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Thoracic inlet X-ray in perioperative evaluation of endotracheal intubation difficulty and complications in patients with goiter

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قال الله تعالى :

(ومن يؤت الحِكمةَ فقد أُوتي خيراً كثيراً)

صدق الله العظيم

البقرة- الآية (269)

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Dedication

To:

My parents

&

My family

With great love

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ABBREVIATIONS

Abbreviation	Meaning
AP	Anterioposterior projection
DEI	Difficult endotracheal intubation
ETT	Endotracheal intubation
K.T.H	Khartoum Teaching Hospital
KVP	Kilovoltage
MA	Milamber
MNG	Multinodular goitre
RAI	Radioactive iodine
S.U.H	Soba University Hospital
T.I.V	Thoracic inlet view
TSH	Thyroid stimulating hormone
Yrs	Years

ABSTRACT

In this study thoracic inlet X- ray, AP and lateral views was assessed in 100 patients with clinically confirmed goiter who underwent thyroidectomy to determine the value of this investigation in diagnosing upper airway obstruction, predicition of difficulty during anaesthetic induction and anticipation of postoperative necessity for ventilation support in these patients. It was combined with other preanasthetic and anaesthetic clinical tests such as malampatti and laryngoscopic grading for assessing the airway and laryngeal intubation as well

This study showed that, conventional radiology is the accepted method for detecting upper airway abnormalities especially in patients with huge goiter with retrosternal extension.

Thoracic inlet x-ray did not predict difficult endotracheal intubation in patients with thyroid enlargement, there were 5 patients who had difficult endotracheal intubation (DEI). It can be of help in prediction of adequacy of manual ventilation, 9 patients had

inadequate ventilation. It anticipated postoperative ventilatry complications, 6 patients needed postoperative support, 4 of them were reintubated while two had tracheostomy. Conventional radiology still has a role in managing patients with goiter as far as it is simple, cheap and available.

Combination of clinical examination and radiological investigations are important in assessing patients with goiter when they undergo thyroidectomy and might give an idea about difficulties during operation.

ملخـــص الأطروحـــة

فى هذه الدراسة تم اختبار فحص الأشعة لمدخل الصدر فى 100 مـريض بتـضخم الغدة الدرقية وأجريت لهم عمليات لازالتها، لمعرفة مدى فائدة هذا الفحص فى تشخيص ضيق مجارى الهواء العليا ، وتوقع صعوبة تنبيب الرغامي وتوقع مضاعفات ضيق التـنفس بعـد إزالة التنبيب عند هؤلاء المرضى. وقد ارفق معه الفحص السريري المسمى مالمباتي ومنظار الحنجرة أثناء التخدير.

أوضحت هذه الدراسة أن الفحص بالأشعة العادية يعتبر مقبـول لتـشخيص مـشاكل الجهاز التنفسي العليا الناتجة من تضخم الغدة الدرقية خاصة عندما تمتد خلف القص.

لا يستطيع فحص الأشعة لمـدخل الـصدر أن يتوقـع صـعوبة تنبيـب الرغـامي (5 مرضى عانوا من صعوبة التنبيب) ، لكنه يمكن أن يساعد فى هذا الشأن خاصـة عنـدما يرفق بالاختبارات الإكلينيكية المخصصة لذلك.

جمع الاختبارات الإكلينيكية مع الفحوصات الشعاعية عند المرضى المصابين بتضخم الغدة الدرقية يعطى فكرة مقبوله عن ما يمكن حدوثه أثناء التنبيب وعند إخراج الأنبوب مـن الرغامي بعد إنتهاء العملية وتوقع حدوث مضاعفات في التنفس (6 مرضى احتاجوا لمـساعدة التنفس) ، ومدى الحوجة إلى أنبوب فتح الرغامي.

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INTRODUCTION

Disease of the thyroid gland is common. For example, in endemic areas, the incidence of goiter is 15 – 30% of the adult population. [1] Certain areas of the Sudan specially in the west are considered as endemic areas.

A goiter of long standing may achieve considerable size, become grossly nodular and gives rise to obstructive symptoms, particularly if there is a retrosternal extension.[2]

Conventional radiology is a good method for detecting upper airway obstruction resulted from thyroid enlargement; it is simple, cheap and causes less ionization.

Some patients with thyroid swelling treated by partial or total thyroidectomy in whom intubation might be difficult and might end with some complications such as airway trauma, pulmonary aspiration and hypoxaemia,[3] due to narrowing or weakness of tracheal rings. The anesthesiologists are aware of the problems of the difficult airway, which is more complicated in patients with thyroid enlargement. Ameticulous assessment of the airway in these patients is mandatory; this will help in reduction of morbidity and mortality.

LITERATURE REVIEW

The thyroid gland

Embryology:

The thyroid gland originates from the base of the tongue in the region of the foramen cecum. The endoderm cells in the mid line of the floor of the pharyngeal anlage thicken and form a median thyroid anlage, which migrate caudally into the neck along a tract that runs anterior to the structures that form the hyoid bone and the larynx; it is composed of epithelial cells that provide the follicular cells of the thyroid. As it descends, it is joined laterally by a pair of components originating from the ultimobranchial bodies of the forth and fifth branchial pouches, these lateral components supply the C cells of the thyroid, which secret calcitonin.[4]

Anatomy:

The normal adult thyroid gland is light brown in color and firm in consistency, weighing 15-20g. It forms by two lateral lobes connected centrally by an isthmus. The lobes are approximately 4cm long, 2 cm wide and 2 to 4 cm thick with the isthmus 0.2 - 0.6 cm thick. The lateral lobes run alongside the trachea, reaching the level of the middle thyroid cartilage superiorly. Laterally, the lobes are adjacent to the carotid sheath and the sternocleidomastoid

muscles; anteriorly, they are adjacent to the strap muscles (sternothyroid and sternohyoid). A pyramidal lobe is present in a proximately 80 percent of individuals, usually just to the left of the midline extending upward from the isthmus along the anterior surface of the thyroid cartilage. It is a remnant of the thyroglossal duct.

