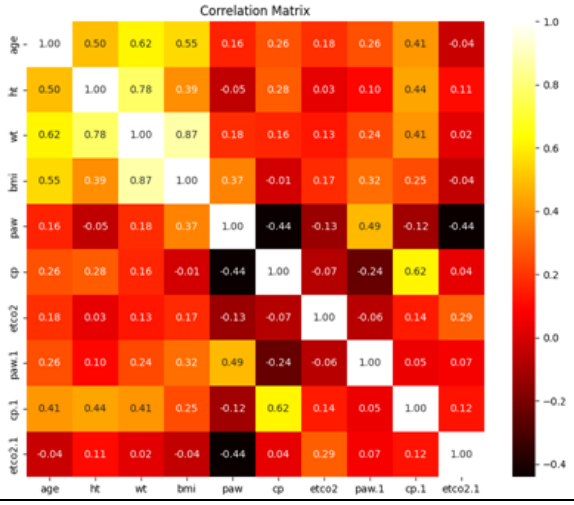
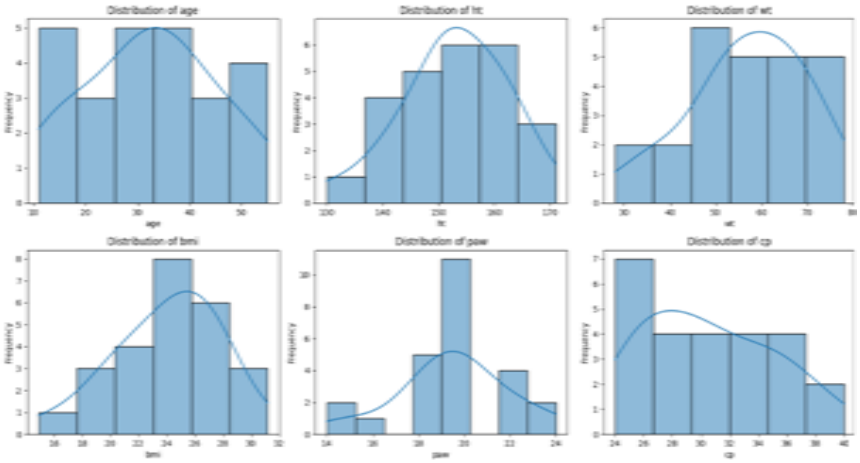


Figure 4 : Correlation Matrix



Graph 1: Distribution of Age, HT, WT, BMI, Paw, CP

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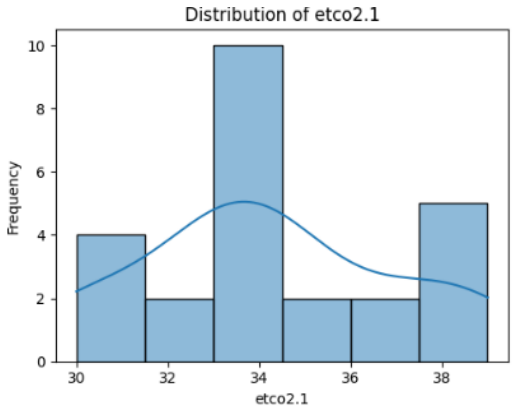
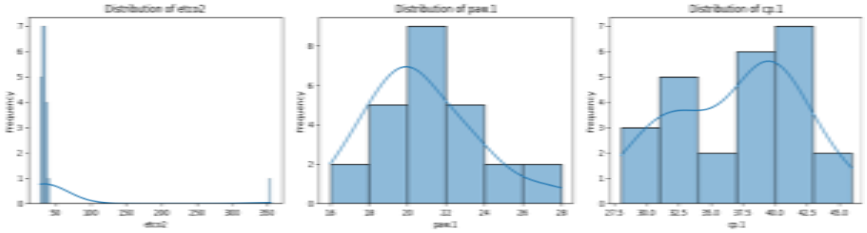


Graph 2: Distribution of $ETCO_2$.1



Graph 3: Distribution of $ETCO_2$.1, Paw.1, CP.1

P Values

age	ht	wt	bmi	paw	cp	etco2	paw.1	cp.1	etco2.1
0	0.011	0.001	0.004	0.443	0.212	0.376	0.218	0.042	0.867
0.011	0	0	0.056	0.817	0.167	0.873	0.648	0.028	0.604
0.001	0	0	0	0.393	0.437	0.532	0.24	0.043	0.909
0.004	0.056	0	0	0.072	0.956	0.407	0.116	0.233	0.844
0.443	0.817	0.393	0.072	0	0.027	0.538	0.014	0.571	0.029
0.212	0.167	0.437	0.956	0.027	0	0.728	0.249	0.001	0.864
0.376	0.873	0.532	0.407	0.538	0.728	0	0.761	0.507	0.163
0.218	0.648	0.24	0.116	0.014	0.249	0.761	0	0.818	0.74
0.042	0.028	0.043	0.233	0.571	0.001	0.507	0.818	0	0.552
0.867	0.604	0.909	0.844	0.029	0.864	0.163	0.74	0.552	0

