ANALYSIS OF VARIOUS TECHNIQUES OF SURGICAL MANAGEMENT OF INFERIOR TURBINATE HYPERTROPHY

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CERTIFICATE

This is to certify that the dissertation entitled, **"ANALYSIS OF VARIOUS TECHNIQUES OF SURGICAL MANAGEMENT OF INFERIOR TURBINATE HYPERTROPHY"** submitted by **Dr. R. Ramesh Kumar,** in partial fulfillment for the award of the **M.S, Degree** in Ear, Nose, Throat by the Tamilnadu Dr. M.G.R. Medical University, Chennai is a bonafide record of the work done by him in the **Upgraded Institute of Oto-Rhino-Laryngology**, Madras Medical College, during the academic year 2005 – 2008.

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CONTENTS

INTRODUCTION

Breathing well is a condition directly related to quality of life. A good breathing demands good permeability of the nasal airways, the physiological entry door of air flow.

Chronic nasal obstruction is a symptom responsible for most patients visit to otorhinolaryngologists in their daily practices. The evolution in rhinology currently offers a wide array of options that allows for a better understanding and treatment of pathologies related to nasal obstruction, through new diagnostic and therapeutic weaponry. However, many times, such a task still poses a challenge.

Turbinate hypertrophy and nasal septal deviation are main causes of nasal obstruction. The association of septal deviation with inferior turbinate hypertrophy on the opposite side of the septum, in a vicarious way, a frequent finding in daily practices. In the setting of the nasal cycle, with alternating expansion of the inferior turbinates, the patient is able to nasal airflow from one side to the other through the day. However, in the cases of partial anatomically compromised nasal passage or misregulation of the erectile tissue, this delicate balance can be disrupted and result in the complaint of nasal obstruction.

Modern pharmacology offers a large number of options for clinical treatment of nasal obstruction due to turbinate hypertrophy, whatever the origin it may be [allergic, idiopathic, drug related or others and by immunology], in allergy cases. However, despite the fact of it still being a controversial issue, most authors agree that when clinical treatment is not enough to offer good nasal permeability, surgical treatment should be indicated.

Turbinate procedures

a. Resection techniques
b. Non resection techniques

Resection techniques

a. Partial turbinectomy
b. Inferior turbinoplasty
c. Sub total turbinectomy
d. Submucous resection
e. Powered turbinectomy

Non resection techniques

a. Out fracturing of inferior turbinate

b. Steroid injection

c. Chemical cautery

d. Cryotherapy

e. Electro cautery

    a. Surface electro cautery

    b. Submucosal electro cautery

f. Laser treatment

In this dissertation only four turbinate procedures have being taken for prospective analysis which are being done commonly in our Govt General Hospital, Madras Medical College, Chennai-3. They are

a. Partial inferior turbinectomy

b. Submucous resection

c. Submucous diathermy

d. Powered turbinectomy

AIMS AND OBJECTIVES OF THE STUDY

1. To analyze the improvement of nasal obstruction in inferior turbinectomy procedures.
2. To identify the reduction in size of inferior turbinate following turbinectomy procedures.
3. To analyze the following surgical procedures by subjective and objective assessment.
    a. Partial inferior turbinectomy
    b. Submucous resection
    c. Submucous diathermy
    d. Powered inferior tubinectomy.

REVIEW OF LITERATURE

Our studies reporting turbinectomy date from 1908 with Escat. In 1920 and on, after Citelli presented this surgical technique to treat nasal obstruction, it was disseminated.

Labayle , in 1949 called the attention to the physiological role of the nasal conchae and described turbinectomy of the bone submucosa.

In 1959, House praised distinct surgical procedures for nasal conchae of bones and mucosa.

Missaka, in 1972, by means of nasal biopsies in patients submitted to turbinectomy, described partial recovery of nasal mucous structures after 6 months of surgery. Today this is the most frequent procedure in routine and is recognized as an effective treatment for nasal obstruction[1,2].

THE LATERAL NASAL WALL

The lateral nasal wall is formed by eight separate bones, each of which has processes that articulate intricately with each other. There are four large bones and four small bones.

Large bones are

a. The maxilla,

b. The ethmoid,

c. The frontal,

d. The sphenoid.

Small bones are

a. The inferior turbinate,
b. The lacrimal bone,
c. The palatine bone,
d. The nasal bone.

Of these the frontal, ethmoid and sphenoid are single unpaired bones in the midline of the skull. The others are paired ones. Hence,although there are two sphenoid, two frontal and two ethmoid sinuses, there is only a single sphenoid, frontal and ethmoid bone.

The Maxilla (Fig.1)

The maxilla forms the base or the framework on which the lateral nasal wall is built. The lateral nasal wall ia formed by medial surface of the maxilla. The maxillary sinus opening is small and not easily seen. This is because the large opening in the maxillary bone is closed off by processes of different bones, which narrow the opening. These processes are

a. The descending process of the lacrimal bone anteriorly
b. The uncinate process of the ethmoid bone anterinferiorly
c. The maxillary process of the inferior turbinate inferiorly.
d. The perpendicular plate of the palatine bone posteriorly.

Certain areas are covered by only a double layer of mucosa of the nasal cavity and the maxillary sinus. These are the anterior and posterior fontanelles. Occasionally, these double layer of the mucosa may be dehiscent to produce accessory ostia. The normal maxillary ostium is hidden deep behind the intermediate portion of the uncinate process.

Anterior to the maxillary hiatus, the maxillary bone is drawn in to a process, which extends superiorly. Since the upper border of this process articulates with frontal bone and the anterior border articulates with the nasal bone, this process is called the frontonasal process of maxilla. The medial surface of this process shows two crests. The upper one is the ethmoidal crest. The most anterior part of the middle turbinate is attached to this ethmoidal crest. The lower crest is called the conchal crest and gives attachment to the inferior turbinate. The smooth area below the conchal crest forms the part of the inferior meatus[12,13].

The Inferior turbinate (Fig.2)

The inferior turbinate is a separate scroll-like bone. Unlike the middle and superior turbinates, it runs a fairly straight course from anterior to posterior. It is approximately 60mm length in anterior to posterior direction. It forms an important component of the nasal valve. It is derived from the maxilloturbinal ridge. Its inferior margin is free and overhangs the inferior meatus. Its superior margin is attaced to the maxilla anteriorly and the palatine bone posteriorly. Approximately 1cm behind its anterior end, superior margin shows a peak or apex. The nasolacrimal duct opens in to the inferior meatus at this peak[14,15].

Processes of inferior turbinate

The inferior turbinate has three processes.

1. Lacrimal process
2. Ethmoidal process
3. Maxillary process

Lacrimal process

It is present anteriorly from its superior margin. The lacrimal process articulates with the descending process of lacrimal bone and thus assists in forming the canal for the nasolacrimal duct.

Ethmoid process

This is little behind the lacrimal process arising from near the superior margin. It articulates with the uncinate process of the ethmoid bone. Thus to recapitulate, the uncinate process is attached to the lacrimal bone at its anterior end and to the inferior turbinate posteriorly.

Maxillary process

The maxillary process arises from the superior border but it curves laterally to attach to the maxilla. It closes off part of the maxillary hiatus and forms part of the lateral wall of the inferior meatus.

Nasal valve (Fig.3)

There are two nasal valve areas.

a. External nasal valve
b. Internal nasal valve

External nasal valve

Boundaries

- Lower lateral cartilages
- Soft tissue alae

- Membranous septum
- Sill of the nostril.

Internal nasal valve

Boundaries

- Septum
- Upper lateral cartilages
- Anterior end of inferior turbinate.

It is approximately 1.3cm from the external nares. It accounts for 50% of airway resistence. Inferior turbinate can affect this area greately[3,4].

Histology (Fig.4)

The inferior turbinate has three layers.

- Medial thin mucosa
- Bone
- Lateral thick mucosa

Mucosa

The mucosa is lined by pseudostratified columnar ciliated respiratory epithelium. The mucosa contains complex array of arteries, veins, and venous sinusoids. The goblet cells are present densely allover the inferior turbinate. The goblet cells produce salts, glycoproteins, polysaccharides, lysozymes.

Nerve supply of nasal cavity

a. Olfactory nerves.

They carry sense of smell and supply olfactory region of nose. They are the central filaments of the olfactory cells and are arranged into 12-20 nerves which pass through the cribriform plate and end in the olfactory bulb. These nerves can carry sheaths of dura, arachnoid and pia with them in to nose.

b. Nerves of common sensation

They are

a. Anterior ethmoidal nerve
b. Branches of spenopalatine ganglion
c. Branches of infraorbital nerve.

The branches of infra orbital nerve supplies vestibule of nose both on its medial and lateral side. Most of the posterior two thirds of the cavity is supplied by branches of spenopalatine ganglion which can be blocked by placing a pledget of cotton soaked in anaesthetic solution near the spenopalatine foramen situated at the posterior extremity of middle turbinate. Anterior ethmoidal nerve which supplies anterior and superior part of the nasal cavity.

d. Autonomic nerves

Parasympathetic nerve fibres supply the nasal glands and control nasal secretion. They come from greater superficial petrosal nerve, travel in the nerve of ptreygoid canal [vidian nerve] and reach the spenopalatine ganglion where they relay before reaching the nasal cavity. They also supply the blood vessels of nose and vasodilation.

Sympathetic nerve fibres come from upper two thoracic segments of spinal cord, pass through superior cervical ganglion, travel in deep petrosal nerve and join the parasympathetic fibres of great petrosal nerve to form the nerve of pterigoid canal . They reach the nasal cavity without relay in the spenopalatine ganglion. Their stimulation causes vasoconstriction. Excessive rhinorrhoea in cases of vasomotor and allergic rhinitis can be controlled by section of the vidian nerve[16,17,18,19].

BLOOD SUPPLY OF LATERAL NASAL WALL

Internal carotid system

a. Anterior ethmoidal
b. Posterior ethmoidal

They are branches of ophthalmic artery.

External carotid system

a. Posterior lateral nasal branches

from spenopalatine artery

b. Greater palatine artery

from maxillary artery

c. Nasal branch of anterior superior dental

from infraorbital branch of maxillary artery

d. Branches of facial artery to nasal vestibule.

Lymphatic drainage

Lymphatics from external nose and anterior part of the nasal cavity drain in to submandibular lymph nodes while those from rest of nasal cavity drain in to upper jugular nodes either directly or through the retropharngeal nodes. Lymphatics of the upper part of nasal cavity communicate with subarachnoid space along the olfactory nerves.

PHYSIOLOGY OF THE NOSE

The nose is the entrance to the lower respiratory tract as well as to the olfactory epithelium[5] .

Functions of the nose related to turbinates

a. Airway
b. Filtration – most particles greater than 30 micrometer
c. Heating – to 31 – 37 degrees
d. Humidification – to 95%

RESPIRATORY MUCOSA

The pseudostratified respiratory mucosa consists of ciliated, intermediate, basal, and goblet cells. They rest on a well-defined basement membrane supported by a relatively deep, loose lamina propria containing small blood vessels, venous plexuses, ducts of mucous and serous glands, sensory nerves, and blood cells (primarily lymphocytes). The blood capillaries and the venules are thin walled and possess a fenestrated endothelial lining and a porous basement membrane.

The tall (15 to 20 microns) columnar ciliated cell is the predominant cell and extends from the basement membrane to the luminal surface, where cilia admixed with microvilli are present. The microvilli are shorter than the cilia and some are branched. The microvilli contain bundles of microfilaments and display hairlike projections. The function of the microvilli is unknown, although it is clear that they greatly increase the cell surface area. The ciliated cell cytoplasm forms complex interdigitations with adjacent cell membranes, presumably to permit intercellular exchange. Irregular intercellular spaces exist to accommodate edema fluid and inflammatory cells for implementation of the immune response.

