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ORIGINAL ARTICLE

Arterial Blood Gas Analysis in Patients with Stridor, and the Impact of Emergency Tracheostomy on It: A Tertiary Care Center Experience

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Abstract

Comparative evaluation of arterial blood gas in patients with stridor, before and after emergency tracheostomy. The present prospective study was conducted in tertiary care Centre from February 2022 to June 2023 on 42 patients who presented with stridor and underwent emergency tracheostomy in our department. After proper history taking and clinical examination, nonsurgical cause of stridor was ruled out. Patients were then classified on the basis of location of cause of stridor (whether oropharyngeal, hypo-pharyngeal, supra-glottic, glottic or sub-glottic). Immediately an arterial blood gas (ABG) analysis was done, and emergency tracheostomy was performed. Following tracheostomy, ABG analysis was done immediately, after 12 h and after 24 h. The mean age of presentation of stridor in our study was 65.02 ± 3.23 years, with male preponderance (Male: female ratio being 3.66:1). Most common etiology of stridor in our study was glottic carcinoma comprising 50%, and least common etiology of stridor was hypopharyngeal carcinoma, and subglottic stenosis comprising 2.4% each. There was statistically significant normalization of ABG in terms of pH, PO2, PCO2, HCO3. Mean pH, PO2, PCO2, and HCO3 before tracheostomy were 7.31, 74.8, 60.6, and 29.8 respectively. Mean pH, PO2, PCO2, HCO3, immediately after tracheostomy were7.38, 91.3, 48.4, and 27.4 respectively. After 12 h of tracheostomy, mean pH, PO2, PCO2, HCO3 were 7.41, 95.4, 42.7, 25.3 respectively. Mean pH, PO2, PCO2, HCO3 24 h after emergency tracheostomy were 7.441, 95.5, 42.8, 24.6 respectively. Emergency tracheostomy in stridor patients improves the acid base and ventilatory status, by relieving the obstruction as evidenced by statistically significant improvement in arterial blood gas values, and can be used as a diagnostic tool in upper airway obstruction.

Keywords Tracheostomy · pH · PCO2 · PO2

Introduction

Stridor may be defined as the noisy breathing (high pitched), which arises when airway is compromised at the level of larynx or trachea [1]. The word stridor is originally derived from a Latin word "stridulus" which means noise that is creaking, whistling, or grating [2]. Stridor can be inspiratory, expiratory or biphasic. If obstruction is above glottis that is extra thoracic, there is inspiratory stridor, where as in case of obstruction at lower trachea, expiratory stridor is present. In case of both supra-glottic and glottic obstruction, biphasic stridor is present [3].

From a cell to an organism, respiration is an important process to get energy; oxygen carried by blood from lungs to the tissue level functions as an essential mediator for the release of energy, and the main byproduct of this is carbon dioxide which gets released in the blood [4]. To evaluate the partial pressures of different gases in blood and acid base content, blood gas analysis is a commonly used diagnostic tool [5]. Blood gas analysis helps us to interpret respiratory, metabolic and circulatory disorders [6]. Literature reveals that in case of upper airway obstruction, there is decreased entry of oxygen into the lungs and in-turn into the blood, and decreased removal of carbon dioxide from the body leading to changes in the partial pressures of the blood gases.

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In patients with stridor, emergency tracheostomy is a lifesaving surgical procedure which is performed to provide long term airway access and helps to maintain oxygenation and tissue perfusion [6]. Tracheostomy is the surgical procedure of creating an opening in trachea [7]. Tracheostomy is done to bypass the airway obstruction and create an alternative pathway for gas exchange with surroundings. By creating an opening in the trachea in stridor patients, there is increase in the entry of oxygen into the lungs and blood, and removal of the carbon dioxide from the body, which in turn physiologically changes the partial pressure of blood gases and acid base balance. This change in partial pressures of blood gases and acid base balance can be seen by analyzing the arterial blood gas samples.

As there is very limited literature on this topic in our sub population, we aim to fill that lacuna with this study. The aim of our study was to evaluate changes in ABG after tracheostomy in patients with stridor.

