"EVALUATION OF MANDIBLE FOR TUMOR INVOLVEMENT IN THE LOWER GINGIVOBUCCAL SULCUS SQUAMOUS CELL CARCINOMA"

By

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In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY
IN
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Under the Guidance of

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I hereby declare that this dissertation entitled **"EVALUATION OF MANDIBLE FOR TUMOR INVOLVEMENT IN THE LOWER GINGIVOBUCCAL SULCUS SQUAMOUS CELL CARCINOMA"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. S.M.AZEEM.MOHIYUDDIN**, Professor and Head of the Department of Otorhinolaryngology , Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of University regulation for the award "**M.S. DEGREE IN OTORHINOLARYNGOLOGY**", the examination to be held in May 2017 by SDUAHER. This has not been submitted by me previously for the award of any degree or diploma from the university or any other university.

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LIST OF ABBREVIATIONS

ABBREVATIONS	
BM	Buccal mucosa
RMT	Retromolar trigone
GBS	Gingivobuccal sulcus
AJCC	American Joint Committee against Cancer
OSCC	Oral squamous cell carcinoma
ITF	Infratemporal fossa
Ca	Carcinoma
CIS	Carcinoma in situ
HPV	Human papilloma virus
VEGF	Vascular endothelial growth factor
EGFR	Epidermal growth factor receptor
SCC	Squamous cell carcinoma
CECT	Contrast enhanced computerized tomography scan
MRI	Magnetic resonance imaging scan
USG	Ultrasonography scan
FNAC	Fine needle aspiration cytology
NACT	Neoadjuvant chemotherapy
RT	Radiotherapy
CT	Chemotherapy
HPE	Histopathological examination
NCCN	National comprehensive cancer network

ABSTRACT

Background: Head and neck cancer is a major health problem that occur in Asia, especially in indian sub continent. Buccal mucosa and lower alveolar complex is the most common site of oral cancer in india, and majority of the Patients present with localy adavced tumor.therefore it also known as " indian oral cancer". Due to close proximity of tumour in these subsites to the mandible ,it is more susceptible to early tumor invasion. Mandibular involvement ranges from 12 to 56 % in this cancer

Aims and objectives:

1) To study the pattern of mandibular involvement in lower gingivo buccal sulcus squamous cell carcinoma.
2) To clinically asses and document involvement of mandible in lower gingivo buccal sulcus squamous cell carcinoma.
3) To assess the histopathological pattern of mandible involvement in resected specimen.
4) To correlate clinical and histopathological findings in lower gingivo buccal sulcus squamous cell carcinoma

Materials and methods: This study was carried out over a period of 19 months from December 2014 to June 2016.38 patients with lower gingivo buccal sulcus squamous cell carcinoma.Patients who met the inclusion/exclusion criteria were included in the study.

Results: 38 patients with oral cancer either reaching or involving lower GBS were included in this study.Appearance of lesion was found to be ulceroproliferative (ulceroexophytic) in majority of the patients(31/38). On imaging (CECT) mandibular erosion was seen in 10 patients (26.3%), in 4 patients (10.5%) the disease was abutting mandible. Disease was not extending to bone in 24 patients(63.2%).

The clinical staging in our study shows 25 patients(65.7%) with stage IVA and in 13 patients(34.2%) with stage III cancer. 92.1% of patients in this study underwent hemimandibulectomy as part of composite resection of tumor and 7.9% patients underwent marginal mandibulectomy. 8/38 patients had bone involvement (21.1%) on decalcified section. On correlation between CECT and HPE with regarding to bone invasion. 10 patients showing bone involvement in CECT, only 6 had bone involvement in HPE , and in 1 patient who had only abutment of disease to mandible showe bone involvement in HPE,1 patient who had no signs of bone involvement in CECT showed evidence of bone involvement in HPE. Among 8 patients who had bone involvement on HPE,5 patients were found to have metastatic lymphnode (4 patients with single metastaic lymphnode and 1 patients with two metastatic lymphnodes).

On minimum follow up of 6 months and mean followup of 11 months , 35 patients (92%) are alive and disease free.1 patient is alive with local recurrence. 2 patients expired due to disease. All patients with recurrence had locally advanced

disease(T4a) and metastaic lymphnodes(1 patients with single metastic lymphnode and 2patients with multiple metastaic lymphnodes).

Conclusion: We conclude that CECT is the one of the good modality of imaging to rule out for mandibular invasion in lower GBS squamous cell carcinoma. Along with proper Clinical examination and radiological assessment preoperatively, a large no of patients with lower gingivo buccal sulcus cancer can be subjected to mandible conserving surgery and thereby reducing the postoperative morbidity and cosmetic defect.

