CURATIVE BENEFIT OF SUBMUCOPERICHONDRIAL RESECTION OPERATION ON PULMONARY ARTERIAL HYPERTENSION IN PATIENTS OF DEVIATED NASAL SEPTUM

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ABSTRACT

Objective: We aimed at establishing a correlation between deviated nasal septum and pulmonary artery hypertension in patients reporting in Otorhinolaryngology (ENT) clinic at Combined Military Hospital Quetta, and evaluating the beneficial impact of sub mucoperichondrial resection (SMR) operation on right heart myocardial function, primarily related to Pulmonary Arterial Pressures of these patients of longstanding nasal septal deviation.

Study Design: Descriptive; hospital-based cross-sectional survey.

Place and Duration of Study: Departments of Otorhinolaryngology & Cardiology, Combined Military Hospital, Quetta, from Sep 2019 to Apr 2021.

Methodology: Electrocardiographic and 2-Dimensional Echocardiographic parameters of 87 randomized patients suffering from symptomatic longstanding deviated nasal septum (DNS) who had consented to undergo sub mucoperichondrial resection (SMR) operation were compared and studied for any change in status of probability of pulmonary arterial hypertension before and two months after their surgery. Probability of pulmonary hypertension was estimated using probability criteria from updated European Society of Cardiology Pulmonary Hypertension Guidelines 2019. Patients were classified into low, intermediate and high probability depending upon the number of criteria fulfilled by echocardiographic parameters.

Results: Two (2.3%) patients suffering from deviated nasal septum presented with *p*-pulmonale. Twelve (13.8%) reported with right bundle branch block, and 7 (8%) patients demonstrated right axis deviation on electrocardiography. Overall high probability to develop pulmonary hypertension was discovered in 2 (2.3%) patients. We observed a significant improvement in pulmonary artery pressures in patients suffering from long term upper airway obstruction, two months following sub mucoperichondrial resection operation, in terms of maximum velocity and peak tricuspid regurgitation, right ventricle/left ventricle basal diameter ratio, flattening of interventricular septum, pulmonary artery diameter, inferior vena cava diameter and right atrial end-diastolic area.

Conclusion: Surgically correcting deflected nasal septum is effective in reducing Pulmonary Artery Pressures, which may prevent longterm complications resulting from longstanding upper airway obstruction.

Keywords: Hypertension, Nasal obstruction, Nasal septum, Pulmonary.

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INTRODUCTION

Blocked nasal air passageis a universalexperience, many a time anatomical, rather than consequent to inflammation. Symptomatically deviated nasal septum affects 76% of population around the world.[1-3] When a deviated septum is severe, it can block one or both sides of the nose and compromise airflow partially or completely, causing strenuous and sometimes sleep-disordered breathing.[4] Quality of life further deteriorates as additional contact of a deviated septum to the dry atmosphere may sometimes contribute to crusting or troublesome epistaxis in certain people. Patients with obstructing nasal septal deviation are often recommended surgical correction to treat recurrent or chronic sinusitis.[5] Nasal septal deviation can present as simple angulation, obstruction, caudal dislocation and thick nasal septum. In severe cases, nasal septal deviation increases upper airway resistance which in turn, raises mean pulmonary arterial pressure (mPAP) by decreasing oxygen saturation and reciprocal increase in carbon dioxide content. Progressive and sustained high pulmonary arterial resistance results from persistent hypercarbia and acidosis, heralding right ventricular failure, and if left untreated, can precipitate life-threatening systemic venous hypertension and corpulmonale. European prevalence of pulmonary arterial hypertension is 6.6-26 cases per million adults.[6] Mortality primarily attributed to right-sided heart failure or

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sudden cardiac arrest in patients suffering from pulmonary artery hypertension is 44-73%.[7-8]

Longstanding dilation of pulmonary artery can sometimes set off cascade of deleterious events like pulmonary artery dissection and rupture, massive hemoptysis, left main compression syndrome where the left main coronary artery becomes compressed against the trunk of pulmonary artery.[9]

In literature, upper airway obstruction due to adenoids, tonsillar hypertrophy and persistent nasal polyposis have been studied as a cause of pulmonary hypertension, but very sparse local data is available to ascertain longstanding nasal septal deflection as a definitive contributory factor.