Material and Methods

This present prospective study was conducted in our tertiary care hospital, from February 2022 to April 2023 on 42 patients.

After approval from ethics committee, and informed consent from the patient, all patients presenting with stridor in Department of ENT & Head Neck Surgery (OPD & causality) and satisfying all the inclusion criteria were included in the study.

Inclusion Criteria

1. Patients of either sex.
2. Patients with stridor, in whom emergency tracheostomy was deemed to be the treatment of choice.

Exclusion Criteria

1. All intubated, mechanically ventilated patients in medical ICU.
2. Neurosurgical patients requiring tracheostomy for tracheobronchial toileting.
3. Patients who have bleeding disorders which are uncorrectable.
4. Patients with negative Allen's test.
5. Patients with pre-operative ABG showing mixed type of acid base disorder, which indicates the co-existing metabolic component.

Pre operative evaluation of all the patients included history taking, clinical examination [general physical examination and ENT examination], necessary investigations [CBC, KFT, LFT, Coagulation profile, ECG, X-ray neck AP and lateral view X-ray chest PA view, blood group and triple serology]. In all patients requiring surgical management [emergency tracheostomy] for relief of upper respiratory tract obstruction, under strict aseptic precautions, in a 2 ml heparinized, de-aired syringe, 1 ml of arterial blood sample was taken and immediately subjected to ABG analysis if ABG sample revealed a respiratory acidosis fitting with the picture which is expected in case of obstruction in upper airway, the patient was included in the study. All patients on admission received IV cannulation with 18G cannula and intravenous fluid resuscitation with 0.9% normal saline solution. Humidified oxygen at the flow rate of 5 L per minute through breathing mask was delivered.

Patient was shifted to emergency operation theatre; minimum mandatory monitor was connected and patient's vitals were recorded. Local anesthesia [1:100000, adrenaline:2% lignocaine] after sensitivity test was injected in skin and subcutaneous tissue below cricoid cartilage and 2 finger breadths above supra-sternal notch. Neck placed in hyperextension; vertical incision given in skin approximately 5 cm in length was made below cricoid cartilage in the midline. Then after dissection of subcutaneous tissue, trachea was identified and window was made in trachea and the appropriate size cuffed tracheostomy tube was inserted.

Immediately after tracheostomy, arterial blood sample was taken in a heparinized syringes as per protocol and subjected to ABG analysis. Patient was shifted to post-operative ward. Arterial blood samples were again withdrawn 12 h and 24 h after tracheostomy.

All the results of ABG analysis were tabulated and entered on MS EXCEL spread sheet and the difference between repeated means was analyzed as well as compared using repeated measures ANOVA followed by Bonferroni post hoc correction.

Observations

In our study, following observations were made:

The mean duration of surgery (tracheostomy) was 18.01 ± 6.33 min in our study.

The mean age of presentation in our study was 65.02 ± 3.23 years, with range being 32–79 years. With increase in age, incidence of stridor also increased (Table 1)

Table 1 Number of patients in a particular age group

Age group(years)	Number of patients
31–45	3 (6.9%)
46–60	11 (25.558%)
61–79	28 (65.1%)

Table 2 Table showing sex distribution of stridor patients

Sex	Number of patients	Percentage
Male	33	78.6%
Female	9	21.4%
Total	42	

Table 3 Showing number of patients corresponding to particular etiology of stridor

Etiology of stridor	Number of patients	Percentage
Growth base of tongue	3	7.1
Supra-glottic carcinoma	11	26.2
Glottic carcinoma	21	50
Sub-glottic stenosis	1	2.4
Hypopharyngeal growth	1	2.4
Trans-glottic carcinoma	3	7.1
Others	2	4.8
Total	42	

significantly different from pre op values (p value < 0.001, Df 41.0).

In Pre-tracheostomy ABG mean PO2 was 74.8., which later on immediately after emergency tracheostomy was 91.3. 12 h and 24 h after tracheostomy the mean PO2 was 95.4 and 95.5 respectively. P value and degree of freedom (Df) between pre-op mean PO2 and all the post op mean PO2 values separately was < 0.001 and 41.0, which is statistically significant.