Basal cells lie on the basement membrane and likely are progenitors of the columnar and goblet cells. Evidence suggests that the primary progenitor may be a nonciliated columnar cell that can form a ciliated cell. Goblet cells taper upward from the basement membrane to an expanded body at the lumen, where microvilli are found on their exposed surfaces. The nucleus is situated basally, and secretory granules that contain mucin are seen toward the lumen. Columnar cells extend from a narrow base at the basement membrane to an expanded surface area covered by microvilli. These cells are related to adjacent cells by tight junctions apically and by interdigitations of the cell membrane. This cell may be the progenitor of the airway epithelium[6].

AIRWAY

The nose provides a semirigid passageway for in- and outgoing air. On entering the nose, the air is directed upward by the nares . The air stream turns 80 to 90 degrees posteriorly as it reaches the nasal vault to traverse a mostly horizontal path until it impacts against the posterior wall of the nasopharynx. At this point, joined by the air stream from the other side, an 80- to 90-degree downward bend occurs. Each of these two bends, termed "impaction points," likely facilitates the removal of particulates contained in the incoming air. Impaction against the adenoid may enable the adenoid to respond immunologically by "sampling" the contaminants contained in the air. "Sniffing" draws the inspired air higher in the nasal cavities to reach the olfactory areas. The expiratory route is generally the reverse of the inspiratory and also may reach the olfactory area[7].

AIR STREAM

The anterior nasal valve, or ostium internum, is located at the limen nasi, some 1.5 to 2 cm posterior to the nares. At this point, the cross-section of the airway is 20 to 40 mm^2 on each side, is the narrowest part of the upper respiratory tract, and provides about 50% of the total airway resistance. Posterior to this in the horizontal section of the nasal airway, the cross-section widens while the air stream remains narrow and thus provides a large surface area in intimate contact with the air stream.

Evidence has accumulated that there is a 21 to 4-hour cyclic alteration of nasal resistance from one side to the other. A prolonged increase in nasal resistance can lead to cor pulmonale, cardiomegaly, and pulmonary edema. The most common sequel to increased nasal resistance is mouth breathing, thus bypassing the air conditioning and cleansing functions of the nose[8].

AIR SPEED (Fig.5)

The air speed is greatest at the anterior nasal valve, reaching 3.3 m/s at an inspiratory flow rate of 200 mL/s compared with 1 mm/sec in secondary bronchi . Beyond the valve, the air speed slows down, thus enabling a longer contact between the incoming air and the nasal walls. At the choana, the stream again narrows.

PARTICLE REMOVAL

The aerodynamic equivalent diameter (AED) is the diameter of a unit density sphere with the same settling speed as the particle in question.

Particles of approximately 5 micro meter AED or greater are 80 to 85% removed by the nose and nasopharynx. Smaller particles penetrate to varying degrees to the lower respiratory tract. Virus-containing droplets coalesce into diameters, frequently exceeding 5 to 6 micro meter, and thus are largely retained in the nose.

AIR CONDITIONING

The air is heated (or cooled) by radiation from the mucosal blood vessels. Humidification occurs by evaporation from the mucous blanket. That this is an efficient mechanism is attested to by the fact that, in the nasopharynx, the inspired air is near normal body temperature and the relative humidity is near 100%.

The mucosal blood vessels lie in two layers of more or less parallel rows. The more superficial layer sends capillaries into the epithelium, and the capillaries of the deeper layer near the basement membrane are fenestrated to facilitate fluid movement. The flow of blood is from posterior to anterior, opposite to the flow of inspired air and mucus. The mechanism of a “counter current” adds to the efficiency of the system[7,8].

The Regenerative effect

The nasal mucous membrane is cooler by varying amounts than the expired air; thus, some condensation on and warming of the membrane occur
—a so-called regenerative effect.

RESPIRATORY CILIA

In humans, the respiratory cilia are found throughout the respiratory tract except for the nasal vestibule, the posterior oropharyngeal wall, portions of the larynx, and terminal ramifications of the bronchial tree. They are found in the Eustachian tube, much of the middle ear, and the paranasal sinuses. Cilia in a modified form also occur in the maculae and cristae in the inner ear and in the eye as retinal rods.

Ciliary Ultrastructure

Human cilia extend about 6 microns above the luminal surface of the cell and are about 0.3 micron in width. As many as, 100 are found on each cell in the nose. Each cilium appears to be anchored to a basal body located just below the cell surface. The structure of the centriole of a dividing cell is similar to the basal body, the former giving rise to the latter and the latter to the cilium.

Each cilium is encased by an extension of the cell plasma membrane. Within the cilium is a sheaf of longitudinally arranged microtubules (or fibrils) termed an axoneme. The microtubules are, in fact, doublets or pairs with nine outer pairs arranged in a cartwheel pattern at the periphery of the axoneme. In addition, two single microtubules are located in the center of the axoneme, creating the characteristic “9 plus 2” pattern .

At the tip of the cilium is a dense cap or crown from which three to seven “claws,” 25 to 35 nm long, project. Below the cell membrane and the axoneme is a short, cylindrical basal body, and below this, the tubules (with a third added to form a triplet) seem to extend into the apical cytoplasm of the cell as a “rootlet.” They converge into a cone-shaped form and acquire periodic striations. This structure, the basal foot, curves in the direction of the effective ciliary beat.

The basal foot has a cross-striated appearance resembling that of collagen fibers. In addition, other fine microtubules, which appear to be branched, attach to adjacent basal bodies, to each other, and ultimately to the junctional complex of the cell, constituting the terminal web.

Looking top-downward on the outer ring of doublets, each is composed of two juxtaposed microtubules—a slightly more centrally located subfiber, A, and a slightly more peripherally located subfiber, B . Two regularly arranged arms extend from A toward B. They are composed of adenosine triphosphate and are called dynein arms. Also present are links attaching each subfiber A to B of the adjacent doublet. They are believed to be of an elastic material called nexin. Extending centrally from A to the central pair are radial spokes.

At the base of the cilium, the two central microtubules terminate, and each of the peripheral doublets continues downward to enter the basal body as a triplet with a subfiber, C, added[9,10].

Ciliary Beat

The to-and-fro movement of the cilium is termed the ciliary beat. The forward beat is the more forceful, effective stroke in which the cilium is fully extended, and the claws at the tip penetrate the top layer of mucus bordering on the luminal surface and propel the mucus forward.

The recovery stroke is less forceful and slower, and the shaft curls back on itself so that it does not reach the overlying flakes of mucus. Beating is metachronous and occurs 1,000 or more times per minute.

The motion of the cilium is caused by the sliding of one tubule against an adjacent one, thus creating a shearing force that induces the bending. The nature of the “nervous” connection between adjacent cilia is not clear; perhaps the “touch” of one cilium against the adjacent cilium is enough to initiate the coordinated, metachronous movement. Energy for this work is derived from the adenosine triphosphate found in the dynein arms. The “spokes” seem to detach and reattach several times during the bending process. The axis of motion of the cilium is defined by a line perpendicular to a plane connecting the central pair of tubules.

In health, particles resting on the mucous blanket are moved by active cilia at 3 to 255 mm per minute, with an average of about 6 mm per minute.

Apparent health exists, however, with speeds at some variance from this average. Dryness of the mucosa is quickly detrimental to ciliary activity. Other factors known to influence clearance speeds are the relative humidity and the pH of the fluids. Numerous structural abnormalities of the axonemal tubules have been found .

Either a dye or saccharin can be used to measure the movement of material resting on the mucous blanket of the nose. Dye or saccharin is placed on the anterior aspect of the nasal mucosa and the time until the color of the dye is seen in the pharynx or the taste is reported by the subject is recorded. The use of tagged particles, developed by Quinlan et al, involves placing an anion exchange resin particle about 0.5 mm in diameter tagged with a technetium 99m ion on the anterior nasal ciliated mucosa, and its clearance can be followed accurately with a gamma camera or multicollimated detectors.

MUCOUS BLANKET

The bilayered mucous blanket, produced mostly by the serous and goblet glands, is a 12 to 15 microns thick, sticky, tenacious, adhesive sheet consisting of an upper, more tenacious mucus riding on the tips of the ciliary shafts and a deeper, thinner periciliary layer. The blanket functions as a lubricant, protects against desiccation, and traps particulate matter and soluble gases. It amounts to 1 to 2 L per day.

In health, the pH is slightly acid. Its approximate composition is

a. 2.5 to 3% glycoprotein,

b. 1 to 2% salts,

c. 95% water.

Immunoglobins comprise about 70% of the protein content. Mucus is found throughout the nose (except the vestibule), paranasal sinuses, middle ear, eustachian tube, and bronchial tree (and extending into the alveoli in the form of surfactant). The beating of the underlying cilia propels the blanket of mucus, along with trapped or dissolved material, in a more or less continuous movement toward the pharyngeal end of the esophagus.

Enveloping the shafts of the mucosal cilia is the thicker, less viscid, and deeper periciliary layer, and above this, interfacing with the luminal surface, is the more viscid layer of mucus riding on the periciliary fluid below. The mucus on the luminal surface may take the form of flakes. Soluble and insoluble matter caught in the mucus and on the mucous flakes are carried posteriorly by the movement of the mucous blanket to the upper end of the esophagus[9,10,11].

MUCOCILIARY TRANSPORT

The mucociliary transport or clearance system is really two systems working in concert with one another. Its motive force is dependent on the actively beating cilia reaching the flakes of mucus at the luminal surface and propelling the flakes and surrounding mucus posteriorly to the esophagus.

The mechanism by which the deeper periciliary, less viscid fluid, with its dissolved contaminants and likely viruses, also moves posteriorly is less well understood. More needs to be learned about the rheology and the effects of various viscoelastic properties, as well as the thickness of the mucous blanket under varying conditions and its relation to health and the cleansing function of the nose.

Although most bacteria seem to impede the metachronous ciliary cycle and efficient transport system little or not at all, *Bordetella pertussis*, *Mycoplasma pneumoniae*, and *Pseudomonas aeruginosa*, among others, do so. Some respiratory viruses and bacteria, notably influenza virus, rhinovirus, adenovirus, herpes simplex virus, and respiratory syncytial virus, seem to impede mucociliary transport by altering either the axonemal ultrastructure or the viscoelastic properties of the mucous blanket[11].

NASAL AIRWAY ASSESSMENT

NASAL EXPIRATORY OR INSPIRATORY PEAK FLOW

Nasal expiratory or inspiratory peak flow, which uses a peak-flow meter, has the advantage of being inexpensive, quick, and easy to perform. It is useful for repeated examinations and compares well with active anterior rhinomanometry. Of the two methods, forced inspiration is preferred, although it can produce significant vestibular collapse in some individuals. Forced expiration inflates the Eustachian tube, which may be uncomfortable and may also produce an unpleasant quantity of mucus in the mask.

RHINOMANOMETRY

Nasal resistence to air flow is calculated from two measurements;

a. Nasal air flow
b. Transnasal pressure

Rhinomanometry attempts to measure nasal airway resistance by making quantitative measurement of nasal flow and pressure. It employs the principle that air will flow through a tube only when there is a pressure differential passing from areas of high to low pressure.

Nasal resistence to air flow may be calculated from the following equation

$$R = P/V$$

R = resistence to air flow, in cmH_2O/litre/s

Or $Pa/cm^3/s$

P = trans nasal pressure, in cm H_2O or Pa

V = nasal air flow, in litre/s or cm^3/s

This equation is a compromise which has been generally accepted by rhinologists and it does not take in to consideration separate components of laminar and turbulent air flow.

When the nasal mucosa is decongested, the reproducibility of rhinomanometry is good, but it requires some expertise to produce consistent results and has therefore remained primarily a research tool. Active anterior rhinomanometry is more commonly used as the posterior technique cannot be used in 20 to 25% of individuals owing to an inability to relax the soft palate.

ACOUSTIC RHINOMETRY

In acoustic rhinometry, an audible sound pulse is electronically generated and is passed into the nose, where it is altered by variations in the cross-sectional area. The reflected signal is picked up by a microphone and analyzed, allowing determination of area within the nasal cavity as a function of distance. From this, volumes may be derived, thus providing topographic information rather than a measure of airflow. It appears to be more reproducible and to have greater applicability than rhinomanometry but is still being evaluated as a clinical tool.