The four parathyroid glands usually are closely related to the thyroid gland, found in posteriolateral surface of the lobes.

The thyroid gland has an abundant blood supply provided by four major arteries. The paired superior thyroid arteries arise as the first branch of the external carotid artery, the paired inferior thyroid arteries arise from the thyrocervical trunk of the subclavian arteries. Occasionally a fifth artery, the thyroid ima, is present, originating directly from the aortic arch or the innominate artery. The venous drainage is via the superior thyroid veins, which drain to the internal jugular veins on both sides, the middle thyroid veins, which can vary in number, the inferior thyroid veins leave the inferior poles bilaterally, usually forming a plexus that drains into brachiocephalic vein. Lymphatic drainage of the thyroid gland is primarily to the internal jugular nodes.[5]

Innervation of the gland is by sympathetic fibers from the superior and middle cervical sympathetic ganglia the fibers enter

with the blood vessels and are vasomotor in action. Parasympathetic fibers are derived from the vagus nerve and reach the gland via branches of the laryngeal nerves.[6]

Laryngeal nerves:

It is important to note the close relationship of the thyroid gland to the recurrent laryngeal nerves. The recurrent laryngeal nerves supply the intrinsic muscles of the larynx and damage to one of them lead to ipsilateral vocal cord paralysis. Similarly, the external branch of the superior laryngeal nerve, which innervates the cricothyroid muscle, also is at risk during thyroid surgery. Damage of either nerve may result in a disability of phonation.

The recurrent laryngeal nerves originate from the vagus nerves, the right recurrent laryngeal nerve originates where the vagus nerve crosses the first part of subclavian artery, it ascends slightly obliquely to enter the larynx at the level of the cricoid cartilage. The left recurrent laryngeal nerve branches from the vagus as it crosses the aortic arch and loops posteriorly around the ligmentum arteriosum before it ascends medially in the tracheosophgeal groove to enter the larynx opposite the contralateral nerve.

The external branch of the superior laryngeal nerve runs in close proximity to the superior pole vessels.[6]

Physiology of the thyroid gland:

The thyroid synthesizes thyroid hormone, which is necessary for normal metabolism, the secretion of thyroid hormones is regulated as follows:

The hypothalamus secretes thyrotropin releasing hormone (TRH) which induces the anterior pituitary to secrete. Thyroid. Stimulating Hormone (TSH). In response to TSH, the thyroid concentrates iodine and synthesizes the thyroid hormones thyroxine (T4) and the more metabolically active form of thyroxin, T3. Free thyroxin is the active form of the hormone and exerts a negative feed back on the pituitary and probably the hypothalamus. [7]

Thyroid diseases:

Hyperthyroidism:

The disease processes associated with increase thyroid secretion result in a predictable hypermetabolic state. Increased thyroid secretion can be caused by primary alterations with in the gland (Graves' disease, toxic nodular goiter, toxic thyroid adenoma) or central nervous system disorders and increased TSH produced stimulation of the thyroid.[8]

Graves' disease (diffuse toxic goiter):

It is the most common cause of hyperthyrodism, most patients are women between the ages of 20-40 years, it is thought to be due to wide variety of antibodies which result in a thyroid-stimulating process.[9]

The diseased gland is enlarged and nodular with increased vascularity. The diffuse enlargement of the gland is grossly visible and that can result in cosmetic deformity and significant tracheal deviation or compression.

The patient with classic Grave's disease usually has a visibly enlarged neck mass, symptoms of thyrotoxicosis and exophthalmos, diagnosis is by combination of clinical presentation, physical examination and thyroid function test.[10]

Treatment of the disease is by radioiodine ablation, surgery or antithyroid medication.

Toxic multinodular Goiter:

The thyroid in patients with toxic multinodular goiter (MNG) usually contains several palpable nodules. Local symptoms of difficulty in breathing is more common than in Graves' disease.

Diagnosis of MNG is by thyroid function test and thyroid scan. Definitive treatment for toxic MNG can be accomplished with RAI or surgery.

Compared to RAI, thyrodictomy has been shown to render patients euthyroid sooner.[11]

Toxic nodule:

A solitary hot nodule is usually caused by a follicular adenoma. Definitive treatment can be accomplished with RAI or surgery (most often lobectomy). RAI treatment may result in persistent nodularity, surgical treatment is a reasonable option for toxic nodule.[12]

Hypothyroidism:

Hypothyroidism is the result of a deficiency of thyroid hormone and is characterized by cold intolerance, weight gain, constipation, dry skin, brittle hair, hoarse voice and fatigue. Hypothyroidism is usually the result of thyroiditis or the result of surgery or RAI ablation.[13]

Hashimoto's thyroiditis:

It is the most common cause of thyroiditis; the disease is common in middle age women. The thyroid gland is involved with a lymphocytic infiltration that eventually results in fibrotic gland. Nodules may be present, and some patients develop local symptoms of compression.[13] As the immune process continues, changes in thyroid function can be altered by levels of antibodies.

Ultimately, a hypothyroid clinical state can occur in patients with persistent TSH-blocking antibodies.[14]

Treatment involves supplementation with thyroxine. Surgery is rarely indicated.

Goiter:

Goiter is a term commonly used to refer to a benign enlargement of the thyroid gland. Goiters can be diffuse or multinodular. Iodine deficiency has been shown to cause goiters. These patients also demonstrate an elevated TSH that is likely to be the etiology of thyroid enlargement.

The etiology of goiters is multi-factorial and probably involves genetic influences and environmental exposures to goitrogens. In most cases, thyroid function is normal and there is little to be gained from treatment with thyroxine.[13]

Goiters often cause symptoms from local compression. The clinical assessment of thyroid size poses many problems and many systems of grading have been used in the past. The system most commonly used today is that of Perez et al (1960), which is shown in the following table [15].