Mean PCO2 in stridor patients before emergency tracheostomy was 60.6 ± 9.01. Immediately after emergency tracheostomy mean PCO2 decreased to 48.4. After 12 h and 24 h of emergency tracheostomy, mean PCO2 was 42.7 and 42.8 respectively. Immediate post op, 12 h post op and 24 h post op mean PCO2 values were significantly different from pre op mean PCO2 values with p value of < 0.001, Df: 41.0).

The mean HCo3 of stridor patients before tracheostomy was 29.8 ± 0.909. Immediately after emergency tracheostomy, mean HCo3 was 27.5 ± 2.59. After 12 h and 24 h of emergency tracheostomy, mean HCo3 was 25.3 and 24.6 respectively. All the post emergency tracheostomy HCo3 values (mean) individually were significantly different from pre op values. (P value: < 0.001, Df: 41.0).

Table 4 Showing arterial blood gas analysis before and after tracheostomy in stridor Patients

	Pre-tracheostomy (mean ± SD)	Immediately after tracheostomy (mean ± SD)	12 h after tracheostomy (mean ± SD)	24 h after tracheostomy (mean ± SD)
PH	7.31 ± 0.025	7.38 ± 0.056	7.41 ± 0.315	7.41 ± 0.0249
PO2	74.8 ± 9.92	91.3 ± 13.41	95.4 ± 3.40	95.5 ± 3.26
PCO2	60.6 ± 9.01	48.4 ± 6.70	42.7 ± 2.35	42.8 ± 2.13
HCO3	29.8 ± 0.909	27.5 ± 2.59	25.3 ± 1.170	24.6 ± 1.49

As shown in Table 2, out of 42 patients in study, 33(78.6%) were male and 9(21.4%) were female, with M:F ratio of 3.66:1, and showing male preponderance.

Among 42 patients in our study (Table 3), glottic cancer was the most common etiology of stridor (50%), and, subglottic stenosis and hypo-pharyngeal growth were least associated with stridor (2.4% each). Supra-glottic carcinoma was the second common etiology of stridor (26.2%). In patients with growth base of tongue and patients with trans glottic carcinoma, incidence of stridor was same (7.1%). The remaining 4.8% of stridor, other (Ludwig's angina, bilateral abductor palsy etc.) was the cause.

In our study (Tables 4 and 5), pre-tracheostomy ABG analysis showed that the mean pH of patients was 7.31 with standard deviation of 0.025. which means that mean PH before emergency tracheostomy in stridor patients was acidic. Mean pH immediately, 12 h and 24 h after emergency tracheostomy was 7.38, 7.41,7.41 respectively. So, it would not be wrong to say that in patients with stridor, emergency tracheostomy plays an important role to improve or normalize the pH, as all the post op values are

Table 5 Showing p values and DF between individual pre-op and post-op means of ABG parameters

		p value	Degree of freedom(Df)
Pre-op pH	Immediate post op Ph	< 0.001	41.0
	12 h post op pH	< 0.001	41.0
	24 h post op Ph	< 0.001	41.0
Pre-op PO2	Immediate post-op PO2	< 0.001	41.0
	12 h post-op PO2	< 0.001	41.0
	24 h post-op PO2	< 0.001	41.0
Pre-op PCO2	Immediate post-op PCO2	< 0.001	41.0
	12 h post op PCO2	< 0.001	41.0
	24 h post op PCO2	< 0.001	41.0
Pre-op HCO3	Immediate post-op HCO3	< 0.001	41.0
	12 h post-op HCO3	< 0.001	41.0
	24 h post-op HCO3	< 0.001	41.0

Discussion

Stridor may be defined as an abnormal, usually high-pitched sound, which is produced due to turbulent flow of air through partially obstructed airway at the level of supraglottis, glottis, sub glottis, or trachea [8]. Stridor being a distressing symptom to the patient demands immediate attention. A thorough evaluation is needed to find the cause of stridor. This is because, if patency of airway is not restored immediately, acute respiratory insufficiency may lead to death of the patient [9].

Thus, emergency tracheostomy is a valuable option in these patients to secure the airway. Emergency Tracheostomy is done to create an alternative pathway below the level of airway obstruction, thus, helping to exchange the body gases with the surrounding environment [2].