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INTRODUCTION

Head and neck cancer is a major health problem that occur in Asia, especially in the Indian sub continent. More than 2 Lakh new Cases of head and neck cancers are diagnosed each year of which India contributes to 7.8% of the global cancer burden and 8.33% of Global cancer death.[1] Buccal mucosa and lower alveolar complex is the most common site of oral cancer in India, and majority of the Patients present with locally advanced tumor. Therefore, it also known as " Indian oral cancer".[2] The wide spread use of smokeless tobacco in the form of betel quid, especially among low socio economic status people across the country is the main cause of high prevalence of this cancer. Lower gingivo-buccal sulcus complex is composed of buccal mucosa, lower gingivo-buccal sulcus, lower gingiva and retromolar trigone. Due to close proximity of tumour in these sites adjacent to the mandible, it is more susceptible to early tumor invasion. Mandibular involvement ranges from 12 to 56 % in this cancer. According to literature,[3] the standard surgical treatment for these cancer is composite resection, which mostly involves segmental (hemi /marginal) mandibulectomy. Recent trends in treatment of oral cancer that is close to, or abutting the mandible are primarily focused on preservation of the mandible , because the mandible has major role in function and cosmetic appearance.

In 1966 Marchetta and Sako and in 1971 Marchetta et al and carter et al demonstrated that periosteal invasion does not occur without actual tumor - Bone abutment. They determined that carcinomatous infiltration of the mandible occurred by direct infiltration rather than by lymphatic spread.[4,5] This study favoured preservation of mandibular continuity

in lesions not invading mandible without compromising local tumor control. Due to advancement in reconstructive techniques ,the function and cosmesis are given importance, therefore surgical techniques which preserve mandible emerged in the treatment of suitable oral cavity cancer.

A good understanding of the pathways of mandibular involvement in oral cancer is necessary to yield better functional, aesthetic and psychological results. Tumors invading mandible will have more aggressive behaviour, and this case requires partial or total mandible resection on that side. In the treatment of lower gingivo-buccal complex cancer, tumour should be evaluated both clinically and radiologically because preserving the mandible may compromise local oncological clearance (margin clearance) in few patients. At the same time, there is need to identify those carcinomas that do not invade mandible for conservation of mandible.

OBJECTIVES

AIM AND OBJECTIVE OF THE STUDY

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REVIEW OF LITERATURE

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HISTORY

Carcinoma is a Greek word meaning a crab. Its Latinised form is 'cancer'. Malignancy is another term from its Latin roots malignus and genus meaning endangering harm. Cancer is a term used to characterize abnormal growth of cells, which may result in the invasion of normal tissue or the spread to organs.

"**The longer you can look back,**

The further you can look"

In historical evidence of buccal mucosa and alveolar lesions have been dated back in time before Christ; Edwin Smith Papyrus (2300 B.C.) and by Ekers Papyrus (1500 B.C.) made references to such tumours.

Cornelius Celsus, a roman in first century A.D., in his multi volume work, 'DE MEDICINO', described ulcers of the mouth and tumours of the gingiva. In 1400 A.D. anatomical dissection begun and with that the truth of the human anatomy began to come out. Wilhelm Fabry (1556-1634 A.D.) reported 600 cases, which had oral surgical problems.

In the earlier part of the twentieth century, surgeons of the German school introduced an array of new techniques for operations involving the tongue, gingiva, mandible and maxilla. Division of mandible for better access of intra oral lesion was first proposed by Langenback. Jaegir in 1831A.D. introduced the practice of splitting the cheek to provide

exposure. Roux (1836 A.D.) and Sedinot (1844 A.D.) split both the mandible and the lip in the midline.

In 1880 T. Kocher described the surgical removal of a tumour of the tongue en bloc with the regional lymph nodes using a mandibulotomy approach.[6] In 1902, Polya and von Navratil stated that, lymphatics of the tongue and floor of mouth passed through mandibular periosteum on the way to the cervical nodes.[7] George Crile in 1906 A.D first described the En block radical neck dissection. This classic report provides the basis for the technique of radical neck dissection as it is practised today.[6]

In 1931A.D. Trotter stressed that a wide microscopically normal tissue margin was essential for cure of carcinoma. With the advent of antibacterial chemotherapy, better wound management, diagnostic tools, advances in pathology, improved surgical techniques, development in anaesthesia and transfusion techniques, the prognosis of cancer surgery improved by leaps and bounds.

The first "commando" operation as it is called now was performed by Grant Ward in 1932 A.D. This en bloc excision of the primary within the oral cavity including portion of the mandible combined with the radical neck dissection was being performed regularly since 1942. Allied commando raids on Dippe in 1942 A.D. compared well with the principle behind the surgery attacking both the primary and the metastatic node disease simultaneously and were therefore referred to as 'commando' a term popular to date.

Thereafter a gradual refinement in technique along with modern concepts of en bloc resection of tumour, mandible and nodes brought in the management of oral malignancies. Some of the pioneers in the field, who made significant contribution, were Hayes Martin, from the Memorial hospital in New York City (1941 A.D.), Sugar and Gilford (1946 A.D.), Conley and Back (1949 A.D.) and Edgerton (1951 A.D.).

Slaughter et al recommended aggressive resection of the mandible for the treatment of lesions that exhibit bone involvement, believing that was implicated via either direct extension or periosteal involvement by lymphatic drainage of the tumour.[8]

In 1951, Ward and Robben recommended the "pull-through" operation for tumours located at a distance greater than 1 cm from the lingual aspect of the mandible in a first attempt at preserving mandibular continuity and advocated segmental mandibulectomy for the tumours that involved or were close to bone for adequate resection.[7,9] Their position was based on the understanding that tongue and floor of mouth lymphatic channels drained though the lingual periosteum into the mandible.