Table (1) : Classification of goiter (Perez et al, 1960)

Grade	Criteria
0a	Thyroid impalpable or if palpable not larger than normal
0b	Thyroid distinctly palpable but usually not visible with the head in a normal or raised position; considered to be definitely larger than normal (i.e. lobes larger than the distal phalanx of the examiner's thumb)
I.	Thyroid easily palpable and visible with the head in a normal position or raised
II.	Thyroid easily visible with the head in a normal position
III.	Goiter visible at a distance
IV.	Monstrous goiter

Surgical resection is indicated in most cases because of local compression. Malignancy may also be a consideration particularly with nodular goiter. Total or sub total thyroidectomy is effective in relieving symptoms however, with long-term follow up subtotal thyroidectomy has been shown to have a recurrence rate of 40% to 50%.[16]

Retrosternal goiter: A goiter developing in the neck may extend inferiorly through the thoracic inlet, usually coming to lie anteriorly in the superior mediastinum. Occasionally such masses are deflected posteriorly, passing behind the trachea and oesophagus. Rarely, there is an enlargement of ectopic thyroid tissue within the superior mediastinum. Symptoms arise from compression of the trachea, superior vena cava or oesophagus. The optimal treatment of retrosternal goiters is surgical removal in most instances it can be removed through cervical incisions.[17]

Thyroid diseases might need to be treated surgically, when there are compressive symptoms, retrosternal goiters, if malignancy is suspected or demonstrated on FNAC, recurrent hyperthyroidism, cosmetic reasons, anxiety, Hashimoto's disease or any suspicion of superimposed lymphoma.[18]

Problems with airway management will be the main concern of the anaesthetist when confronted by a patient with goiter, the patient may give a history of respiratory difficulties such as positional dyspnoea.[19]

One of the useful, routine investigations in-patient with thyroid swelling is thoracic inlet X- ray (AP and lateral views).

The thyroid gland extends from the lower third of the thyroid cartilage inferiorly for a distance of 5 cm to about the level of the

first thoracic vertebra. Normally the thyroid gland is not discernible on AP projections of the neck, and only the narrow median portion, the isthmus, is visualized on lateral projections. These radiographs (AP and lateral T.I.V) generally demonstrate any intrathoracic extension of the gland, any compression or displacement of the trachea by the enlarged gland, the presence of any calcium deposits, and the need for further evaluation.[20]

The thyroid masses in the mediastinum represent extensions of either nodular colloid goiters, or occasionally carcinomas, the masses usually have a well defined outline which may be spherical or lobular. Almost all intrathoracic thyroid masses displace the trachea which may be substantially narrowed[21].

For optimal assessment of thoracic inlet X-ray first we need to know the anatomy of upper airways very well.

Upper airways:

The trachea is a tube, which, in children and young adults passes downwards and backwards close to the midline and has sufficient flexibility to adapt to body position. In adult the aorta may cause a recognizable impression; in infants and young children the brachiocephalic artery may indent the trachea. In older individuals the intrathoracic portion deviates slightly to the right to accommodate the left-sided arch. With unfolding and ectasia of the

aorta, the trachea deviates more to the right as it descends into the chest and may also bow forward.

The trachea has 16-20 incomplete C, or horseshoe shaped cartilage rings, which give the trachea a corrugated outline.

In cross section the trachea is usually round, oval with a flattened posterior margin, the posterior margin being formed by the fibromuscular membrane. It may occasionally show other configurations such as a square or inverted pear shape.

The trachea enters the thorax 1 to 3 cm above the level of the suprasternal notch and the intrathoracic portion is 6-9 cm in length.

The range of tracheal diameters in adults on chest radiography in men is 1.3 to 2.5 cm, in coronal plane, and 1.3 to 2.7 cm, in sagittal plane whereas in women the diameters are 1.0 to 2.1 cm, in coronal plane, and 1.0 to 2.3 cm, in sagittal plane. The trachea divides into the two main stem bronchi at the carina at approximately the level of D5; the left main bronchus is approximately 5cm long and the right main bronchus is approximately 2.5 cm in length; the range of the subcarinal angle is wide, it ranges between (35° - 90.5°).

On thoracic inlet radiograph, the intrathoracic thyroid masses have a well-defined outline that may be spherical or lobular. The

masses very frequently displace and/or narrow the trachea; occasionally the narrowing is substantial and may result in change of voice and stridor. The pattern of tracheal displacement depends on the location of the mass, which is usually predominantly anterior or lateral to the trachea but may be posterior to it which may be seen in one-quarter of cases. Posteriorly placed thyroid masses may separate the trachea and oesophagus; goiters rarely pass posterior to the esophagus. Occasionally, intrathoracic goiters compress the brachiocephalic veins, a process that may result in superior vena cava syndrome.[22]

Thoracic inlet x-ray views:

The most common reason for this radiographic examination is the assessment of tracheal displacement and compression by thyroid enlargement and retrosternal extension.[23]

Anatomy of thoracic inlet:

The thoracic inlet is bounded posteriorly by the first thoracic vertebra, anteriorly by the manubrium sterni and laterally by the first ribs. Through it pass the trachea, oesophagus, major vessels and nerves.

Basic views:

Antero-posterior: The patient lies supine on the x-ray table, with the chin raised. The exposure may be made either on

arrested full inspiration or preferably, with the patient performing the valsalva maneuver. For this, the patient is asked to take in a deep breath and then to breathe out against closed glottis.

Center: X-ray beam is directed to sternal notch.

Lateral: The patient stands lateral to the cassette, with the chin raised and the arm nearer the cassette raised over the head. The exposure is made on full arrested inspiration. The focus-film distance used is 120 cm (48 inches) high kilovoltage is used. The x-ray beam is centered just above the head of the humerus remote from the cassette.