Foregoing in view, the rationale of our research is to establish a definitive correlation between nasal septal deviation and pulmonary arterial hypertension, and to underscore the restorative gain of submucoperichondrial resection operation of deviated nasal septum on this debilitating cardio-pulmonary state.

METHODOLOGY

Population of Quetta city was 1,001,205 according to 2017 census. Considering global prevalence of pulmonary hypertension as 6%, confidence level of 95% and margin of error at 5, our minimum sample size turned out to be 87, by applying following formula: n = N*X/(X + N1), where, X = Zα/22*p*(1-p)/MOE2, and Zα/2 is the critical value of the normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion, and N is the population size. Note that a Finite Population Correction had been applied to the sample size formula.

Inclusion Critera: We randomly included 87 patients suffering from symptomatic deviated nasal septum (DNS) who had consented to undergo submucoperichondrial resection (SMR) operation. Each patient was requested a thorough preoperative ENT and cardiologist's review. A clinical inquiry was made to establish degree of nasal blockage in terms of (0-10) visual analogue scale (VAS), where 0 denoted no nasal obstruction, and 10 measured complete nasal obstruction. Patients' accounts were followed by anterior and posterior rhinoscopy using a standard medium-sized Thudicum nasal speculum andposterior rhinoscopy mirror. We performed Cottle's test to demonstrate nasal patency.

Baseline laboratory panel and routine chest radiograph was requested on account of anesthesia fitness for surgery.

Exclusion Critera: A consultant cardiologist would exclude any evidence of left-sided heart disease, lung disease or hypoxia, thromboembolic disease conditions, myeloproliferative disorders, sarcoidosis, pulmonary granulomatous inflammation and any systemic metabolic disorder. Patients unwilling for surgery and unsuitable for general anesthesia were excluded.

2-D echocardiography was performed by the same operator (cardiologist) before and after surgery with the same equipment i.e. Vivid E-6. Electrocardiographic parameters would include p-pulmonale, right bundle branch block and right axis deviation. 2-dimensional echocardiographic parameters would encompass peak tricuspid regurgitation velocity, right ventricle/left ventricle basal diameter ratio, flattening of inter-ventricular septum, pulmonary artery diameter, inferior vena caval diameter and right atrium end-diastolic area. We maintained the data in SPSS version-26. To standardize operating technique, classic submucoperichondrial resection (SMR) operation was performed in every patient under complete anesthesia by the same surgeon.Cardiologist's review two months after surgery incorporated careful evaluation of same parameters to ascertain any change in the preoperative status. We analyzed the data in SPSS version-26. Descriptive statics were applied to define frequency variables. We established a statistical correlation between nasal obstruction score and probability of pulmonary arterial hypertension by applying chi square test. Independent sample t-test was applied to compare the means of continuous variables. We kept arbitrary level of statistical significance at p-value 0.05.

RESULTS

75 (86.2%) participants of our study were males, and 12 (13.8%) were females. Mean age of the patients was 25.09 (SD ± 6.43) years. The youngest of all the patients was 14 years of age, whereas maxim-um age in our study population was 48 years (Figure-1).

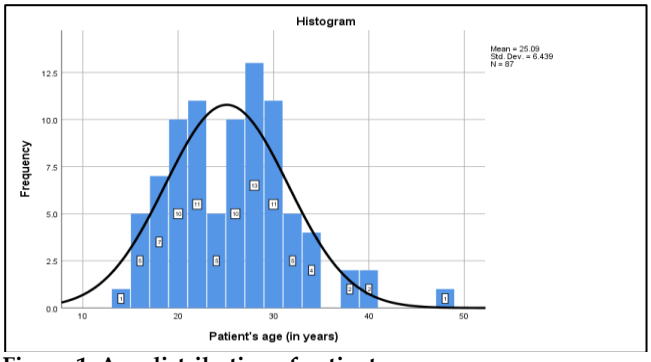

Figure-1: Age distribution of patients.