A major advantage of the technique of acoustic rhinometry is that it provides a measure of nasal cross sectional area along the length of the nasal passage., unlike rhinomanometry which is limited to measuring the narrowest point of the nasal airway.

FACTORS CONTRIBUTING TO VARIABILITY IN OBJECTIVE AIRWAY TESTING IN GENERAL

- Nasal cycle causes variability in unilateral resistance, but total nasal resistance remains relatively constant .
- Secretions can increase nasal resistance
- No change caused by nose blowing
- Exercise causes a reduction in resistance
- Hyperventilation increases nasal resistance
- Breathing CO_2 decreases nasal resistance
- Nasal resistance is greatest when supine and least in the upright sitting position
- Nasal resistance is highest at night and in the early morning.
- Medications decongestant spray decreases nasal resistance
- No effect on the airway from saline nasal drops
- Aspirin causes a small increase in nasal resistance

- Antihistamine treatment may increase the nasal resistance in the unchallenged nose
- Smokers had significantly higher nasal resistance than nonsmokers.
- Nasal resistance increases with height in adults
- No correlation between nasal resistance and height in children
- Age: No change in nasal resistance with increasing age in adults

  Decrease in nasal resistance with advancing age in adults

  Nasal resistance increases with age in children .

In Acoustic rhinometry

- Temperature: 1-mm shift in anatomic features for every 2.5˚C difference in temperature
- Race : Minimal cross-sectional area was significantly lower in whites and Asians than in blacks; volumes smallest in Asians, largest in blacks
- Computer software may erroneously locate the minimal cross-sectional area at the outer end of the nosepiece, thus necessitating the establishment of a zero point.

In Rhinomanometry

- Temperature: Cold air increases nasal resistance

- Race Nasal: resistance is greater in whites than in blacks and intermediate in Asians
- Humidity: No change with changes in humid

COMMONEST TURBINATE DISORDERS

a. Allergic rhinitis
b. Acute rhinosinusitis
c. Chronic rhinosinusitis
d. Vasomotor rhinitis
e. Drug induced rhinitis
f. Atrophic rhinitis
g. Others – synechiae, polypoid changes.

Turbinate procedures

a. Resection techniques
b. Non resection techniques

Resection techniques

a. Partial turbinectomy

b. Inferior turbinoplasty
c. Sub total turbinectomy
d. Submucous resection
e. Powered turbinectomy

Non resection techniques

a. Out fracturing of inferior turbinate
b. Steroid injection
c. Chemical cautery
d. Cryotherapy
e. Electro cautery
    a. Surface electro cautery
    b. Submucosal electro cautery
f. Laser treatment

Advantage of resection techniques

a. Effect long lasting
b. Major improvements innasal airway and congestion

Disadvantage of resection techniques

a. More invasive
b. Take longer time to heal
c. Have the added risk of intra operative and post operative hemorrhage
d. Increased risk of dryness
e. Increased risk of atrophic rhinitis

Advantage of nonresection techniques

a. Less invasive
b. Faster to heal
c. Less likely to result in a dry nose and atrophic rhinitis

Disadvantage of nonresection techniques

a. Only small incremental improvement in nasal airway
b. In the long term it more likely to be associated with recurrent
    1. Rhinorrhea
    2. Congestion

3. Obstruction secondary to mucosal regrowth and hypertrophy.

Anaesthesia

The choice of anaesthetic technique will vary depending on the precise technique employed and the other procedures to be done in combination with the turbinate procedure. When only the turbinate procedure is to be performed, general anaesthesia is rarely necessary. Unless extenuation circumstances exist, a local anaesthesia with mild sedation is usually sufficient

In most cases 4% cocaine solution is used as a topical agent to decongest the nose and provide some anaesthesia of the turbinate mucosa. The solution is applied via cottonoids or cotton pledgets around the turbinate. Alternatives include oxymetazoline or phenylephrine in combination with lidocaine, or a topical decongestant alone. Cocaine flakes are not necessary for isolated turbinate procedures.

Local anaesthesia is injected after the topical agent has taken effect. Most commonly 1% lidocaine with 1 : 1,00,000 epinephrine is used. Approximately 3 to 5 ml is injected for each turbinate, divided between the posterior end, anterior edge, and the medial mucosa.

When the turbinate procedure is performed in combination with other procedures, such as septoplasty or sinus surgery, the selection of anaesthesia is based on the requirements of these procedures.

Submucous resection of the inferior turbinate

Submucous resection of inferior turbinate can be performed using a speculum and head light or nasal endoscopes. After the anaesthesia is applied, the incision is made along the inferior edge of the turbinate. The incision is best made with a no 11 blade. The incision is carried down to bone from as far posterior as can be comfortably reached to anteriorly into nasal root.

The mucosa is then elevated from both the medial and lateral surfaces of the turbinate bone using either a cottle elevator or an angled turbinate scissors. While retracting the mucosal flaps with the nasal speculum, the turbinate bone is resected. This can be accomplished either by cutting it with the turbinate scissors or using a rongeur to remove the bone piecemeal. The flaps are then cauterized along the raw surface to prevent hemorrhage and laid back together. If necessary a pack may be placed to stent the flaps during the initial stage of healing. A piece of rolled telfa is favoured for this purpose.

Postoperative care consists of serial removal of crust from the healing incision. This will often only be required on two or three occasions during the postoperative period. Adherent scabs should be left in place until they soften and separate naturally. The patient should be encouraged to use normal nasal saline drops frequently until healing is complete. Topical nasal steroids, decongestants and antihistaminics are withheld until the effect of the procedure is known and the need for these medications is confirmed[39].

Powered inferior turbinectomy (fig.8,9)

A spinal needle attached to a 2 ml syringe is used to infiltrate along the posterior inferior border of inferior turbinate. The turbinate is fractured medially, allowing space for the endoscope and powered microdebrider to be placed. A 12 degree or straight blade is used in oscillate mode to remove the soft tissue from the lateral aspect of the vertical portion of the inferior turbinate

The debrider is then set on forward and the majority of the bone removed with the rotating blade. If the oscillate mode is used for bone removal this will often result in bone and portions of the medial surface of the turbinate being removed. If possible this should be avoided because this portion of the turbinate should be preserved so it can be rolled upon itself at the end of the procedure[41].

The residual bony fragments are dissected free with the malleable probe or double right angled ball probe.

The inferior turbinate bone often thickens considerably as the dissection is continued anteriorly. It is often useful to use the paediatric backbiter to facilitate the dissection of this bone. Removal of this bone is critical, this is the narrowest region of the nose and the greatest degree of benefit can be achieved here.

After all the lateral mucosa and bone have been removed the remaining mucosa is rolled upon itself, covering the raw area. The freer's elevator is used to roll the mucosa and if necessary fracture the horizontal portion of the remaining inferior turbinate laterally. This reduce the size of the turbinate by 50%.

A rectangle sheet of surgicel is placed over the rolled turbinate to keep it in place and prevent the mucosa from unrolling. It also provides a degree of hemostasis. No other packing is placed in the nose.

Patients starts saline nasal spray within a few hours of the surgery. This is continued for one month postoperatively. After one day patients are allowed to very gently blow their nose after saline wash. Antibiotics are given for 5 days. Patients are reviewed after 2 weeks.

Electro cautery of the inferior turbinate

Electro cautery can be performed in two ways

a. Surface cautery
b. Submucosal cautery

Surface electro cautery

The purpose of surface electro cautery is selective ablation of the bulbous mucosa of the turbinate. This is useful in treating mulberry turbinate, which is hypertrophy of the posterior tip of the turbinate. Suction cautery is favored in such cases because the cautery instrument can be bent to improve the angle of the approach, has an insulated tip and evacuates the smoke as it is produced. The latter feature increases visualization and shortens surgery time[42].

When performing surface cautery a setting of 20 to 25 mA is used. The cautery is used to vaporize the exact amount of mucosa necessary to achieve the desired effect. After surgery the patient usually develops crusting over the cauterized areas. This is treated by manually removing loose crusts and mucous leaving adherent scabs attached. The patient is encouraged to use saline nasal spray liberally until the scab loosens up, at which time it can be removed. Typically, it takes 3 to 4 weeks but may take as long as 6 weeks if aggressive mucosal ablation is performed.

Submucosal cautery (fig.7)

Intra mucosal cautery is useful when attempting to induce involution of the mucosal glands with in the submucosa without damaging the overlying ciliated mucosa. This procedure is indicated for watery rhinorrhea associated with chronic rhinitis. Needle tip cautery is used for this procedure.

After adequate anaesthesia, the needle is inserted in to the submucosa of the turbinate along the inferior edge. The cautery is set for 15 mA and turned on for 30 to 45 seconds. The cautery is then removed and reinserted medially and superiorly a distance of 1 to 2 cm from the initial site. The cautery is repeated in this location and then moved superiorly again and repeated. Three locations along the medial surface are generally used. After this procedure, postoperative care is not normally required[34,35].

Out-fracture of the inferior turbinate

As out-fracture of the inferior turbinate is generally done in conjunction with other nasal surgery, the mucosa will probably already be congested. If not either 4% cocaine solution or a topical decongestant in combination with lidocaine is applied to the turbinate mucosa using cotton pledgets. After adequate decongestion, the turbinate can be anaesthetized, if necessary, using 1% lidocaine with 1:100000 epinephrine. The favored technique for out-fracture is first to displace the turbinate medially, then to lateralize it.

A freer elevator or a boise elevator is placed lateral to the turbinate and firmly rotated medially by pushing up and in. The instrument is then reapplied to the medial surface and the turbinate is fully lateralized, making sure that the turbinate bone is fractured along its entire length. Packing is usually not needed, but may be useful in holding the turbinate laterally during initial healing. Little or no postoperative care is required[28,29].

Intraturbinal corticosteroid injection

Enthusiasm for intraturbinal corticosteroid injection diminished after reports of temporary and permanent blindness appeared. These may have occurred owing to retrograde flow of particulate matter into the ophthalmic circulation, possibly associated with inadequate vasoconstriction[30,44,45].

Laser turbinectomy

A variety of cutting and coagulating lasers have been used to "cauterize" and reduce the inferior turbinate, including carbondioxide, argon, KTP and neodymium:YAG lasers. A cross-hatching of the mucosa is thought to optimize shrinkage while preserving mucosa[36,38].

Cryosurgery with liquid nitrogen.

This was popular in the past but has largely been superseded by other techniques[33].

Inferior turbinoplasty of the inferior turbinate

Inferior turbinoplasty of the inferior turbinate can be performed either with the standard head light and nasal speculum or endoscopically. The anaesthesia for this procedure is the same as described earlier. Once adequate anaesthesia has been obtained, the standard procedure is performed by making an incision using a no. 11 scalpel, along the inferior edge of the turbinate up to the anterior attachment.

The medial mucosa is next elevated from the turbinate bone using cottle elevator. The mucosa of the turbinate is densely adherent to the underlying bone and the surface of the bone is quit irregular, making this elevation somewhat difficult. The elevator should be firmly applied to the bone and the mucosa scraped from the bone . The gentle sweeping motion used to elevate the mucosa from the bone of the posterior septum during septoplasty does not work well for this procedure and may result in mucosal tears.

After the mucosa is elevated, there will be strands of tissue remaining that connect the mucosa to the bone. These should be lysed with an angled turbinate scissors. The same scissors can be used to extend the flap posteriorly and to release the flap from the posterior aspect of the turbinate.

After the flap is completely elevated the turbinate scissors are used to excise the bone and lateral mucosa of the anterior two thirds of the turbinate. The scissors are first angled superiorly to catch the leading edge of the turbinate bone, then directed posteriorly, parallel to the inferior edge for 1 to 2 cm and finally inferiorly to come across the inferior edge of the turbinate anterior to the posterior attachment of the turbinate.