Supplementary views:

Accessory lateral view: The patient stands lateral to the cassette, with one shoulder against it, the hands behind the back and the shoulders forced back. The chin should be raised. This is a difficult position to maintain and immediately before the exposure is made the patient should be encouraged again to pull the shoulders right back. The upper border of the cassette is placed at the level of the angle of the jaw to reduce the contrast between the upper and lower parts of the trachea, high kilovoltage technique is employed or a wedge filter may be used. The use of a multi-layer cassette is of advantage to show with one exposure both the dense retrosternal area and the less dense upper part of the

trachea. The exposure is made on arrested full inspiration or, preferably, with the patient performing the valsalva manoeuver.[24] The X-ray beam is centered to the sternal notch.

Lateral soft tissue view of neck: if the upper trachea is over-exposed on the basic lateral view, a further lateral view is taken as for the larynx.

Difficult intubation:

Generally difficult intubation may be anticipated or un-anticipated. Difficult intubation may be anticipated from evidence sought at the preoperative visit. It is important to be aware of that because poor management of difficult intubation is a significant cause of anaesthetic morbidity and mortality. Sequelae include dental and airway trauma, pulmonary aspiration and hypoxaemia.[25]

Thyroid enlargement is one of the important causes of difficult intubation, the anaesthetist should expect that 6% of tracheal intubation for thyroid surgery will be difficult.[26]

The thyroid gland incompletely encircles the trachea. Glandular enlargement can cause tracheal compression. The anatomic location of the thyroid either suprasternal or with retrosternal extension has important implications, airway involvement can include deviation, compression, or luminal

narrowing. With muscle relaxation a thyroid with retrosternal extension can cause tracheal compression following the administration of agents that result in loss of respiratory muscle tone.

Identification of patients with a potentially difficult airway before anesthesia allows time to plan an appropriate anaesthetic technique. Previous anaesthetic records should always be consulted. However, a past record of normal tracheal intubation is no guarantee against difficulty on subsequent occasions as airway anatomy can be altered, e.g. by pregnancy or the development of disease of the cervical spine. The presence of stridor or hoarse voice are warning signs for the anesthetist.[27]

Potential difficult endotracheal intubation risk factors in thyroid surgery are sex (male), body mass index, mallampati class, thyromental distance, neck mobility, cormack grade, cancerous goiter, tracheal deviation or compression [28].

In assessing the possibility of air way obstruction, chest X-ray and computed tomography scanning of the neck are helpful in evaluating tracheal position and airway obstruction.[27]

Many additional clinical tests to predict difficult intubation have been described. None of these tests is totally reliable, but their use may complement routine examination of the airway.

Mallampati and his associates[29] in a prospective study have developed a useful clinical test. The patient was seated at 90 degree to the horizontal, facing the anaesthetist, and invited to extrude the tongue as far as possible, permitting allocation of the patient to one of three classes. In class one the faucial pillars, soft palate and uvula are seen. In class two the pillars of fauces and soft palate are seen, but the uvula is masked by the base of the tongue. In class three only the soft palate is seen. Samsoon and Young[30] developed this further in a retrospective study and introduced a class four in which the soft palate was not visible.

In practice, this test suggests a higher incidence of difficult intubation if the posterior pharyngeal wall is not visualized. The predictive value of this test may be strengthened if the thyromental distance (the distance between the thyroid cartilage prominence and the bony point of the chin during full head extension) is less than 6.5cm. The mallampati classification correlates with view obtained at laryngoscopy in which the amount of glottis visible was graded according to the classification of Cromack and Lehance[31] into three graded, in grade (I) glottis (including anterior and posterior commissures) could be fully exposed, grade (II) glottis could be partially exposed, grade (III) glottis could not be seen and in grade (IV) even the epiglottis could not be seen.

One of the most serious complication of thyroid surgery is postoperative respiratory failure, the causes of which include hemorrhage, respiratory obstruction, recurrent laryngeal nerve palsies, tracheomalacia, pneumothorax and hypocalcemia.[32] There are six pre-operative predictive factors for the development of serious post operative respiratory obstruction these are goiter for more than 5 yrs, pre-operative recurrent laryngeal nerve palsy, significant tracheal narrowing and or deviation, retrosternal extension, difficult endotracheal intubation, thyroid cancer [33].

Acute respiratory insufficiency secondary to bilateral vocal cord paralysis from recurrent laryngeal nerve compression has been reported in patients with intrathoracic goiter.[34]

Injury to bilateral recurrent laryngeal nerves results in respiratory obstruction. Patients demonstrate paramedian position of both of the true vocal cords. These patients require emergent airway intervention including intubation or tracheostomy. Patients with unilateral recurrent laryngeal nerve paralysis present with hoarseness and minimal signs of airway obstruction.[32]

OBJECTIVES

To evaluate the value of conventional radiology in the following:

- The incidence of radiological abnormalities in a series of consecutive patients with goiter undergoing thyroidectomy.
- The relationship between the degree of tracheal abnormality and difficulties in breathing.
- Establishing relation between radiological tracheal abnormalities and the degree of difficulty in manual ventilation and tracheal intubation.
- In relation between radiological tracheal abnormalities and airways assessment by mallampati and direct laryngoscope.
- Prediction of postoperative respiratory complications and the need for ventilatory support and tracheostomy.

PATIENTS AND METHODS

This prospective study was conducted at Soba University Hospital and Khartoum Teaching Hospitals, Khartoum, Sudan in the period between October 2003 and August 2004. These two hospitals are the referral hospitals in the country.

One hundred patients with clinically confirmed thyroid enlargement from different parts of the Sudan were included.

The inclusion and exclusion criteria:

The inclusion criterion was patients with thyroid swellings requiring endotracheal anesthesia for thyroid surgery. The exclusion criteria were: patients with the following:

- Patients with known cardiovascular and respiratory pathology.
- Patients who had previous difficult intubation or tracheostomy.
- Pregnant ladies.
- Patient proved to have thyroid malignancy.