Majority of the patients (42.53%) had angulated type of deviated nasal septum at first presentation (Figure-2). Our patients reported a highly significant improvement in symptomatic nasal obstruction two months following the sub mucoperichondrial resection (SMR) operation, (*p*-value 0.000). On a subjective 0-10 visual analog scale, pre-operative mean score for nasal obstruction was 7.90 (SD ± 1.152), whereas post-operative mean score (two months after the operation) was 2.03 (SD ± 1.005). We observed a strong correlation between the type of deviated nasal septum (DNS) and the degree of pre-operative subjectively felt nasal obstruction (*p*-value 0.010).

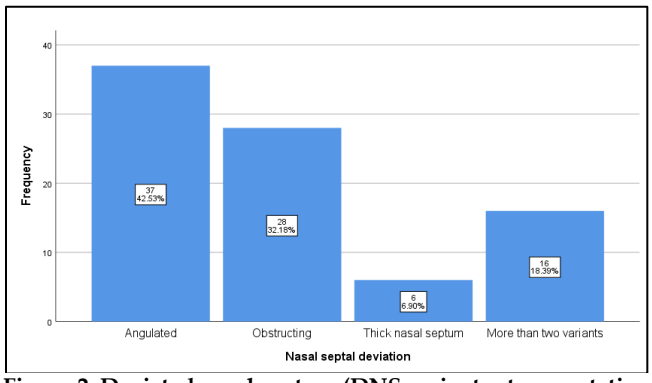

Figure-2: Deviated nasal septum (DNS variants at presentation.

Pre-operative cardiologic work-up of these patients revealed presence of p-pulmonale in 2 (2.3%) patients, right bundle branch block in 12 (13.8%) individuals, and right axis deviation in 7 (8%) patients. Pre-operative mean echocardiographic parameters were recorded as maximum velocity (Vmax) as 2.36 (SD ± 0.510) ms-1; peak tricuspid regurgitation (Peak TRV) as 24.04 (SD ± 9.66)mmHg; and right ventricle: left ventricle (RV: LV) basal diameter ratio as 0.666 (SD ± 0.052). None of the patient exhibited flattening of interventricular septum on pre-operative evaluation. Echocardiographic assessment at initial consultation revealed mean pulmonary arterial diameter and inferior vena cava diameter to be 19.39 (SD ± 2.64) mm and 15.55 (SD ± 1.60) mm, respectively. Before surgery, mean right atrial end-diastolic area in the study population was recorded to be 13.307 (SD ± 2.46) cm^2. By applying European Society of Cardiology (ESC) guidelines for pulmonary hypertension 2019, we established a high probability of developing pulmonary arterial hypertension in 2 (2.30%) of our patients, (Figure-3).

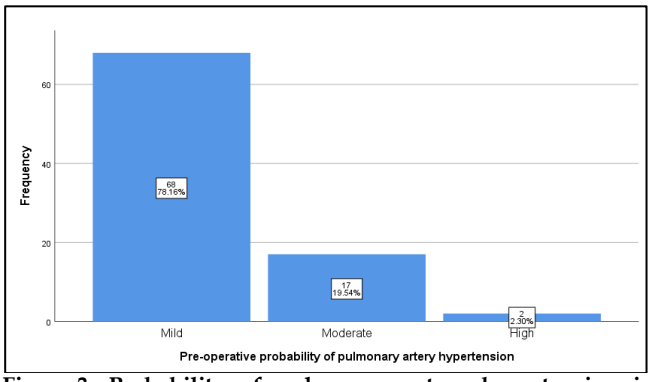

Figure-3: Probability of pulmonary artery hypertension in patients of deviated nasal septum.

At two months' interval following submucoperichondrial resection, we observed a significant improvement in Vmax and PeakTRV following surgery for treatment of nasal obstruction. Similarly analysis of other echocardiographic parameters like right ventricle /left ventricle (RV/LV) basal diameter ratio, flattening of interventricular septum, pulmonary artery diameter, inferior vena cava diameter and right atrial end-diastolic area also displayed an improvement (*p*-value 0.000) (Table). Statistical analysis of probability for having pulmonary hypertension before and after surgery in these patients turned out to be highly significant (*p*-value 0.000).