After the resection, the free bone edge and deep surface of the flap cauterized if necessary. A suction cautery is most useful for this step. Next the residual turbinate bone is lateralized and the mucosal flap is draped over the bone stump. The final step is to assess the posterior aspect of the turbinate. If this is bulbous and potentially obstructive, even suction cautery is used to shrink the mucosa. If there is concern about postoperative hemorrhage, a rolled telfa covered with antibiotic ointment is placed under the flap.

Postoperative care is similar to that for submucous resection.

Endoscopic turbinoplasty

The endoscopic technique is performed in much the same manner but with few modifications. Instead of using a cottle elevator to raise the medial flap, straight endoscopic scissors are used. These instruments have short blades at the end of the long shaft with a trigger grip. After the incision the scissors are used to cut the mucosa from the underlying the bone. When the flap is elevated, the same scissors are used to resect the turbinate.

Partial resection of the inferior turbinate (fig.6)

Anaesthesia is accomplished as for the procedure described earlier. The clamp is placed over the anterior inferior two-thirds or, less of the turbinate. The clamp is left there for 2 to 3 minutes and then released. The angled turbinate scissors are then used to cut along the crush line created by the clamp. After the turbinate is resected suction cautery can be used to coagulate the raw edge. This will decrease the incidence of postoperative bleeding and obviate the need for the packing the nose.

These operations tend to take longer to heal than the other procedures and therefore require more intensive postoperative care. Crusts are removed after one week and then every other week until healing is complete. Frequent nasal saline drops advised until healing[27].

Complications

a. Hemorrhage
b. Scarring
c. Atrophic rhinitis
d. Nasolacrimal duct injury
e. Foul odor.

MATERIALS AND METHODS

SUBJECTS

All patients with nasal obstruction attending government general hospital between September 2005 – October 2007.

PERIOD OF STUDY

September 2005 – October 2007

DESIGN OF STUDY

Prospective study

INFORMED CONSENT

Obtained from all the patients

INCLUSION CRITERIA:

Adult patients with nasal obstruction and inferior turbinate hypertrophy not responding to medical treatment with or with out septal deviation

EXCLUSION CRITERIA:

Nasal obstruction with inferior turbinate hypertrophy with

a. Sino nasal polyposis
b. Fungal sinusitis
c. Neoplasms

d. chronic sinusitis

Patients attending government general hospital during the study period with features of nasal obstruction and inferior turbinate hypertrophy were treated with topical decongestants and anti histaminics for a period of six weeks. Those who did not improve with medical treatment were included in our study.

Subjective assessment of nasal obstruction was done by visual analogue scoring before surgery and graded in to mild, moderate, and severe. They were also subjected to nasal endoscopy for objective assessment of inferior turbinate size and graded as I, II, III.

Patients included in this study underwent these procedures by random allocation.

a. Partial inferior turbinectomy
b. submucous resection
c. submucous diathermy
d. powered turbinectomy

The improvement in nasal obstruction following surgery was assessed after three months by complete questionnaires and size of the inferior turbinate assessed by nasal endoscopy.

Grading of inferior turbinate size (Fig.11)

Grade I – Mild enlargement with no obvious nasal obstruction.

Grade II – The inferior turbinate occupies half of the nasal cavity with nasal onstruction.

Grade III – Complete occlusion of the nasal cavity.

This study conducted only after informing the patients and after obtaining their written consent for surgical intervention.

OBSERVATIONS AND RESULTS

The following data is obtained from the Patients attending government general hospital during the period of study who had features of nasal obstruction with inferior turbinate hypertrophy who had undergone various turbinectomy procedures.

DISCUSSION

Inferior turbinate surgery are advocated for relief of symptoms in patients with nasal obstruction. Sixty patients with inferior turbinate hypertrophy and nasal obstruction had undergone procedures like partial inferior turbinectomy, submucous resection, submucous diathermy and powered turbinectomy by random allocation. Hence 15 patients underwent each procedure. They were analyzed subjectively and objectively by visual analogue scale and nasal endoscopy respectively both in pre operative and post operative state.

SOCIO DEMOGRAPHIC DATA

Age distribution (Table.2,3,4,5)

The age of the patients varied between 11 to 59 years. Their distribution is

Age		n
10-29years	-	39
30-49years	-	16
>50years	-	5

Most of the patients were below 30 years of age.

Sex distribution (Table.1)

Our study has 34 males and 26 females. Their sex ratio was 1.3:1

Turbinectomy procedures

In our study out of 60 patients, 56 patients had improved nasal obstruction after turbinectomy procedures. It is about 93% totally who had undergone turbinectomy procedures.

Partial inferior turbinectomy (Table.6,7)

Out of the 15 patients who underwent this procedure, subjective analysis showed 73% to have severe nasal obstruction pre operatively. In the post operative period nobody had severe obstruction and only 7% had moderate obstruction.

Nasal endoscopic examination revealed 67% to have grade III inferior turbinate pre operatively and 0% post operatively.

Ophir et al studied 186 patients using surveys and performing previous rhinoscopy 10 to 15 years after they were submitted to partial inferior turbinectomy. They demonstrated that there was improvement in nasal obstruction in 92%. But in our study 93% patients had significant improvement in nasal obstruction.

Submucous resection (Table.8,9)

Subjective assessment in the pre and post operative state showed 67% and 0% to have severe nasal obstruction respectively.

Endoscopic examination revealed 60% and 0% to have grade III size of the inferior turbinate in pre and post operative states respectively.

Out of 10 patients who had severe nasal obstruction, only four of them had mild nasal obstruction post operatively. One patient who had moderate nasal obstruction was not improved.

Mori et al followed 45 patients who were submitted to submucous resection during 3 to 5 years after surgery. They observed that there was significant improvement of nasal obstruction: 82% responded well after three years and 79% after five years. In our study the improvement was 93%. In our study post operative analysis was done after three months, so after sometime patients may recur.

Submucous diathermy (Table.10,11)

Visual analogue scoring showed 60% and 7% to have severe nasal obstruction in pre and post operative state respectively. The total improvement in nasal obstruction was 93%

Nasal endoscopy showed 53% and 7% to have grade III size of inferior turbinate in pre and post operative states respectively. The total improve in nasal inferior turbinate size was 87%. Two out of fifteen patients had no improvement after submucous diathermy.

Fradis et al compared partial inferior turbinectomy with submucous diathermy. They found that nasal obstruction improvement in partial turbinectomy was 93% and in submucous diathermy was 78%. In our study the improvement was 87% in submucous diathermy may be due to early assessment in post operative period.

Powered turbinectomy (Table.12,13)

Pre operative and post operative assessment of nasal obstruction by subjective analysis showed 80% and 0% to have moderate nasal obstruction respectively.

Objective analysis revealed 67% to have grade II inferior turbinate and 33% to have grade II turbinate size in pre and post operative state respectively.

Friedman et al found that the ideal turbinate surgery would be limited to the erectile submucosal tissue and to the bony turbinate. Reduction of bone creates more space, while surgery on sub mucosal tissue creates scarring that minimize the engorgement of inferior turbinate. They conducted a study in 120 patients with symptoms in the severe and moderate range of nasal obstruction. They found 100% improvement in nasal obstruction post operatively.

CONCLUSION

1. 93% of the patients had improved airway after surgery
2. In partial inferior turbinectomy, the overall improvement is 93% by both subjective and objective assessment.
3. In submucous resection, the overall improvement is 93% by both subjective and objective assessment.
4. In submucous diathermy, the overall improvement is 87% by both subjective and objective assessment.
5. In powered turbinectomy, the overall improvement is 100% by both subjective and objective assessment.
6. On analyzing these four turbinectomy procedures, the powered turbinectomy procedure is best for relieving nasal obstruction and for reducing turbinate size.

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PROFORMA

Case No.	:		
Name	:	IP/OPNo.	:
Age	:	D.O.A.	:
Sex	:	D.O.D	:
Occupation	:	Diagnosis	:
Income	:	Results	:
Address	:		
Phone No.	:		

I. PRESENTING COMPLAINTS

1. Nasal obstruction :

2. Nasal discharge :

3. Headache :

4. Facial pain:

5. Loss of smell :

6. Bleeding through nose :

II. PAST HISTORY

- ❖ History of Tuberculosis / Syphilis/ Leprosy
- ❖ History of infectious fever - Measles/Chicken pox/Typhoid
- ❖ History of trauma or allergy
- ❖ Surgery for any other disease in neck and throat
- ❖ History of irradiation
- ❖ History of diabetes or myxoedema
- ❖ Diseases of CNS

III. FAMILY HISTORY

- ❖ Similar complaints in any other member in the family
- ❖ History of T.B./Diabetes/ Hypertension
  - (a) Duration
  - (b) Onset

IV. PERSONAL HISTORY

- ❖ Diet/Sleep/appetite

- ❖ Micturationlbowel habits

- ❖ Habits : Smoking
  : Pan/Beetlenut chewing
  : Alcohol intake
  : Exposure to venereal diseases status

- ❖ Hygiene/Socio-economic Status

- ❖ Exposure to dusty atmosphere or chemical irritants or fumes etc.,

V. PHYSICAL EXAMINATION

(a) Built - Good / Moderate/Poor

(b) Nutrition - Good/Moderate/Poor

(c) Mental Status - Conscious /Co-operative

(d) Pallor / Icterus / Cyanosis! Clubbing / Pedal Edema

(e) Lymph-node status

Size/Shape/No/Consistency/Mobility/Overlying Skin

Vital Data - Temperature
- Pulse
- Respiratory rate

- Blood Pressure

VI. SYSTEMIC EXAMINATION

(a) Cardiovascular system

(b) Respiratory system

(c) Per Abdomen

(d) Central Nervous systems

VII. ENT EXAMINATION

a) Examination of Nose

Anterior rhinoscopy

Postnasal examination

b) Examination of Throat

- Oral Cavity & Oropharynx
- Indirect laryngoscopic examination

c) Examination of Ear

d) Examination of Neck

VIII. PROVISIONAL DIAGNOSIS

IX. INVESTIGATIONS

(a) Blood-Hb%/BT/CT/TC/DC/ESR

Blood Urea/Serum creatinine/Blood Cholesterol

Blood VDRL

(b) Urine - Albumin / Sugar/Microscopy

(c) Stool Examination for - ova / Cyst

(d) Sputum for AFB/ X-ray Chest

(e) X- ray PNS

(f) CT Scan para nasal sinuses

(g) Diagnostic Nasal Endoscopy

(h) Allergic Tests.