Sample size:

The sample size was calculated according to the following:

$$N= (z)^2 (pq) /(d)^2.$$

Where:

N= sample size

Z= preset confidence level (95%)

P= the expected value of the study variable to be estimated

q=1-p

d= margin of error of the estimation

Clinical assessment:

All patients had a through clinical interview in the ward with special emphasis on the age, presenting symptoms and duration of each symptom. Past history of surgery or previous exposure to general anesthesia and if there was any difficulty in that exposure or any post anesthetic complication. All patients had meticulous general and local clinical examination. Most of them had Indirect laryngoscopy for visualization of vocal cords at Khartoum ENT Hospital.

Radiological examination:

All patients had thoracic inlet X-ray to clarify the extent and effect of the thyroid swelling on the airway passages. It was performed preoperatively in the X-ray room.

Two different views were taken the AP and lateral. The AP view done in erect position, raised chin, arrested full inspiration, X-ray

beam center to sternal notch, 65 KVP 200 MA, 0.14 second, 120 cm distance.

For lateral view, the patient stands lateral to X-ray film with the chin raised, the hands behind the back and the shoulder forced back. The exposure is made on full arrested inspiration with focus film distance, used 120 cm and 70 KVP 200 MA, 0.18 second center just above the head of the humerus away from the cassette. The machine used is Toshiba ordinary X-ray machine with stand bucky. The green film size B (24 × 30 cm) was used, and was manually processed. Any X-ray view with technical faults e.g. under or over exposed or badly developed was repeated.

The x-ray films were read by the investigator and rechecked by independent radiologist (Dr. Osman Abdelwahab).

Anaesthetic assessment:

All patients were assessed pre-operatively by a consultant anaesthetist or trained registrar for the airway adequacy using mallampati predictive test. During the events of tracheal intubation, laryngoscopy was done and according to visualization of the larynx, the patients were graded. The introduction of the endotracheal tube was classified as easy or difficult and the number of trials of intubation. Assessment of recurrent laryngeal

nerves function was done post operatively by visualization of vocal cords movement.

Sources of errors:

All x-ray were reported by the investigator, but the intubation was done by different anesthetists.

Data analysis:

The data were analyzed by computer programme using SPSS/PC package.

Simple frequency distribution, cross tabulations and predictive values were used to evaluate accuracy of each method and compared with actual situation.

Definitions:

- Tracheal narrowing: Is that when the tracheal coronal diameter is less than lower limit of the normal diameter (1.3 – 2.5cm) in coronal plane.
- Tracheal deviation: Is defined as mild when it is less than one inch, moderate when it is between 1-2 inches and severe when it is more than 2 inches.
- Retrosternal goiter: Is soft tissue mass appearing in x-ray in the superior part of anterior mediastinum and may associated with soft tissue mass in the neck.

- Difficult endotracheal intubation is that when there are more than two trials or when it takes more than ten minutes[35].
- Tracheomalacia is softening of tracheal rings due to pressure necrosis of cartilaginous tracheal rings in presence of a goiter.

RESULTS

The net sample size of this prospective study was 100 patients with clinically confirmed goiter, approximately two third of them were seen at Soba University Hospital. There were 23 males (23%) and 77 females (77%) (**Fig. 1**). The patients ages ranged between 15 and 64 years with a mean age of (42.59 + 14.9) years (**Fig. 2**).

The duration of the goiter ranged between less than one year and more than 45 years. Most of patients (85%) had the goiter for more than one year (**Fig. 3**).

The common preoperative symptoms were upper airway obstruction such as difficulty in breathing (40%), choking (23%), regurgitation (10%) and hoarseness of voice (17%) as shown in (**Fig. 4**).

All patients had thoracic inlet x-ray preoperatively. In 94% of them there were evidence of soft tissue swelling, 33% of them had retrosternal extension of the thyroid gland and 17% showed calcification (**Fig. 5**).

In thoracic inlet view (T.I.V). The trachea was in the central position in 8 patients (8%), deviated to the right side in 67 patients (67%) or deviated to the left side in 25 patients (25%) (**Fig. 6**).

The severity of tracheal deviation was classified to mild which means less than one inch, and this was evidenced in 54% of the patients, moderate when it was between 1 - 2 inches and this found to be 46% of the patients and severe deviation when it was more than two inches. This is shown in (**Fig. 7**).

Narrowing of the trachea was documented in 39 patients (39%), while normal tracheal caliber was in 61 patients (61%) (**Fig. 8**) of the 39 patients who had tracheal narrowing, 9 (23.1%) patients had the narrowing at C_5C_6, 15 (38.45%) patients had it at C_6 C_7 and in 15 (38.45%) patients it was at the level of C_7 T_1 (**Fig. 9**).

In the pre anaesthetic assessment, intubation difficulty was graded by malampti showed grade I in 50 patients (50%), grade II in 37 patients (37%), grade III in nine patients (9%) and grade IV in four patients (4%). This shown in (**Fig. 10**).

Anaesthetic assessment, laryngoscopic view findings showed grade I in 60 patients (60%), grade II in 27 patients (27%), grade III in seven patients (7%) and grade IV in six patients (6%) (**Fig. 11**).

Ventilation via facemask and bag was found to be adequate in 91 patients (91%) and inadequate in 9 (9%) patients (**Fig. 12**).

Most of the patients (86%) had one intubation trial, nine patients (9%) had two trials and five patients had more then two trails (**Fig. 13**).

Postoperatively only six patients (6%) needed ventilatory support, four patients (4%) were reintubated and tracheostomy was done in the other two patients (2%) (**Fig. 14**). Only one patient had partial recurrent laryngeal nerve palsy, which was the left one.