Table: Single sample t-test.

Diagnostic test	Parameter	Single sample t test statics		
		Sig. (2 tailed)	95% confidence interval of the difference	
			Lower	Upper
Electrocardiography	*p*-pulmonale	0.000	1.94	2.01
	Right bundle branch block	0.000	1.79	1.94
	Right axis deviation	0.000	1.86	1.98
Echocardiography	V max	0.000	2.25	2.47
	Peak TRV	0.000	21.98	26.10
	RV:LV basal diameter ratio	0.000	0.655	0.677
	Interventricular septal flattening	t cannot be computed because the standard deviation is 0		
	Pulmonary arterial diameter	0.000	18.82	19.95
	Inferior vena cava diameter	0.000	15.21	15.89
	Right atrial end-diastolic area	0.000	12.78	13.83
	Probability	0.000	2.14	2.34

DISCUSSION

Pulmonary hypertension denotes a resting mean pulmonary arterial pressure of more than 25 mmHg or more than 30 mmHg after exertion. Hypoxia consequent to chronic upper airway obstruction increases pulmonary vascular resistance typically due to vasoconstriction, remodeling and thrombosis of small pulmonary arteries and arterioles. Microscopic endothelial dysfunction triggers deranged endothelial cell proliferation, eventuating into a constant decline in production of vasodilators like prostacyclin and nitric oxide; and proportionate over expression of vasoconstrictors like endothelin. The outcome is hyperplasia and hypertrophy of intima, media and adventitia of pulmonary arterial vasculature.

Pulmonary artery hypertension is responsible for premature disability and death in more than 25 million individuals world over.[10] There exists a close correlation between sleep disordered breathing and pulmonary artery hypertension revolving around complex neuro-hormonal events. OSA (obstructive sleep apnea), or sleep disordered breathing is characterized by paroxysms of upper airway obstruction that result in repetitive hypoxemia and sleep disruption. Various neuropsychological and cardiovascular complications, including daytime hyper somnolence, cognitive impairment, systemic and pulmonary hypertension and cardiac arrhythmias arise from OSA. Causes of sleep disordered breathing are diverse and include deviated nasal septum, nasal polypi, hypertrophied turbinate, adenoid vegetation and large tonsils etc.[11] Due to high global prevalence, nasal septum deviation (DNS) in adults is assumed to be a leading cause of upper airway resistance. Such lasting hypoxia gradually reflects surge in pulmonary vascular resistance and pulmonary arterial pressure precipitating right ventricular.[12]

Detrimental impact of increased upper airway resistance caused by adeno-tonsillar hypertrophy has been documented in children.[13] Artak *et al*, pointed out a high mean pulmonary artery pressure (MPAP) levels in children with hypertrophied adenoids or large tonsils.[14] As cited by Nader *et al*, Naiboglu *et al*, demonstrated in their work that adeno-tonsillectomy significantly improved elevated pulmonary arterial pressures in these children. Preoperative echocardiography was considered to be beneficial for assessing cardiopulmonary status of such children and might be useful at decision making for adeno-tonsillectomy. Tissue Doppler echocardiography; Tricuspid annular plane systolic excursion (TAPSE); Tricuspid isovolumic acceleration (TIVA) have been utilized as useful tools for evaluation of preoperative and postoperative ventricular function in children with hyper resistant upper airways due to adeno-tonsillar hypertrophy. Early correction of upper airway resistance has been shown to significantly alleviate cor pulmonale in children often featured by stridor, day time hyper somnolence, arterial hypoxia and hypercarbia, pulmonary congestion and right heart strain. Constant hypoventilation during sleep leads to both pulmonary and systemic arterial hypertension, which may produce generalized cardiomegaly and congestive heart failure.[15-18]