X. FINAL DIAGNOSIS

XI. MANAGEMENT

XII. FOLLOW UP

MASTER CHART

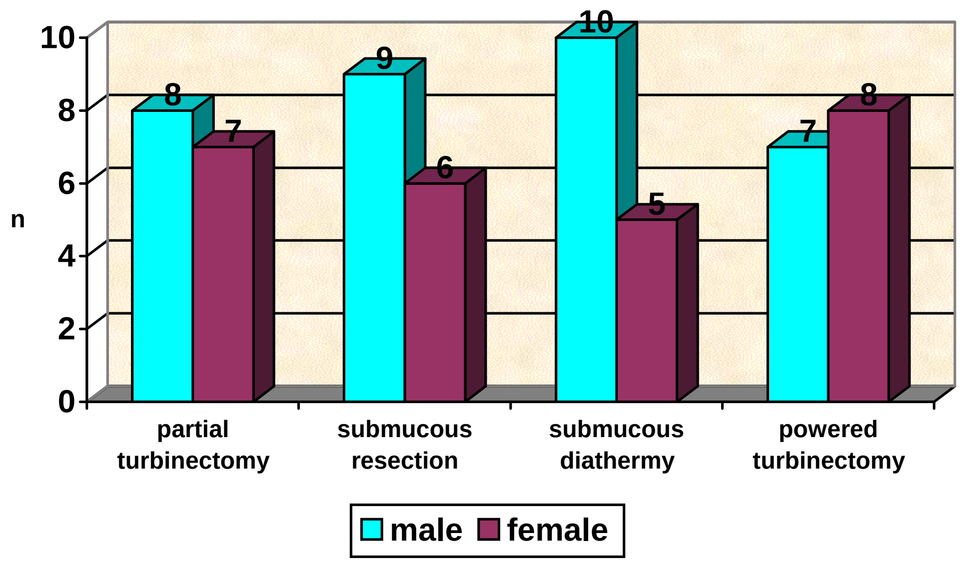
Sex distribution in turbinectomy procedures

Table.1

Procedures	Male		Female	
	n	Percentage	n	Percentage
Partial inferior Turbinectomy	8	13	7	11.7
Submucous Resection	9	15	6	10
Submucous Diathermy	10	16.7	5	8.3
Powered Turbinectomy	7	11.7	8	13

Chart 1:

Sex distribution



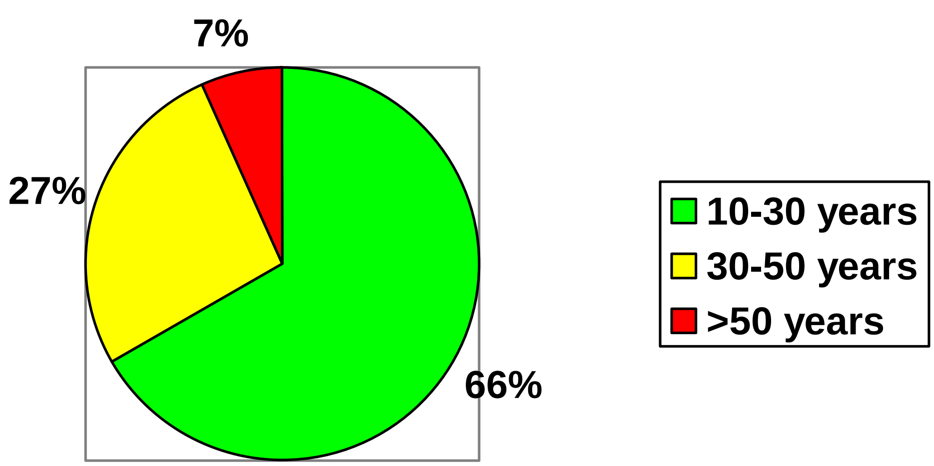
Age incidence in patients undergone partial inferior turbinectomy

Table 2

Age	n	Percentage
10-30 years	10	66.67%
30-50 years	4	26.67%
>50 years	1	6.67%

Chart 2

Percentage of age distribition



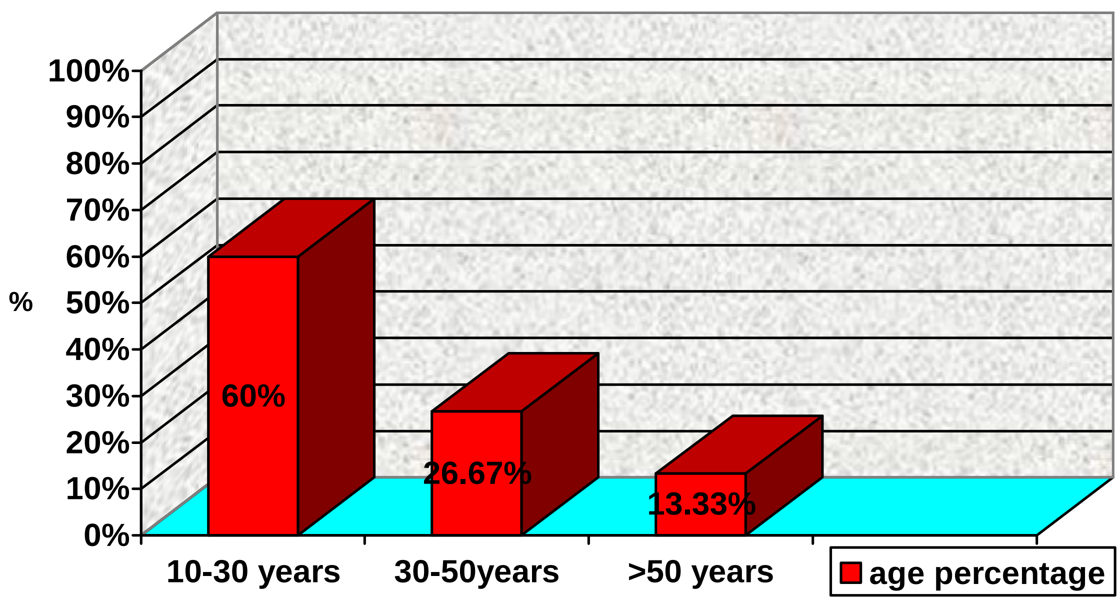
Age incidence in patients undergone submucous resection

Table 3

Age	n	Percentage
10-30 years	9	60%
30-50 years	4	26.67%
>50 years	2	13.33%

Chart 3

Percentage of age distribition



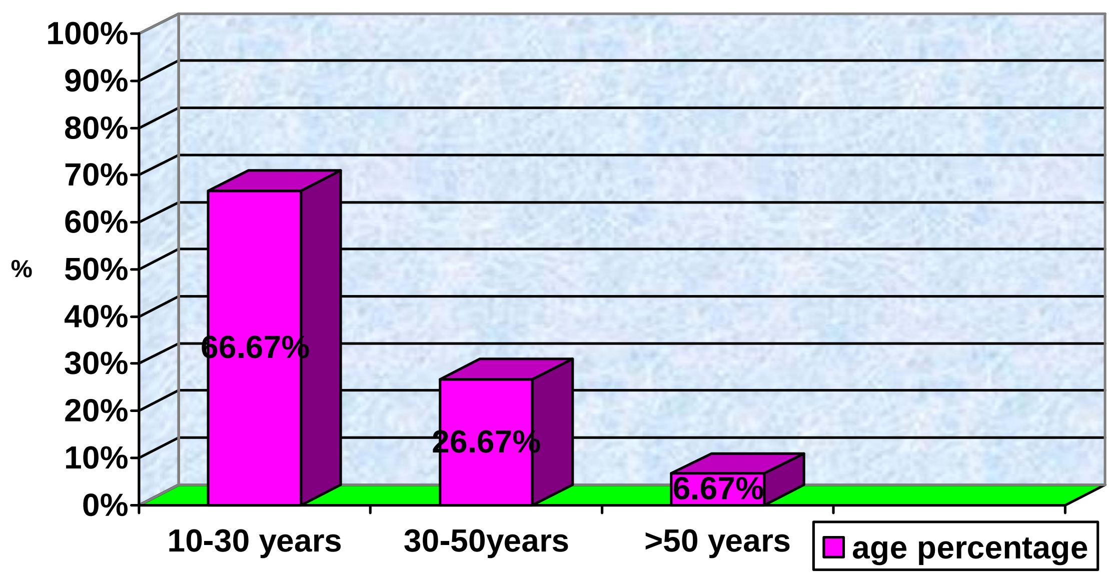
Age incidence in patients undergone submucous diathermy

Table 4

Age	n	Percentage
10-30 years	10	66.67%
30-50 years	4	26.67%
>50 years	1	6.67%

Chart 4

Percentage of age distribition



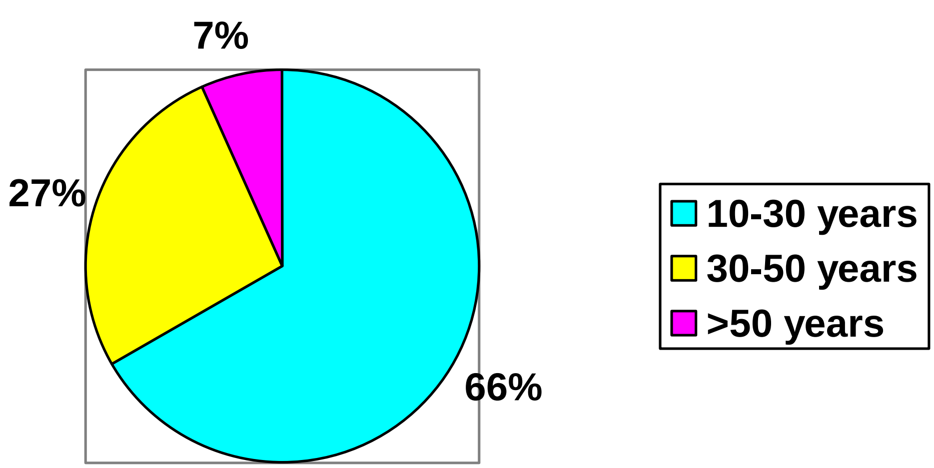
Age incidence in powered turbinectomy

Table 5

Age	n	Percentage
10-30 years	10	66.67%
30-50 years	4	26.67%
>50 years	1	6.67%

Chart 5

Percentage of age distribition



Partial inferior turbinectomy

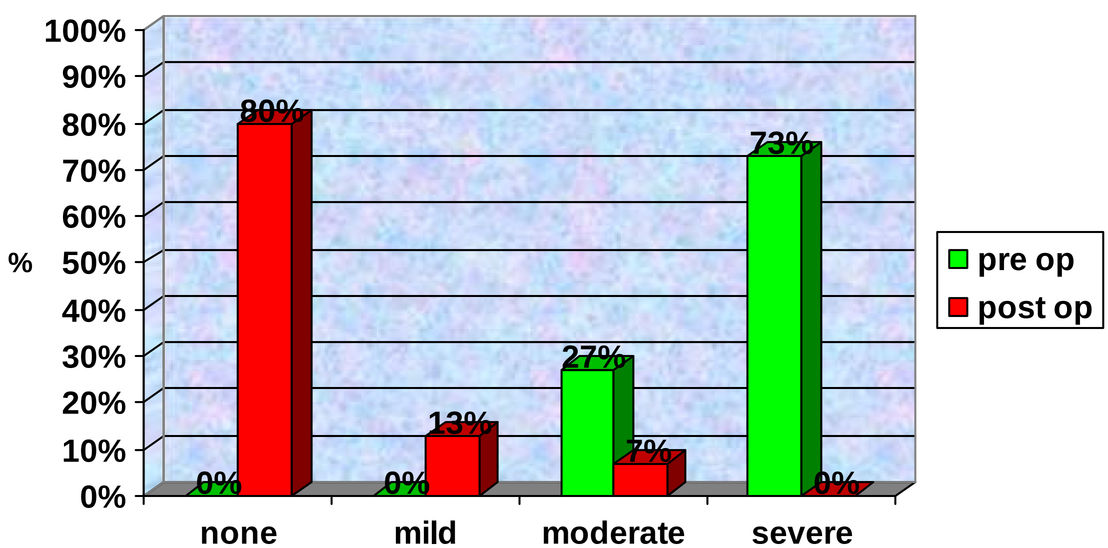
Subjective assessment of nasal obstruction

Table 6

Pre operative								Post operative							
None		**Mild**		**Moderate**		**Severe**		**None**		**Mild**		**Moderate**		**Severe**	
n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	0	0	0	4	27	11	73	12	80	2	13	1	7	0	0

Chart 6.