(**Table 1a**) correlates the radiological finding, retrosternal extension with the presenting symptoms; out of 100, 33 patients had retrosternal extension: out of these 33 patients 21 (64%) had difficulty in breathing and 12 (36%) had no difficulty in breathing (P = 0.003). (**Table 1b**) shows nine patients (27%) had chocking, while 24 (73%) patients had no chocking of those with retrosternal goiter; 14 (21%) of the 67 with no retrosternal extension had chocking while 53 (79%) had no chocking (P = 0.575) not significant. Also hoarseness of voice (**Table1c**) and regurgitation (**Table1d**) were not significant with P. value of 0.428 & 0.056 respectively.

Table 2a correlates radiological findings, tracheal narrowing, with presenting symptoms; 39 patients had tracheal narrowing; of these 39 patients 23 (59%) had difficulty in breathing,

while 16 (41%) patients had no difficulty in breathing. Of the 61 patients who had no tracheal narrowing, 17 (28%) patients had difficulty in breathing, 44 (72%) patients had no difficulty in breathing (P= 0.009). Table 2b shows 13 (33%) patients out of 39 patients who had tracheal narrowing had chocking while 26 (67%) had no chocking (P= 0.276). It was not significant, also hoarseness of voice (**Table 2c**) and regurgitation (**Table 2d**) were not significant (P= 0.400), (P= 0.151) respectively.

(**Table 3a, 3b, 3c & 3d**) shows the radiological findings related to tracheal deviation and clinical symptoms of difficulty in breathing, chocking, hoarseness of voice and regurgitation. Out of 100 patients 92 (92%) had tracheal deviation, but no statistical significance was found between them and the above mentioned symptoms.

(**Table 4a, 4b, 4c & 4d**) shows the correlation between radiological finding, soft tissue calcification and presenting symptoms, there was a significant correlation between difficulty in breathing and soft tissue calcification (P = 0.038). It might be due to chronicity. No significant relation was found between soft tissue calcification, chocking, hoarseness of voice or regurgitation.

(**Table 5**) relates radiological findings and number of endotrachael intubation trials. No statistical significance was found.

(Table 6) shows the relation between tracheal intubation and preanaesthetic assessment "Mallampatti grading". There was a significant correlation between them (P = 0.035).

(Table 7) shows the relation between tracheal intubation and laryngoscopic view. There was a significant correlation (P = 0.000).

(Table 8) shows the relation between endotracheal intubation, tracheal deviation and Mallampatti grading.

(Table 9) shows the relation between endotracheal intubation, tracheal deviation and laryngoscopic view.

According to **(Table 10)**, which shows correlation between x-ray findings and ventilation via face-mask and bag, 9 patients had inadequate ventilation; 7 (78%) of them had retrosternal extension, while only 2 (22%) had no retrosternal extension. Out of 91 patients who had adequate ventilation; 26 (29%) had retrosternal extension while 65 (71%) patients had no retrosternal extension (P = 0.013). It was significant **(Table 10a)**. The others radiological findings, tracheal narrowing, tracheal deviation and soft tissue calcification had no significant correlation with ventilation via face mask and bag **(Table 10b, 10c, 10d)**.

(Table 11) shows the relation between x-ray findings and postoperative necessity for airway support, 6 patients out of 100

needed support; 5 (83%) out of them had retrosernal extension while only one (17%) had no retrosternal extension, of the 94 patients who did not need support 28 (30%) patients had retrosternal extension while 66 (70%) patients had no retrosternal extension (P = 0.007). It was significant **(Table 11a)**.

(Table 11b) shows 5 (83%) patients out of the six who needed ventilatory support had tracheal narrowing while only one (17%) patient had no tracheal narrowing, out of 96 patients who did not need support 34 (36%) patients had tracheal narrowing, 60 (64%) patients had no tracheal narrowing (P = 0.022). **(Table 11d)** shows positive correlation between soft tissue calcification and necessity for postoperative support (P = 0.026). No significant relation between tracheal deviation and necessity for postoperative support **(Table 11c)**.

DISCUSSION

Thyroid diseases are a common problem in the Sudan and due to multi-factorial reasons many patients present with huge goiter. Some of these patients require at certain stage surgery, which might be difficult during manual ventilation, endotracheal intubation, extubation and the patient might need postoperative airway support. Hence this prospective study was conducted to evaluate the value of conventional radiology in the detection of tracheal abnormality due to thyroid swelling such as tracheal narrowing and deviation, to confirm that it is a cause of upper respiratory tract obstruction and test this investigation as a predictive tool in anticipating difficulties during anaesthetic process and necessity for post operative support.

Thoracic inlet view could be done for many reasons but it requested mainly for patients with thyroid swelling, it shows the tracheal abnormalities caused by goiter, tracheal narrowing was found in 39% of patients, mild tracheal deviation was found in 54% of patients and moderate tracheal deviation was found in 46% of patients. The incidence of substernal goiter is difficult to assess but reportedly ranges from 2.6-21% patients undergoing thyroidectomy. The wide range in reported incidence is largely due

to variation in definition of substernal goiter[36]. In this study retrosternal goiter was found in 33% of patients.

Difficulty in breathing significantly correlated with retrosternal extension, tracheal narrowing and soft tissue calcification. So the presence of difficulty in breathing can be considered as a serious symptom in patients with thyroid swelling. The thoracic inlet x-ray is of value in such patients and it is recommended for detecting these changes.

According to these significant associations conventional radiology can be a good investigation in diagnosing upper airway obstruction.

According to **(Table 5)**, which correlates the radiological findings with number of intubation trials, we have 5 patients who had more than two trials so the incidence of endotracheal difficulty in thyroid surgery is 5% which correlates well with the literature [26] but we couldn't find significant correlation between radiological findings and difficult endotracheal intubation. This was mentioned by A. Bouaggad & Nejmi in Morocco when they studied 320 patients with goiter to investigate the incidence of difficult intubation (DEI) and to evaluate factors linked to it, they concluded that the large goiter is not associated with a more frequent DEI[29].