Coexisting allergic rhinitis with a persistent deviated nasal septum (DNS) compounds the outcome. Cited by Lima *et al*, Bayrak *et al*, in their research demonstrated a significant association of rise in pulmonary arterial pressure and pulmonary arterial flow compensatory to hypoxia in thirty five patients suffering from seasonal allergic rhinitis.[19] Nasal septum is acritical factor influencing nasal airflow dynamics. About 75-90% of people in our society have some type of nasal deformity. Worldwide prevalence of deviated nasal septum is more than 60%.[21] There are many reasons for nasal obstruction but deviated nasal septum accounts for more than half of the resistance of nasal airways against air flow. Detrimental impact of deviated nasal septum (DNS) has been proposedto be of same magnitude as extensive nasal polyposis in causing alveolar hypoventilation and cor pulmonale. Ghazipour *et al* confirmed a mean decrease of 3.25 mmHg in mean pulmonary artery pressure (MPAP) after surgical correction of upper airway obstruction.[21] Varying degree of septal deformity of nose takes place constantly both at parturition as well as in adult life.[22] Hassanpour *et al* also highlighted a link between nasal obstruction and right ventricular strain, that regardless of the cause, persistently deviated and a rather obstructing nasal septum lowered down oxygen saturation and a proportionate rise in carbondioxide content in the blood. Increased pulmonary artery pressure after hypoxia associated pulmonary vasoconstriction resulting in ventricular hypertrophy due to overburden of the right cardiac ventricle which then led to right cardiac failure.[23]

Our research conforms to the work of Fidan and Aksakai, who demonstrateda significant decline in mean pulmonary artery pressure (MPAP) after surgical correction of markedly deviated nasal.[24] In yet another publication, Simsek and Simsek exclusively evaluated beneficial impact of nasal surgery on right heart

myocardium in patients having sleep disordered breathing due to nasal obstruction. This project incorporated an advanced cytologic examination technology elaborating recovery of right ventricular systolic function following nasal septal corrective surgery.[12] Hassanpour *et al*, also studied the beneficial outcome of septorhinoplasty operation on pulmonary artery pressure. Using a Doppler echocardiography, performed by an expert cardiologist, they found a higher mean preoperative mean pulmonary artery pressure (MPAP)in persons suffering from nasal obstruction secondary to deviated nasal septum (22.5 mmHg in men and 20.03 mmHg in women) than normal population (20 mm Hg). The MPAP of 14.5% patients was greater than 25 mmHg. Markedly deviated septum carried definitive implicationon cardiovascular system due to increase in MPAP.[23,25,26] Sub mucoperichondrial resection (SMR) operation and septoplasty provided qualitative and quantitative relief in upper airway obstruction associated cardiovascular symptoms.[27-29] In a regional study, Smitha *et al* demonstrated a mean systolic and diastolic blood pressure recording of 141.82 ± SD 1.70 mmHg and 91.04 ± SD1.21 mmHg, respectively. These recordings declined to mean systolic and diastolic blood pressure of 128.93 ± 8.60 mmHg and 85.05 ± 4.85 mm Hg respectively 12 months after nasal septal corrective surgery.[28] Reciprocally, effective management of hypertension decreases the risk of, myocardial infarction, stroke, chronic kidney disease and heart failure. Ozkececi *et al*, also confirmed that MPAP decreased and right ventricular function tended to recover after septoplasty operation.[30] Bansal and Singh strongly advocated surgical correction of deviated nasal septum in patients suffering from hypertension and who were at risk of developing myocardial infarction.[29]

In author's view longer follow up may have resulted in more comparable results in terms of recovery and improvement in ventricular function parameters, following surgery for deflected nasal septum.

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LIMITATION OF STUDY

A larger sample size and multi-centre research would help in further strengthening of our conclusion.

CONCLUSION

Longstanding deviated nasal septum (DNS) causes pulmonary arterial hypertension by pronouncing the effects of hypoxia and resulting acidosis on pulmonary artery, thereby putting a constant strain on myocardium of right ventricle. Submucoperichondrial resection (SMR) operation relieves upper airway resistance and efficiently reduces strain on myocardium.

Conflict of Interest: None.

Authors' Contribution

NAS: Conceptualization, Write-up, Data collection, statistical analysis, proof reading, AAC: Data collection, proof reading, KN: Literature search, AK: Data Collection, RF: Data collection, SAAS: Literature search, proof reading.

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