Percentage of grading



Partial inferior turbinectomy

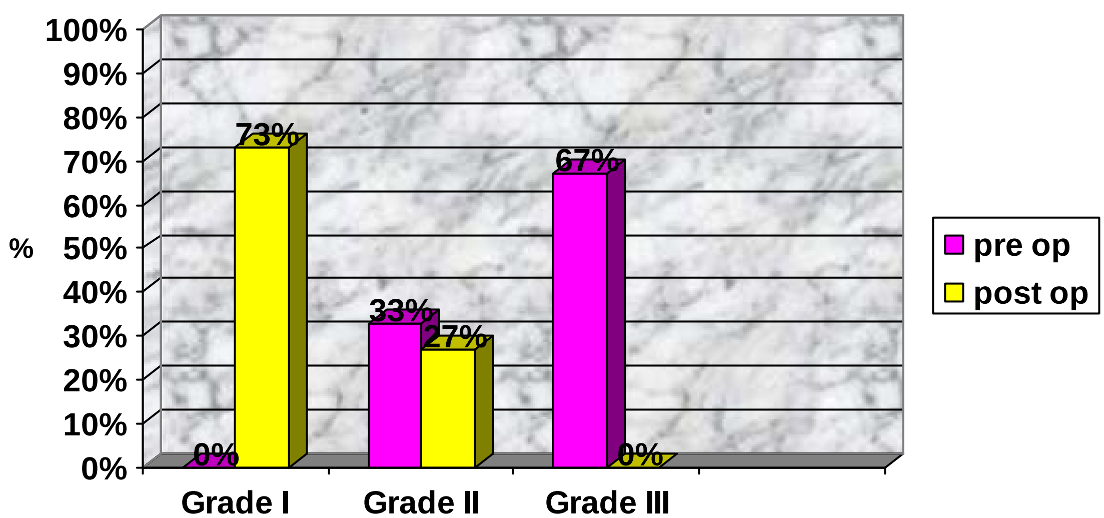
Objective assessment of inferior turbinate size

Table 7

Pre operative						Post operative					
Grade I		**Grade II**		**Grade III**		**Grade I**		**Grade II**		**Grade III**	
n	%	n	%	n	%	n	%	n	%	n	%
0	0	5	33	10	67	11	73	4	27	0	0

Chart 7

Percentage of grading



Submucous resection

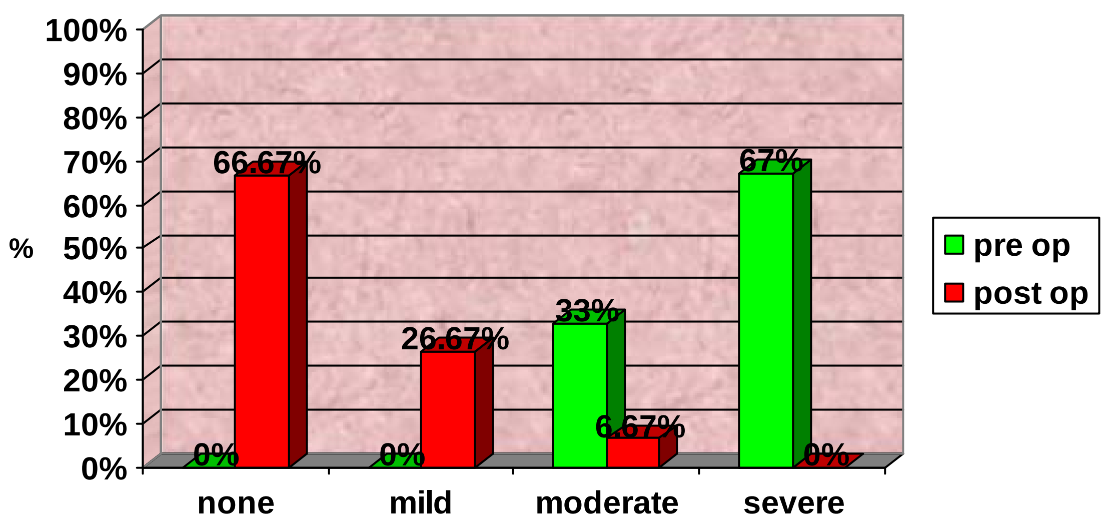
Subjective assessment of nasal obstruction

Table 8

Pre operative								Post operative							
None		Mild		Moderate		Severe		None		Mild		Moderate		Severe	
n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	0	0	0	5	33	10	67	10	66.67	4	26.67	1	6. 67	0	0

Chart 8.

Percentage of grading



Submucous resection

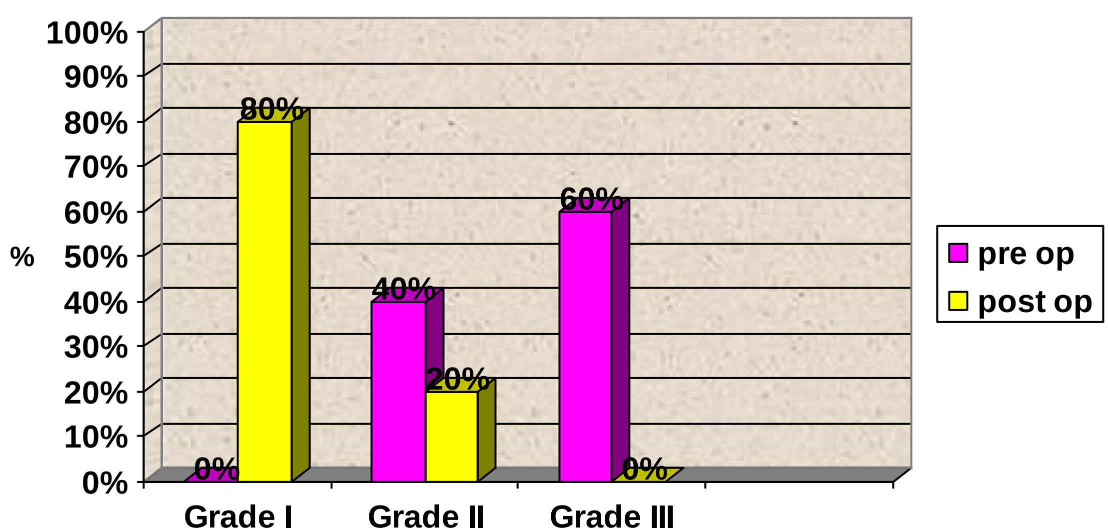
Objective assessment of inferior turbinate size

Table 9

Pre operative						Post operative					
Grade I		**Grade II**		**Grade III**		**Grade I**		**Grade II**		**Grade III**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	0	6	40	9	60	12	80	3	20	0	0

Chart 9

Percentage of grading



Submucous diathermy

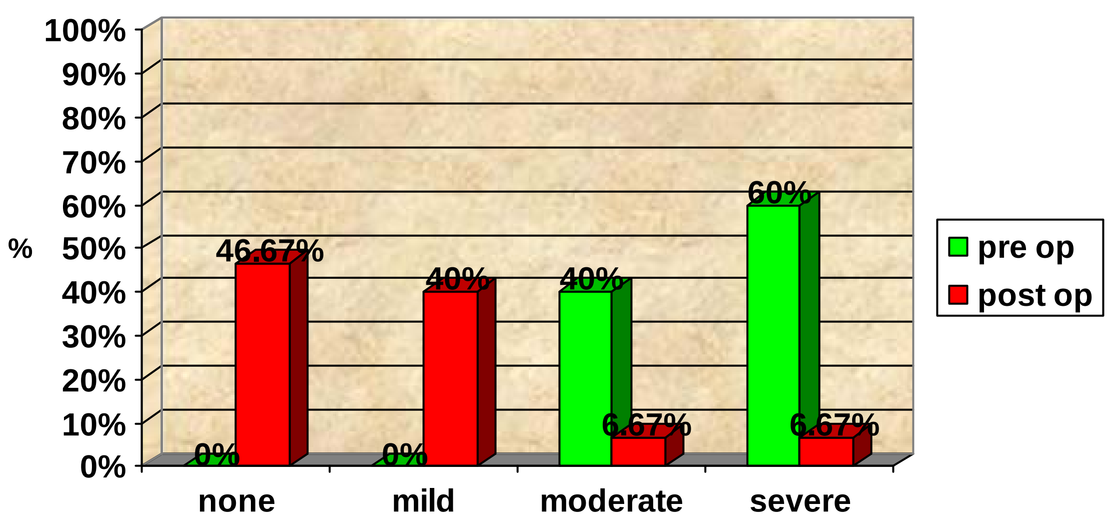
Subjective assessment of nasal obstruction

Table 10

Pre operative								Post operative							
None		**Mild**		**Moderate**		**Severe**		**None**		**Mild**		**Moderate**		**Severe**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	0	0	0	6	40	9	60	7	46.67	6	40	1	6. 67	1	6. 67

Chart 10.

Percentage of grading



Submucous diathermy

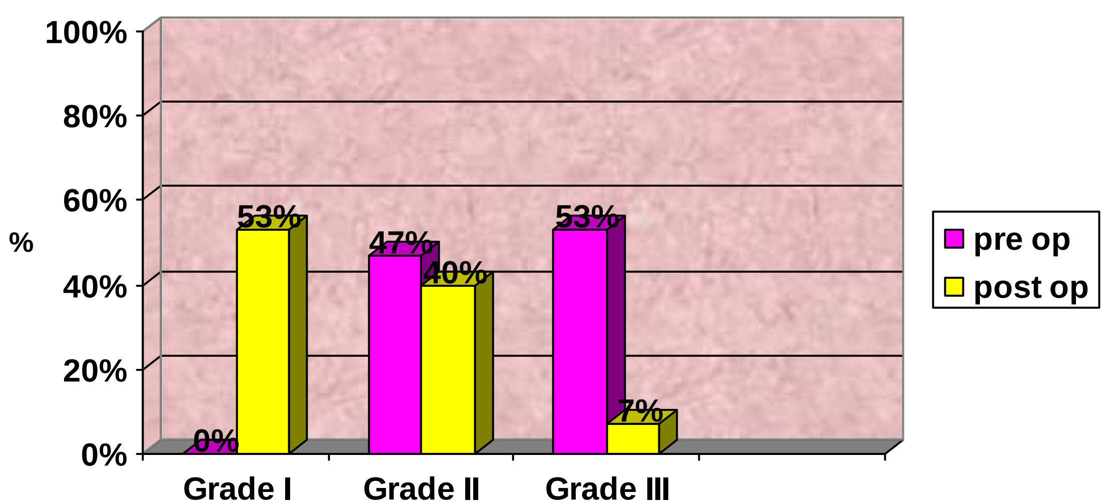
Objective assessment of inferior turbinate size

Table 11

Pre operative						Post operative					
Grade I		**Grade II**		**Grade III**		**Grade I**		**Grade II**		**Grade III**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	0	7	47	8	53	8	53	6	40	1	7

Chart 11

Percentage of grading



Powered turbinectomy

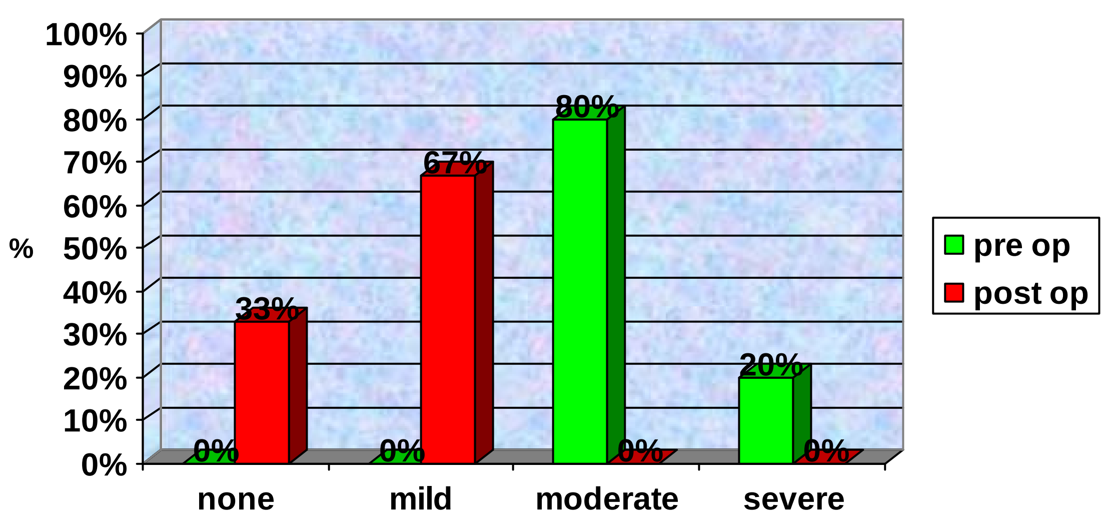
Subjective assessment of nasal obstruction

Table 12

Pre operative								Post operative							
None		**Mild**		**Moderate**		**Severe**		**None**		**Mild**		**Moderate**		**Severe**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	0	0	0	12	80	3	20	5	33	10	67	0	0	0	0

Chart 12.