To check the effectiveness of tracheostomy in relieving the acute respiratory insufficiency, arterial blood gases will thus be a valuable parameter. Thus postop, pH, PO2, PCO2, HCO3, values were analyzed with reference to pre-op values and an inference was drawn. In our study we attempted to study the changes in arterial blood gas values in stridor patients after tracheostomy.

The mean age of presentation in our study was 65.02, with range of 32–79 years (Table 1). Among total 42 patients, 28(66.66%) patients were in age group of > 60 years. Patients in age group of 31–45 were 3(7.1%), and 11 (26.1%) patients were in age group of 46–60. These observations show that the incidence of stridor increases with increase in age. These results were inconsistent to the study conducted by Althan et al. The mean age was lower than that reported by Crofts et al. [10], Friedman et al. [11].

This increase in incidence of stridor with increase in age can be attributed to the fact that, with increase in age, there is increase in the incidence of laryngeal, hypopharyngeal cancer.

Comparing the males with the females (Table 2), out of 42 patients, 33(78.6%) were males and the remaining 9(21.4%) were females. The sex ratio was 3.66:1. Thus showing male preponderance. These results were in consistent to the study conducted by Hazard et al. which also showed male preponderance (1.18:1; M: F). Crofts et al., also reported the male preponderance (2.1:1; M: F). This can be explained by the fact that there is increased incidence of laryngeal, hypopharyngeal and oropharyngeal carcinoma in men than female [10].

Among the 42 patients studied (Table 3), 21 cases accounting to about 50% were glottis growth followed by supraglottic growth which is present in 11 cases accounting to about 26.2%. Base of tongue and trans glottic growth were equal in incidence, comprising 3 patients (7.1%) each. Incidence of stridor in patients of sub glottis stenosis and growth hypopharynx was lowest comprising 1 patient (2.4%) each. Other causes of stridor like Ludwig's angina, bilateral abductor palsy, etc. constitute only 4.8% (2 patients). However, study conducted by H Meuden et al. 1980, showed hypopharyngeal growth as the most common etiology of stridor.

In patients with stridor, before emergency tracheostomy, the mean pH was 7.31 ± 0.025, with min. of 7.26 and max. 7.34. There was improvement in the pH immediately after tracheostomy in stridor patients, as the mean pH was 7.38 ± 0.056. After 12 h and 24 h post tracheostomy, the mean pH was almost same which is 7.41. But 12 h and 24 h post emergency tracheostomy pH was better than pre-op and immediate post op pH. There was no further deterioration in pH after emergency tracheostomy. This can be attributed to the fact that tracheostomy aids the air entry into the lungs and removal of CO2 from lungs in stridor patients, which in-turn increases the partial pressure of oxygen in arterial blood and decreases the partial pressure of CO2 in arterial blood gas. Due to fall in PCO2, PH becomes less acidic [12].

Analysis of PO2 values in stridor patients before and after tracheostomy reveal that, there is increase in partial pressure of oxygen after tracheostomy. Mean PO2 before tracheostomy in stridor patients was 74.8, but immediately after tracheostomy mean PO2 was 91.3. After 12 h and 24 h of emergency tracheostomy in stridor patients, mean PO2 was 95.4 and 95.5 respectively. This could be explained by the fact that tracheostomy decreases the physiological dead space and also by-passes the airway obstruction, hence increases the air perfusion and in-turn increases the PO2 [13].

Pre tracheostomy mean PCO2 was 60.6 that is hypercarbia. Immediately after tracheostomy mean PCO2 reached to 48.4, which meant that there was decrease in PCO2 and hence normalization of hypercarbia. After 12 h and 24 h of tracheostomy, mean PCO2 reached to 42.7 and 42.8 respectively, showing very little normalization of PCO2. This is because of the fact that the retained CO2 due to airway obstruction washes out after tracheostomy and decreases the PCO2 in blood.