Figure 5 : P Values

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R Values

age	ht	wt	bmi	paw	cp	etco2	paw.1	cp.1	etco2.1
1	0.497	0.615	0.551	0.161	0.259	0.185	0.255	0.409	-0.035
0.497	1	0.78	0.387	-0.049	0.285	0.034	0.096	0.439	0.109
0.615	0.78	1	0.872	0.179	0.163	0.131	0.244	0.409	0.024
0.551	0.387	0.872	1	0.366	-0.012	0.173	0.322	0.247	-0.042
0.161	-0.049	0.179	0.366	1	-0.441	-0.129	0.487	-0.119	-0.438
0.259	0.285	0.163	-0.012	-0.441	1	-0.073	-0.239	0.616	0.036
0.185	0.034	0.131	0.173	-0.129	-0.073	1	-0.064	0.139	0.288
0.255	0.096	0.244	0.322	0.487	-0.239	-0.064	1	0.048	0.07
0.409	0.439	0.409	0.247	-0.119	0.616	0.139	0.048	1	0.125
-0.035	0.109	0.024	-0.042	-0.438	0.036	0.288	0.07	0.125	1

Figure 6 : R Values

(Neck Extension)

Sl. No.	Cuff Pressure Before Positioning	Cuff Pressure After Positioning
1	14	17
2	15	18
3	22	19
4	20	22
5	18	20
6	20	22
7	24	28
8	20	18
9	19	20
10	22	20
11	20	18
12	22	20

Table 2 – Neck Extension

(Neck Flexion)

Sl. No.	Cuff Pressure Before Positioning	Cuff Pressure After Positioning
1	19	26
2	20	22
3	18	20
4	20	21
5	18	16
6	16	18
7	22	23
8	24	30
9	18	20
10	20	24
11	19	23

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12	20	24
13	18	20

Table 3 – Neck Flexion

P – Values

BMI – PAW 0.072
PAW – CP 0.027
PAW- Paw_1 0.014
PAW – CP_1 0.5
CP-CP_1 0.001
ET CO_2- PAW 0.029

DISCUSSION

Airway protection and aspiration prevention are the two major goals of ENT anaesthesia a part from desensitising the respiratory tract and prevention of bleeding.

Oral and pharyngeal mucosal handing, pooling of blood and secretions in the absence of swallowing reflex increase the risk of aspiration especially in positive pressure ventilation.[1]

The presence of an adequately inflated cuff at the distal end of endotracheal tube offers several advantages including offering a perfect glottis seal, prevention of gross aspiration and ability to withstand positive pressure ventilation.[2]

Glottis and vocal cards themselves are avoid of blood apply and derive supply from tracheal capillaries.

An optimal tracheal capillary pressure of 5-8mm Hg or 10-20 cm of water should be ideally maintained even in the presence of an inflated cuff.[3]

The endotracheal tube cuff pressure has been described to increase in head up positions, nitrous oxide anesthesia, hypothermia causing tracheal capillary ischemia.

Prolonged surgery, head down position have been found to reduce cuff pressure.

A raised cuff pressure in a critical care unit patient on ventilation may promote risk of tracheal scarring, narrowing and silent regurgitation of pooled secretion and precipitate aspiration prevention.

A low cuff pressure increases risk of aspiration. While both neck extension and neck flexion as in rose position for tonsillectomy and the latter with endoscopic sinus surgery caused rise in cuff pressure there are studies conducted in neurosurgical patients where reduction in cuff pressure was noted at various points of the procedure.[4]

The cuff endotracheal tube is inflated with air to achieve an adequate seal to prevent micro aspiration. Over inflation of cuff decrease mucosal perfusion leading to pressure necrosis and nerve palsies. Inadequate seal can lead to micro aspiration.

Several factors are responsible for change in cuff pressure such as time position pressure ventilation, use of nitrous oxide, altitude, muscle relaxation, sedation, hypothermia, different neck body positions, position of endotracheal tube duration of intubation and co-existence of laryngeal edema and bronchoconstriction.