Percentage of grading



Powered turbinectomy

Objective assessment of inferior turbinate size

Table 13

Pre operative						Post operative					
Grade I		**Grade II**		**Grade III**		**Grade I**		**Grade II**		**Grade III**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0	0	10	67	5	33	10	67	5	33	0	0

Chart 13

Percentage of grading

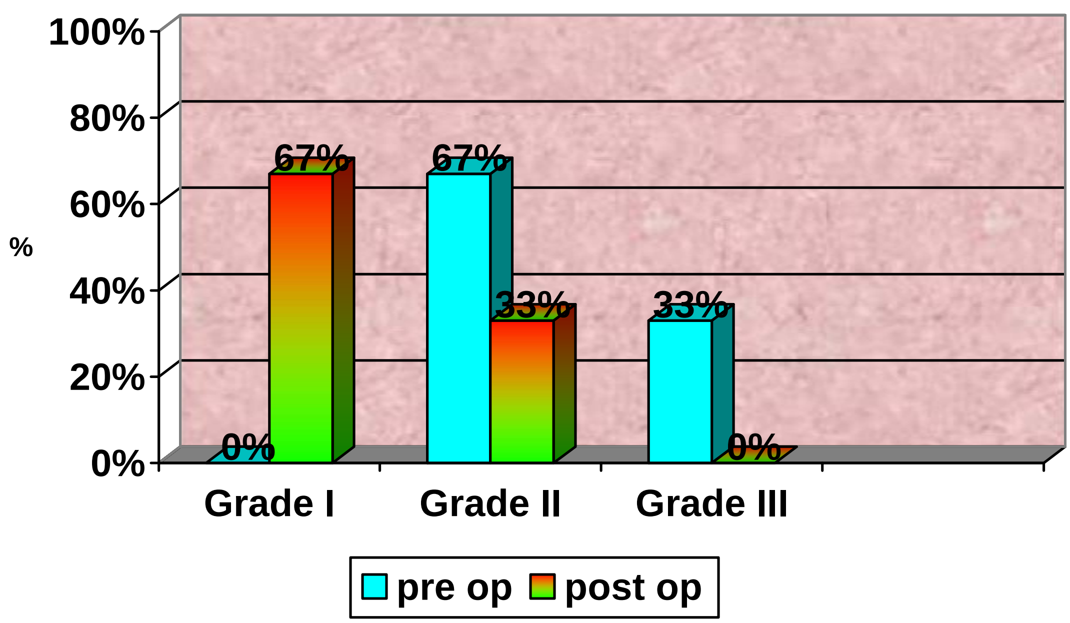


Fig.1 Anatomy of maxilla

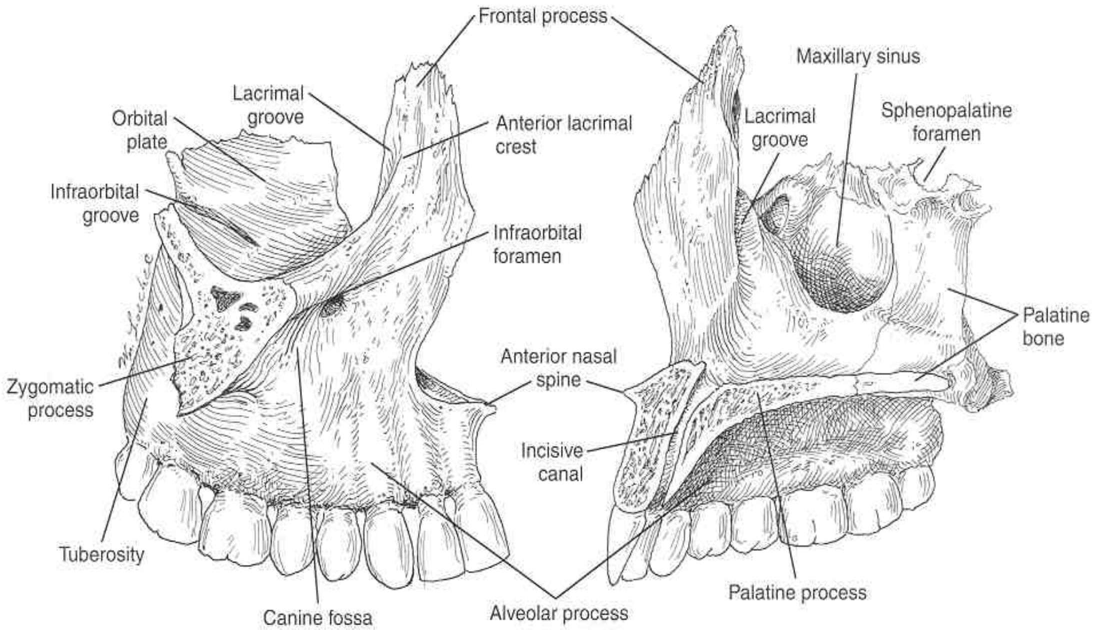
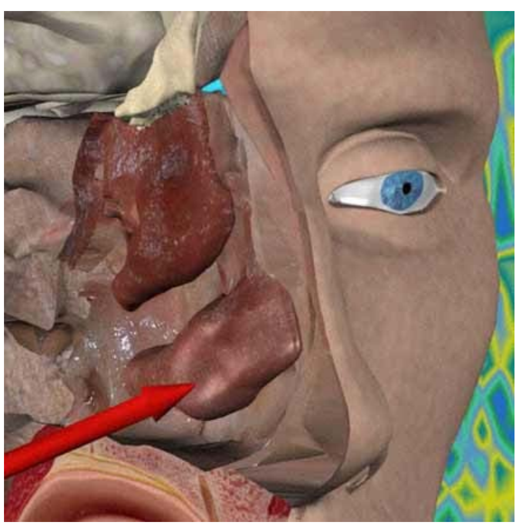


Fig.2 Inferior turbinate



Nasal valve

Fig.3a

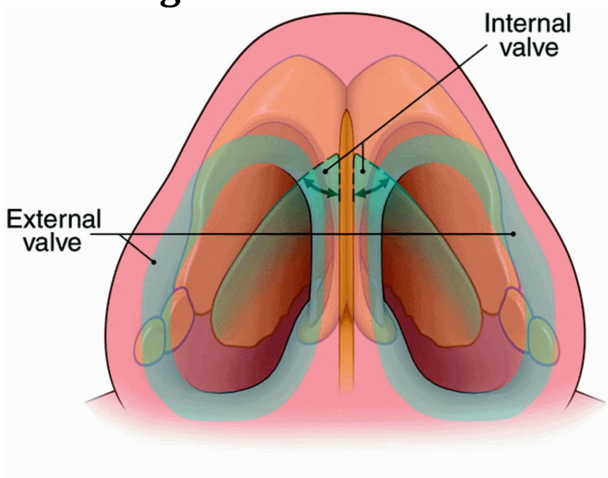


Fig.3b

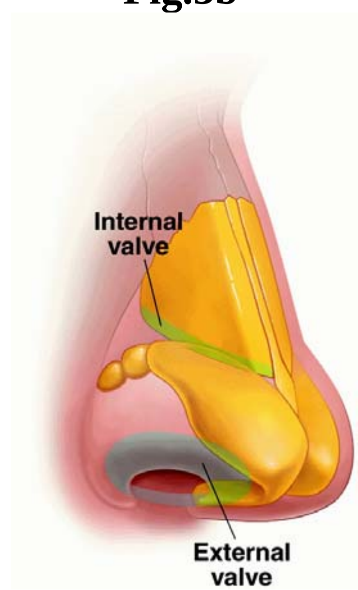
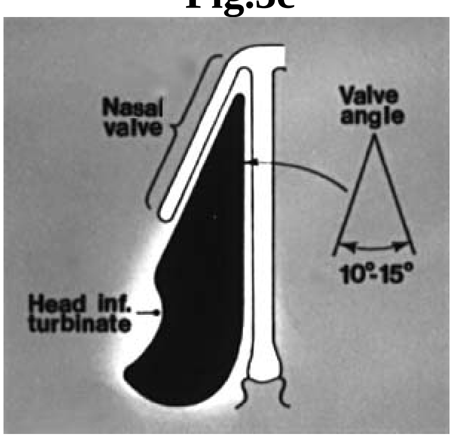
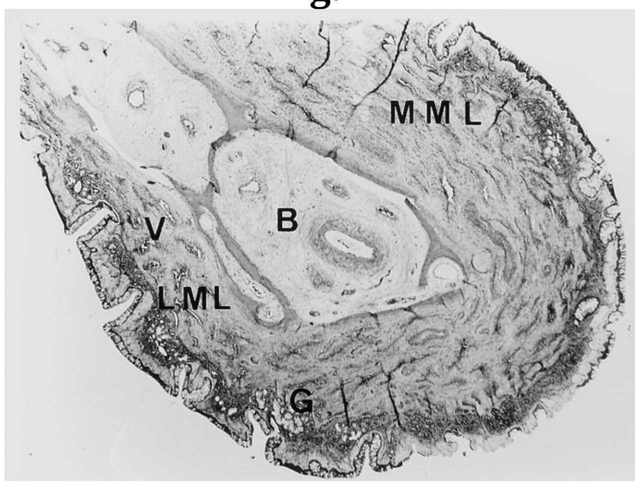


Fig.3c



Histology of turbinate mucosa
Fig.4



MML	**-**	**Medial thin mucosa**
B	**-**	**Bone**
LML	**-**	**Lateral thick mucosa**

Fig.5 Diagram of the nasal airway and air speed, the size of the dot indicating the velocity.