Pre tracheostomy mean arterial bicarbonate was 29.8, which is more than normal. But immediately after emergency tracheostomy, mean arterial blood bicarbonate was 27.5, which is normal. After 12 h and 24 h of tracheostomy, mean bicarbonate values were 25.3 and 24.6 which are also normal. So, it is not wrong to say that after emergency tracheostomy, there is normalization of bicarbonate in blood. This can be attributed to the reason that after emergency tracheostomy, there is removal of CO2 from body, which is an acidic blood gas. In compensation to that, body's homeostasis mechanism normalizes the initially elevated HCO3.

Although our study is one of the few studies done on this topic in this sub-population, the limitations of our study

were we did not include duration of stridor and duration of the surgical procedure.

Conclusion

Patients who have upper airway obstruction, will commonly have acute primary uncompensated respiratory acidosis. In these patients, emergency tracheostomy will be the intervention of choice, as it improves the acid base balance and ventilatory status by by-passing the obstruction as evidenced by statistically significant improvement in ABG value. Also, ABG can be used as diagnostic tool in stridor patients to find the extent of obstruction.

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Data Availability Available with corresponding author upon reasonable request.

Declarations

Conflict of interest The authors declare they have no competing interests.

Ethical Approval and Consent to Participate The study was conducted after approval by Institutional Ethics Committee of GMC Jammu. Written informed consent was taken from all subjects or their legal guardian in case of age of patient being less than 18 years. No animals were used in the study.

Human or Animal Rights The study was conducted on 42 human patients (no animal was used for research) and was issued by institutional ethical committee GMC. Jammu.

Consent for Publication Written informed consent to publish patient's clinical details was obtained from all subjects or their legal guardian in case of subject under 18 years.

Informed Consent Written informed consent was taken from all the study patients in the language that patients/ attendants understood.

References

1. Selvam DK, Vikram VJ, Sakteeswaran M, Mohammed IMP (2017) A study on paediatric stridor causes and management: case series. Int J Otolaryngol Head Neck Surg 3(4):1031–1035. https://doi.org/10.18203/ijohns20174327
2. Patnaik S et al (2021) Etiology, clinical profile, evaluation, and management of stridor in children. Indian J Pediatr 88(11):11155–21120. https://doi.org/10.1007/s12098-021-03722-8
3. Hollinger LD et al (1980) Etiology of stridor in the neonate, infant and child. Ann Otol Rhino Laryngol 89(5 Pt 1):397–400. https://doi.org/10.1177/000348948008900502
4. Chourpiliadis C et al (2022) Physiology, respirator rate. Statpearls Publishing, Treasure Island (FL)
5. Castro D. et al. (2023) Arterial Blood Gas.In: statpearls[Internet] . Treasure island (FL): Statpearls Publishing. 30725564/ NBK536919
6. Hohn A et al (2017) Awake tracheostomy in a patient with stridor and dyspnea caused by a sizeable malignant thyroid tumor: a case report and short review of the literature. Clin Case Rep 5(11):1891–1895. https://doi.org/10.1002/ccr3.1216
7. Leyn PD et al (2007) Tracheostomy: clinical review and guidelines. Eur J Cardiothorac Surg 32(3):412–421. https://doi.org/10.1016/j.ejcts.2007.05.018
8. Benson BE et al. (2022) Stridor clinical presentation. Medscape
9. Kamath MP et al (2010) Role of estimation of arterial blood gases in the management of stridor. Indian J Otolaryngol Head Neck Surg 62(2):125–130. https://doi.org/10.1007/s12070-010-0025-5
10. Crofis SL, Aieer A, McGuire GP, Wong DT, Charles D (1995) Can J Anaesth 42:775–799
11. Friedman Y, Fildes J, Mizock B, Samuel J, Patel S, Appavu S, Roberts R (1996) Comparison of percutaneous and surgical tracheostomies. Chest 110:480–485
12. Wagner PD et al (2015) The physiological basis of pulmonary gas exchange: implications for clinical interpretation of arterial blood gases. Eur Respir J 45(1):227–243. https://doi.org/10.1183/09031936.00039214
13. Davis K, Robert S et al (1999) Changes in respiratory mechanics after tracheostomy. Arch Surg 134(1):59–62. https://doi.org/10.1001/archsurg.134.1.59