Sole et al showed that cuff pressure over time results in reduction of cuff pressure.[5] Skeletal muscle tone and consciousness in the patients are responsible in maintaining the upper airway structures and laryngeal dimensions in position. In the supine position a patient under general anaesthesia has loss of tonicity of muscle and the neck leading to posterior displacement

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of upper airway structures. Gravity and loss of activity of muscle also push the upper airway structure posteriorly, this might cause a reduction in cuff pressure which continues to be low over a period of time.[6]

Anatomic relationship between endotracheal tube and larynx constantly fluctuates because of changing levels of consciousness and muscle relaxation, Anatomy of trachea, cuff positioning over trachea and cuff physical characteristics such as material, diameter, thickness, compliance and geometry also influence cuff pressure.[7]

Lower cuff pressures have been observed in patients when the endotracheal tubes have gone deeper into the trachea. Neurosurgical procedure involve some element of flexion, extension and mild rotation of the neck. Extension at the atlanto occipital joint is often expected. A continuous infusion of muscle relaxant such as atracurium as per the requirement of the surgery also contributes to a lax larynx and fall in cuff pressure.

Multiple mechanical factors such as defect in inflation valve, pilot balloon and cuff itself can result in the decrease in cuff pressure.[8] Similarly a kink or an extra fold of the cuff can increase the cuff pressures.

Large volume, low pressure endotracheal tube cuff are claimed to have less deleterious effect on tracheal mucosa then high pressure low volume cuffs.[9] Low pressure cuffs may be easily over inflated due to nitrous oxide or positive pressure ventilation to yield pressure that will exceed capillary perfusion pressure. In an endoscopic study of effects of four large volume cuffs by R.D Seeglobin et al various types of large volume endotracheal tubes were studied. Portex profile, Searle sensiv, mallinckrodt H1-L0, and lanz type endotracheal tubes were included in the study.[3]

Tracheal mucosal blood flow was assessed by then using an endoscopic photographic technique by varying the cuff inflation pressures. It was found that these cuffs impaired the mucosal blood flow when over pressurized experimentally in the study.[10]

This impairment of tracheal mucosal blood flow is an important factor in tracheal morbidity associated with intubation. Hence the study recommended the a cuff inflation pressure of 30 cm H_2O (22 mm Hg) should not be exceeded.

At the seal point the tracheal red rubber tubes armoured later and softway tubes exerted pressure above the mean systemic arterial pressure.

The lanz tube is designed to have an over pressure safety balloon could maintain a lateral wall pressure below mean capillary perfusion pressure even when over inflated.

Stijn I blot et al in 2016 did further studies on endotracheal tubes will polyurathane cuffs versus polyvinyl chloride cuffs in conventional endotracheal tubes.

Endoscopic photographic technique threw more light on blood vessels in the sub mucosa and mucosal blood flow.[3]

The cuff tracheal area was examined and photographed at zero airway pressure by GL van hesselt et al. The typical pattern of blood supply to the tracheal mucosa involved anterior and posterior arterioles running around and across the tracheal rings. Anteriorly arterioles run circumferentially in the sub mucosa in between the tracheal rings with branches crossing the sub mucosa over the rings; posterior arterioles and veins run longitudinally in the submucosa.[3] As the cuff pressure rises the posterior wall becomes stretched from the normal flat configuration to accommodate the shape inflating cuff. Based on this anatomy the effect of lateral wall pressure on mucosal blood flow can be looked at anteriorly and posteriorly. The lanz tubes cannot be inflated beyond 27 cm of water owing to their pressure limiting balloons. The Searle sensiv, portex profile and mallinckrodt H1-L0 tubes could be inflated exceed 100 cm H_2O. Numerous

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folds of redundant cuff material with secretions and air bubbles tracking on them were seen. This endoscopic technique clearly visualized the state of blood flow in tracheal mucosa and submucosa which was evaluated at different cuff pressure measured in cm of water.

At 25 cm of H2O anteriorly and posteriorly the blood vessels were of normal calibre and the hue of the mucosa was uniform.

At 30 cm of water – anteriorly the mucosa over tracheal rings was less pink than in intercartilaginous area. Vessels in the submucosa overlying the tracheal rings were of normal caliber and the mucosal hue was similar to that overlying the rings.

At 40 cm of H2O – anteriorly the mucosa over the cartilaginous rings was very pale. Some vessels of reduced calibre could be seen in the submucosa overlying the rings the mucosa in the intercartilaginous area retained its normal hue and the vessels in the submucosa were of normal calibre. Posteriorly the mucosa was pale and with the stretching of posterior wall, the arterioles in the submucosa became attenuated.[3]

At 50 cm of water- anteriorly the mucosa overlying the tracheal rings was blanched and no blood vessels could be seen in the submucosa. The intercartilaginous mucosa retained its normal hue. Posteriorly the mucosa was blanched and the vessels in the submucosa were more attenuated.