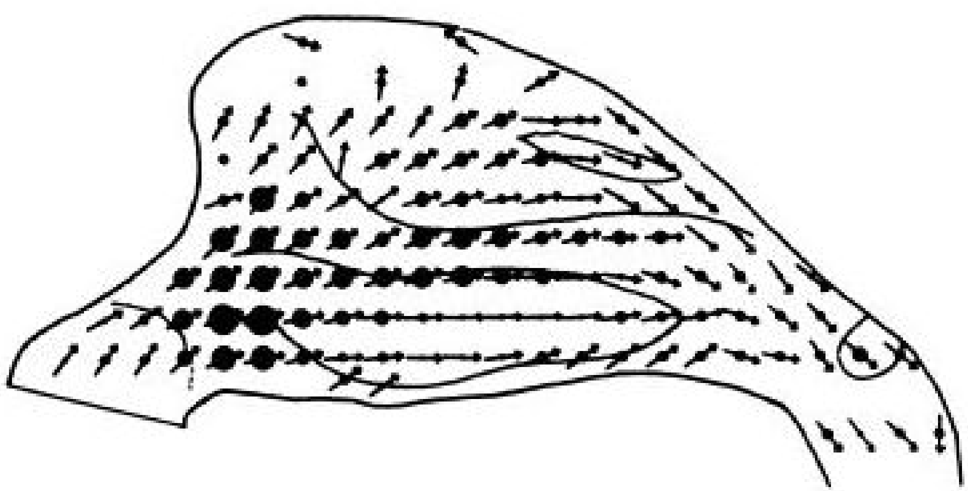


Fig.6 Partial inferior turbinectomy

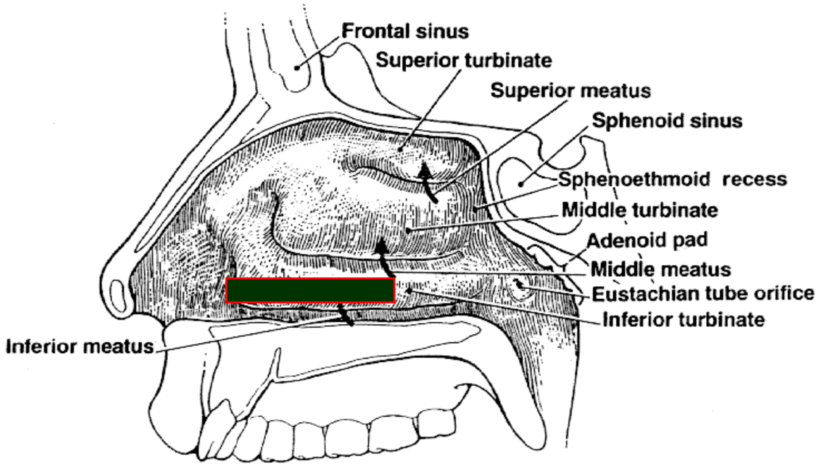


Fig.7 Submucous diathermy

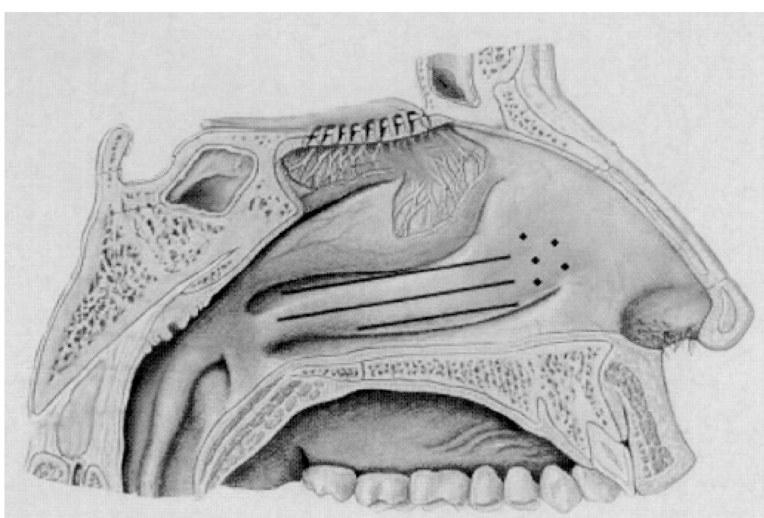


Fig.8 Powered turbinectomy

Fig.8a

Fig.8b

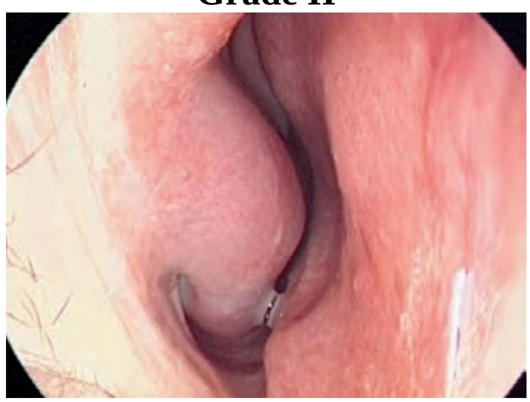
Fig.8c

Fig.8d

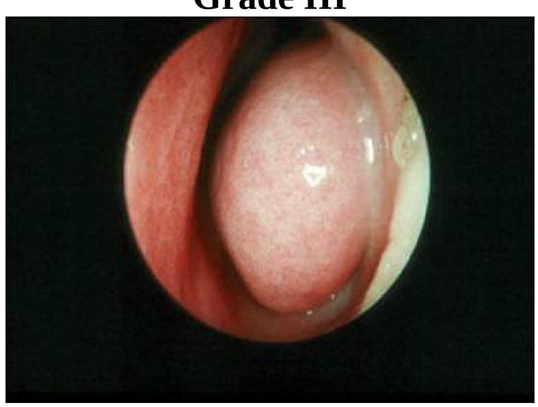
Fig.11 INFERIOR TURBINATE SIZE GRADING

Grade I

Grade II

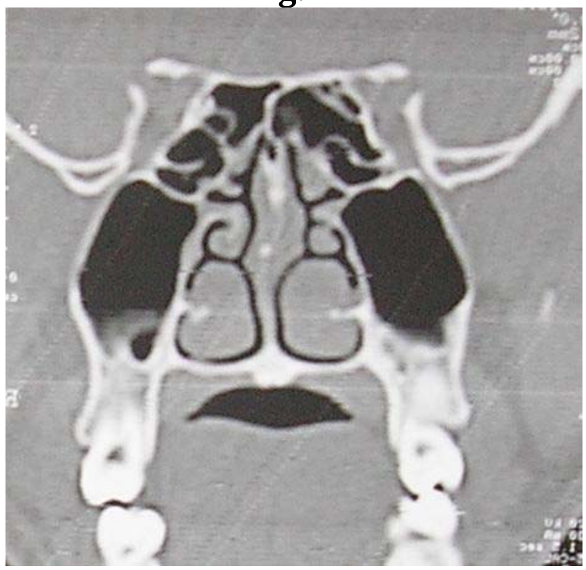


Grade III



CT scan showing bilateral inferior turbinate hypertrophy

Fig.12



Post operative CT picture of partial turbinectomy

Fig.13

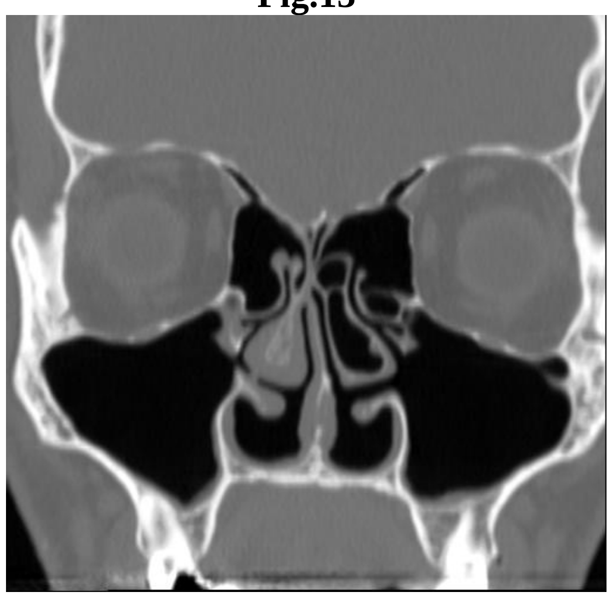


Fig .9 MICRODEBRIDER FOR POWERED TURBINECTOMY

Fig.10 INSTRUMENTS USED FOR TURBINATE REDUCTION

SL. NO	TYPE OF SURGERY	NAME	AGE	SEX	PRE OPERATIVE GRADING		POST OPERATIVE GRADING	
					NASAL OBSTRUCTION	TURBINATE SIZE GRADE	NASAL OBSTRUCTION	TURBINATE SIZE GRADE
1	Partial turbinectomy	Jeyanthi	29	F	3 severe	III	0 none	I
2	Partial turbinectomy	Parveen	12	F	2 moderate	II	0 none	I
3	Partial turbinectomy	Muthulakshmi	57	F	3 severe	III	1 mild	II
4	Partial turbinectomy	Savithri	45	F	3 severe	III	0 none	I
5	Partial turbinectomy	Raja	30	M	3 severe	III	0 none	I
6	Partial turbinectomy	Anbu	24	M	2 moderate	II	2 moderate	II
7	Partial turbinectomy	Latha	20	F	3 severe	III	0 none	I
8	Partial turbinectomy	Prasath	37	M	3 severe	III	0 none	I
9	Partial turbinectomy	Vignesh	24	M	3 severe	III	1 mild	II
10	Partial turbinectomy	Ilandevi	29	F	2 moderate	II	0 none	I
11	Partial turbinectomy	Ganesan	47	M	3 severe	III	0 none	I
12	Partial turbinectomy	Gokul	16	M	2 moderate	II	0 none	I
13	Partial turbinectomy	Chinnaponnu	35	F	3 severe	III	0 none	I
14	Partial turbinectomy	Senthilnathan	20	M	3 severe	III	0 none	II
15	Partial turbinectomy	Vinoth kumar	29	M	3 severe	II	0 none	I
16	Submucous resection	Ethiraj	18	M	3 severe	III	0 none	I
17	Submucous resection	Nagaraj	40	M	2 moderate	II	0 none	I
18	Submucous resection	Perumal	24	M	3 severe	III	1 mild	II
19	Submucous resection	chinnamma	55	F	2 moderate	II	0 none	I
20	Submucous resection	Muthusamy	23	M	3 severe	III	1 mild	II
21	Submucous resection	Sekar	29	M	2 moderate	II	2 moderate	II

SL. NO	TYPE OF SURGERY	NAME	AGE	SEX	PRE OPERATIVE GRADING		POST OPERATIVE GRADING	
					NASAL OBSTRUCTION	TURBINATE SIZE GRADE	NASAL OBSTRUCTION	TURBINATE SIZE GRADE
22	Submucous resection	Indra	35	F	3 severe	III	1 mild	I
23	Submucous resection	Mani	58	M	3 severe	III	0 none	I
24	Submucous resection	Kumari	19	F	2 moderate	II	0 none	I
25	Submucous resection	Arunkumar	25	M	3 severe	III	0 none	I
26	Submucous resection	Parvathy	19	F	3 severe	III	1 mild	II
27	Submucous resection	Mohan	27	M	2 moderate	II	0 none	I
28	Submucous resection	Vidya	38	F	3 severe	III	0 none	I
29	Submucous resection	Purusothaman	30	M	3 severe	III	0 none	I
30	Submucous resection	Baby	49	F	3 severe	II	0 none	I
31	Submocous diathermy	Raghu	11	M	2 moderate	II	0 none	I
32	Submocous diathermy	Ramalingam	45	M	3 severe	III	1 mild	II
33	Submocous diathermy	Suresh	19	M	3 severe	III	1 mild	I
34	Submocous diathermy	Victoria	28	F	3 severe	III	3severe	III
35	Submocous diathermy	Ramesh	37	M	2 moderate	II	2 moderate	II
36	Submocous diathermy	Hemamalathi	24	F	3 severe	III	1 mild	II
37	Submocous diathermy	Chandrakala	31	F	2 moderate	II	0 none	I
38	Submocous diathermy	Aswin	19	M	3 severe	III	1 mild	II
39	Submocous diathermy	Rajaram	28	M	2 moderate	II	0 none	I
40	Submocous diathermy	Chella ponni	55	F	3 severe	III	1 mild	II
41	Submocous diathermy	Senthil	30	M	2 moderate	II	0 none	I
42	Submocous diathermy	Karthikeyan	40	M	3 severe	III	1 mild	II

SL. NO	TYPE OF SURGERY	NAME	AGE	SEX	PRE OPERATIVE GRADING		POST OPERATIVE GRADING	
					NASAL OBSTRUCTION	TURBINATE SIZE GRADE	NASAL OBSTRUCTION	TURBINATE SIZE GRADE
43	Submocous diathermy	Kasthuri	30	F	2 moderate	II	0 none	I
44	Submocous diathermy	Pasupathy	23	M	3 severe	III	1 mild	I
45	Submocous diathermy	Palani	27	M	3 severe	II	0 none	I
46	Powered turbinectomy	Sobiya	21	F	2 moderate	II	0 none	I
47	Powered turbinectomy	Saraswathi	22	F	3 severe	III	1 mild	II
48	Powered turbinectomy	Ramnath	25	M	2 moderate	II	0 none	I
49	Powered turbinectomy	Vanitha	38	F	2 moderate	III	1 mild	II
50	Powered turbinectomy	Selvi	25	F	2 moderate	II	1 mild	I
51	Powered turbinectomy	Palanisamy	40	M	2 moderate	III	1 mild	II
52	Powered turbinectomy	Subburam	28	M	2 moderate	II	1 mild	I
53	Powered turbinectomy	Gajalakshmi	24	F	2 moderate	II	0 none	I
54	Powered turbinectomy	Bala sundaram	57	M	2 moderate	II	1 mild	I
55	Powered turbinectomy	Venkatesh	25	M	3 severe	III	1 mild	II
56	Powered turbinectomy	Sornamala	47	F	2 moderate	II	1 mild	I
57	Powered turbinectomy	Prabhu	23	M	2 moderate	II	0 none	I
58	Powered turbinectomy	Manimegalai	36	F	2 moderate	II	0 none	I
59	Powered turbinectomy	Vignesh	20	M	2 moderate	II	1 mild	I
60	Powered turbinectomy	chandrasekar	18	M	3 severe	III	1 mild	II