A different idea was mentioned by Voyages and Kyriakos[37] who concluded that goiter, when accompanied by airway deformity, constitutes an aggravating factor for difficult endotracheal intubation.

There was a significant association between x-ray findings (Retrosternal extension) and ventilation via face-mask and bag so conventional radiology can be of value in anticipating difficulty of manual ventilation.

A laryngoscopic view graded according to Cormack and Lehane was used in this study. An intubation was considered difficult if it was grade 3 or 4. It found to be statistically significant (P 0.000). Mallampati grading also was tested, intubation was found to be difficult with Mallampati grade 4 (P = 0.035), this in line with a study done in 1997 concluded that difficult intubation was significantly more common in patients with Mallampati grade 3 however; it had low sensitivity (60%) and specificity (72%). The test had a limited clinical value.[38] Hence more than one pre-anaesthetic test should be used for the prediction of difficult intubation. However, no correlation could be found between airway assessment (Mallampati, Laryngoscopic view) and the radiological findings of retrosternal extension, tracheal deviation and tracheal narrowing.

In evaluating airway obstruction post operatively, one patient had partial recurrent laryngeal nerve palsy; there was no correlation between the radiological finding and the nerve palsy in this patient. As the incidence of this complication is small it is difficult to draw a conclusion. Permanent recurrent laryngeal nerve injury is a relatively uncommon event, with a rate of approximately 1%, the rate is probably lower in patients with benign disease and higher in patients with large invasive, or recurrent thyroid carcinoma.[39]

The problems associated with huge goiters include difficult intubation, large blood loss, prolonged operating time and post operative tracheomalacia.[40,41] In general the incidence of respiratory complications of tracheal extubation and in recovery room is greater than that at intubation.[42] These complications include coughing, oxygen desaturaion, laryngospasm and respiratory obstruction. Complications will be more expected when there is retrosternal extension, these complications are hematoma, recurrent laryngeal nerve injury, pneumothorax, pneumonia, tracheomalacia[43].These informations are in line with this study as six patients needed postoperative support, according to **(Table 11)** there was significant association between necessity for airway support and retrosternal extension (P = 0.007) another significant

association with tracheal narrowing (P = 0.022), third association with soft tissue calcification (P = 0.026). According to these significant associations conventional radiology is a good tool for prediction of postoperative necessity for airway support.

Four out of the six patients who needed support were reintubated and tracheostomy was done in the remaining two. In most of them the cause of necessity for airway support was tracheomalacia. It is a life-threatening complication,[44] which should be considered before extubation. Management of tracheomalacia requires urgent reintubation, possibly tracheostomy and some form of tracheal support.[45]

The incidence of tracheomalacia will depend on the frequency of large neglected goiter which caused prolonged tracheal compression, in a prospective study of 103 patients in Khartoum, post-operative respiratory complications occurred in 32 patients and were obstructive in 24 patients, tracheostomy was necessary in 13 patients, five patients of them was due to tracheomalacia.[33], when it was present dangerous consequences can result after removal of the thyroid, for collapse or narrowing of the trachea would occur with inspiration, resulting in respiratory embarrassment. Although tracheal resection may be performed in some cases, the treatment of choice is endotracheal intubation[46].

CONCLUSION

- Thoracic inlet X-ray can help in the detection of tracheal abnormality and prediction of airway complication post operatively in patients with thyroid enlargement.

- Thoracic inlet x-ray cannot predict difficult endotracheal intubation in patients with thyroid enlargement but can be of help, specially when combined with other clinical tests.

- Conventional radiology still has a role in managing patients with thyroid swelling as far as its simple, cheap and available.

RECOMMENDATIONS

- Thoracic inlet X-ray is recommended as one of routine investigations in patients with thyroid swelling.

- Simple investigations like thoracic inlet x-ray should not be over looked or under estimated and doctors should try to maximize its benefit especially in hospitals where advanced investigations are not available.

- Clinicians should be encouraged to conduct this reasonable X-ray view in the management of patients with thyroid enlargement specially in those who may need surgical intervention.

- The value of modern investigations such as CT or even MRI should be assessed for their value in patients with thyroid swelling specially when it extended retrosternally.

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Table (1): Correlation between retrosternal extension and presenting symptoms.

Present symptoms	**Retrosternal extension**		
	Yes	No	Significance
a) Difficulty in breathing:			
Yes	21 (64%)	19 (28%)	
No	12 (36%)	48 (72%)	P = 0.003
Total	**33 (100%)**	**67 (100%)**	
b) Chocking:			
Yes	9 (27%)	14 (21%)	
No	24 (73%)	53 (79%)	P = 0.575
Total	**33 (100%)**	**67 (100%)**	
c) Hoarseness of voice:			
Yes	8 (24%)	9 (13%)	
No	25 (76%)	58 (87%)	P = 0.428
Total	**33 (100%)**	**67 (100%)**	
d) Regurgitation:			
Yes	6 (18%)	4 (6%)	
No	27 (82%)	63 (94%)	P = 0.056
Total	**33 (100%)**	**67 (100%)**	

Table (2): Correlation between tracheal narrowing and presenting symptoms.

Present symptoms	**Tracheal narrowing**		
	Yes	No	Significance
a) Difficulty in breathing:			
Yes	23 (59%)	17 (28%)	
No	16 (41%)	44 (72%)	P = 0.009
Total	**39 (100%)**	**61 (100%)**	
b) Chocking:			
Yes	13 (33%)	10 (16%)	
No	26 (67%)	51 (84%)	P = 0.276
Total	**39 (100%)**	**67 (100%)**	
c) Hoarseness of voice:			
Yes	6 (15%)	11 (18%)	
No	33 (85%)	50 (82%)	P = 0.400
Total	**39 (100%)**	**61 (100%)**	
d) Regurgitation:			
Yes	6 (15%)	4 (7%)	
No	33 (85%)	57 (93%)	P = 0.151
Total	**39 (100%)**	**61 (100%)**	

Table (3): Correlation between tracheal deviation and presenting symptoms.