At 60-100 cm of H2O - anteriorly the mucosa overlying the tracheal rings remained blanched with no blood vessels in submucosa. The mucosa in the intercartilaginous area had normal hue with normal calibre vessels. Posteriorly the vessels became more attenuated and visible only intermittently as perfusion pressure exceeded lateral wall pressure.[3]

Rose position in otolaryngology surgeries

The patient is positioned supine with head extended by placing a pillow or sandbag beneath the shoulders. The advantage is that larynx lies at a higher level than oral cavity. Hence there is no risk of aspiration, surgical exposure is good.

While placing in the rose position care should be taken to avoid hypertension of neck as this would make the cervical vertebral bodies more prominent with risk of damage to ligaments on cartilage of vertebral spine or bodies.

Indications for rose position

- Tonsillectomy
- Adenoidectomy
- Palato pharyngo uvulo plasty
- Trans oral removal of styloid process
- Coblation and ablation of adenoids
- Thyroidectomy
- Vascular tongue tie release
- Biopsy of palatal and tonsillar lesions
- Cleft palate repair

Contraindications

- Atlanto axial joint instability as in down’s syndrome
- Cervical spine fractures.

Indications for head up position

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- Endoscopic sinus surgery
- Transnasal endoscopy
- Nasal bone fracture reduction and stabilization
- Surgery for epistaxis, biopsies
- Rhinosporiodiosis and polyps in the nasal cavity.

Advantages

- Improved venous drainage
- Reduced bleeding
- Improved surgical access

Disadvantages

- Risk of aspiration
- Proper throat packing is compulsory

The morbidity associated with cuffed endotracheal tubes is multifactorial. Use of mert materials, tube sizes, lateral wall pressure, use of steroids and duration of intubation have all been attributed to in this regard. Awareness of high lateral wall pressure generated by low volume high pressure cuffs and the irritability to deduce lateral wall pressure from intra cuff pressure led to the development of large volume cuffs. The large volume cuffs were designed such that the intra cuff pressure by effecting a clinical seal at low intra cuff pressure. Nordin et al did animal experiments with rabbits and concluded that superficial damage occurred within 15 minutes duration of around 27 cm H_2O Pressure.[11] The basement membrane was damaged with a pressure of 68 cm H_2O or more in 15 minutes.

The damage was not progressive with time. With a lateral wall pressure of 100 mm Hg, progressive damage of basement membrane and mucosal stroma occurred.[12]

Dobrin and Canfield et al used thermistor technique to detect tracheal mucosal blood flow.[2] The maintenance of mucosal hue inspite of gradual increase in cuff pressure, was attributed to blood flow through sub mucosal sinusoids. It has been proposed that large volume high pressure cuffs by draping the intercartilaginous mucosa achieve a sparing effect on capillary blood flow over the cartilaginous rings by applying pressure to arterioles in the intercartilaginous submucosa thus raising the effective perfusion pressure.[10]

Thus it is inferred that it is ideal to monitor endotracheal cuff pressure especially is altered positions of the patient due to surgical needs as well as in prolonged surgeries. Tracheal mucosal morbidity could be significantly reduced if the cuff pressure is maintained throughout the procedure within normal limits Some studies show reduced cerebral tissue oxygenation in rose position but no neurological deficit was clinically detectable.[3]

The effect of rose position on endotracheal cuff pressure was evaluated. Significant increase in endotracheal cuff pressure from normal range was noted and the same was corrected. ($p=0.001$)

A prolonged surgery of more than one hour on rose position as in thyroid surgery or cleft palate repair may cause significant compression or tracheal capillary blood flow and ischemia, especially in ASA III and IV patients. The effect of increased endotracheal cuff pressure in short duration surgeries of around 30 minutes go unnoticed.

Hence periodic measurement of endotracheal cuff pressure is indicated and in mediate correction is recommended especially in long duration surgeries. Having elaborated on neck

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extension, we may further analyze a reverse trendelenberg and mild flexion of neck in nasal procedure.

The patient is positioned supine with head tilted towards the surgeon and head end of bed raised to 15 degrees and head stabilized on a head ring. This posture also eventually weds to mild flexion.

CONCLUSION

Endotracheal general anaesthesia is mandatory to protect airway and prevent aspiration in head and neck surgeries. ENT surgeries adopt rose position head up with neck flexion as common surgical postures for accessibility. Rise in endotracheal cuff pressure was significant more so in Rose position. Various studies using endoscopy photographic technique and thermistor techniques have also demonstrated considerable pressure on the lateral wall reducing tracheal mucosal capillary flow.

It is recommended to periodically monitor and maintain the endotracheal cuff pressure around 30cm of water for ideal conditions of continuous tracheal capillary mucosa blood flow.

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