Present symptoms	**Tracheal deviation**		
	Yes	No	Significance
a) Difficulty in breathing:			
Yes	38 (41%)	02 (25%)	P = 0.538
No	54 (59%)	06 (75%)	
Total	**92 (100%)**	**08 (100%)**	
b) Chocking:			
Yes	21 (33%)	02 (25%)	P = 0.374
No	71 (77%)	06 (75%)	
Total	**92 (100%)**	**08 (100%)**	
c) Hoarseness of voice:			
Yes	17 (18%)	0 (0%)	P = 0.875
No	75 (82%)	08 (100%)	
Total	**92 (100%)**	**08 (100%)**	
d) Regurgitation:			
Yes	10 (11%)	0 (0%)	P = 0.065
No	82 (89%)	08 (100%)	
Total	**92 (100%)**	**08 (100%)**	

Table (4): Correlation between soft tissue calcification and presenting symptoms.

Present symptoms	**Soft tissue calcification**		
	Yes	No	Significance
a) Difficulty in breathing:			
Yes	11 (65%)	29 (35%)	P = 0.038
No	06 (35%)	54 (65%)	
Total	**17 (100%)**	**83 (100%)**	
b) Chocking:			
Yes	05 (29%)	18 (22%)	P = 0.174
No	12 (71%)	65 (78%)	
Total	**17 (100%)**	**83 (100%)**	
c) Hoarseness of voice:			
Yes	05 (29%)	12 (14%)	P = 0.163
No	12 (71%)	71 (86%)	
Total	**17 (100%)**	**83 (100%)**	
d) Regurgitation:			
Yes	04 (31%)	06 (7%)	P = 0.641
No	13 (69%)	77 (83%)	
Total	**17 (100%)**	**83 (100%)**	

Table (5): Correlation between radiological findings and endotracheal intubation according to number of trials.

Intubation	Retrosternal extension		Tracheal narrowing		Tracheal deviation		Soft tissue calcification	
	Yes	No	Yes	No	Yes	No	Yes	No
1	27	59	32	54	78	8	15	71
2	3	6	4	5	9	0	2	7
> 2	3	2	3	2	5	0	0	5
Total	**33**	**67**	**39**	**61**	**92**	**8**	**17**	**83**
P. value	**0.417**		**0.561**		**0.301**		**0.546**	

Table (6): The relation between tracheal intubation and Mallampatti grading.

Malampatti Grading	**No.**	**Easy (one trial)**	**Moderate (2 trials)**	**Difficult more than 2 trials**
Grade I	50	47	2	1
Grade II	37	31	4	2
Grade III	9	6	2	1
Grade IV	4	2	1	1
Total	**100**	**86**	**9**	**5**

P. value = 0.035

Table (7): The relation between tracheal intubation and Laryngoscopic view.

Laryngoscopic View	No	Easy (one trial)	Moderate (2 trials)	Difficult (> 2 trils)
Grade I	60	59	-	1
Grade II	27	20	6	1
Grade III	7	5	2	-
Grade IV	6	2	1	3
Total	**100**	**86**	**9**	**5**

P. value = 0.000

Table (8): The relation between endotracheal intubation, tracheal deviation and Malampatti grading.

Intubation	Tracheal deviation		MGI	MGII	MGIII	MGIV
	Yes	No				
1 trail	78	8	47	31	06	02
2 trails	09	0	02	04	02	01
> 2 trials	05	0	02	02	01	01
Total	**100**		**50**	**37**	**09**	**04**

Table (9): The relation between endotracheal intubation, tracheal deviation and laryngoscopic view.

Intubation	Tracheal deviation		MGI	MGII	MGIII	MGIV
	Yes	No				
1 trial	78	8	59	20	05	02
2 trials	09	0	0	06	02	01
> 2 trials	05	0	01	01	0	03
Total	100		60	27	07	03

Table (10): X-ray findings in relation to ventilation via face-mask and bag.

X-ray findings	Ventilation via face-mask and bag		
	Adequate	**Inadequate**	**Significance**
a) Retrosternal extension:			
Yes	26 (29%)	7 (78%)	P = 0.013
No	65 (71%)	2 (22%)	
Total	**91 (100%)**	**9 (100%)**	
b) Tracheal narrowing:			
Yes	34 (37%)	5 (56%)	P = 0.286
No	57 (63%)	4 (44%)	
Total	**91 (100%)**	**9 (100%)**	
c) Tracheal deviation:			
Yes	83 (91%)	9 (100%)	P = 0.323
No	8 (9%)	0 (0%)	
Total	**91 (100%)**	**9 (100%)**	
d) Calcification:			
Yes	14 (15%)	3 (33%)	P = 0.171
No	77 (85%)	6 (67%)	
Total	**91 (100%)**	**9 (100%)**	

Table (11): X-ray findings in relation to postoperative necessity for airway support.

Radiological findings	Postoperative necessity for airway support		Significance
	No support	**Need support**	
a) Retrosternal extension:			
Yes	28 (30%)	5 (83%)	P = 0.007
No	66 (70%)	1 (17%)	
Total	**94 (100%)**	**6 (100%)**	
b) Tracheal narrowing:			
Yes	34 (36%)	5 (83%)	P = 0.022
No	60 (64%)	1 (17%)	
Total	**94 (100%)**	**6 (100%)**	
c) Tracheal deviation:			
Yes	86 (91%)	6 (100%)	P = 0.624
No	8 (9%)	0 (0%)	
Total	**94 (100%)**	**6 (100%)**	
d) Calcification:			
Yes	14 (15%)	3 (50%)	P = 0.026
No	80 (85%)	3 (50%)	
Total	**94 (100%)**	**6 (100%)**	