In 1953 Greer et al described the marginal mandibulectomy technique in a study of 21 patients, removing only part of the mandibular thickness for the treatment of intraoral cancer.[10] During the 1950s and 1960s, the emphasis shifted from the excision of tumour to excision of tumour combined with the reconstructive aspect of surgery

Important pioneers and contributors in this field are listed below:

- 1951 A.D. -- Edgerton advocated the use of skin graft.[11]
- 1956 A.D. -- Klopp and Schurter described the local tongue flap.[13]

- 1957 A.D. -- Edgerton and D'Perez described Submandibular apron flap.
- 1963 A.D. -- Deltopectoral flap (medially based) was described by Bakamjiam.[14]
- 1979 A.D. -- Stephan Ariyan described the pectoralis major myocutaneous flap based on the pectoral branch of the thoraco- acromial artery. This is 'the work horse' of the head and neck reconstruction surgery.[15]
-

The forehead flap has been in use for a long time and was first described by McGregor, who advocated its use for resurfacing of the oral cavity.[16] [17] There are a wide range of 'free flaps' available, but among them important ones are the free osteomyocutaneous groin flap, osteomyocutaneous rib flaps and also the radial forearm flap termed as 'The Chinese flap' developed by Dr. Yang Goufan, Chen Baoqui and Gao Yucht of the Shenjeing military hospital, in 1978A.D.[18]

Traditional commando operation was based on the belief that the lymphatics of the floor of mouth drained through the mandible and the periosteum of the mandible to the lymph nodes of the neck. But later it was demonstrated by Marchetta et al[19,20] that the mandible was involved by tumour only if there was direct extension through the periosteum rather than through periosteal lymphatics. Therefore a new horizon opened as conservative resection of the mandible, which was oncologically feasible, and functionally and cosmetically better acceptable. Marginal mandibulectomy can be done to remove the tumour with an adequate margin without significantly disrupting mandibular form or function.

Barttelbort et al suggested a unified theory of tumour invasion of the mandible.[21] The cancer initially invades the mandible in the portion superior to the mylohyoid muscle along a broad front, quickly affecting the inferior alveolar canal. However, only as a relatively late phenomenon can the tumour invade the inferior lingual plate and the inferior cortical edge. For that reason, marginal mandibulectomy has the potential of removing the tissues at risk over an adequate length without significantly disturbing mandibular form. Minimum 10 mm inferior bone segment should be left behind so as to eliminate the risk of fracture.[22] As in edentulous mandible, there is significant decrease in vertical height of mandible. Therefore marginal mandibulectomy should not be attempted as it may predispose to pathological fractures.[18]

Shah et al proposed that while performing marginal mandibulectomy, right angled cuts at the site should be avoided, since these lead to points of excessive stress leading to the risk of spontaneous fracture.[23]

McGregor and MacDonald evaluated irradiated preserved mandibles in situ and showed that there were multiple foci of tumour invasion of bone wherever tumour had approached the bone.[24] Radiation had altered bone's resistance to tumour spread. Marginal mandibulectomy should not be performed in post-radiated patients, as there is risk of inadequate resection leaving behind foci of tumor.

Marginal mandibulectomy is an oncologic operation, which involves ideal selection of patients, proper osteotomy techniques and accurate clinical and radiological evaluation of mandible.

With the technological advancement, availability of sophisticated instruments, performance of various osteotomies for marginal mandibulectomy has been made simple, safe and easy. While performing the osteotomy for marginal mandibulectomy, smooth rather than angled corners should be made as it minimizes stress and prevents fracture.[23]

Marginal mandibulectomy should not be performed on patients with gross destruction of the cortex of the mandible demonstrated on preoperative radiological studies, invasion of the mandibular canal by cancer, massive soft tissue disease surrounding the lingual or the lateral cortex of the mandible.[25] Presence of tumour on the alveolar process of an irradiated edentulous mandible[23] or in an edentulous mandible with reduced vertical height of bone which carries a risk of a pathological fracture[25] and avascular necrosis after marginal mandibulectomy. In the above circumstances, segmental or hemimandibulectomy should be done.[24,25,26]

Brown et al showed that larger and deeper tumours are more likely to invade the mandible and show more aggressive pattern of invasion in the bone.[27] In such cases, a segmental resection would be a safer oncological option. If panoramic roentgenography is showing an erosive bone defect confined to a superficial area of the alveolar bone, or no bone involvement at all, then marginal resection of the mandible might be indicated.

ANATOMY OF ORAL CAVITY:[28]

Oral cavity extends from vermilion border of the lip anteriorly, posterosuperiorly to junction of hard and soft palate, inferiorly till circumvallate papillae and laterally till anterior tonsillar pillars.

Sub sites of the oral cavity are upper and lower dento alveolar ridge, anterior 2/3rd of tongue, retromolar trigone, floor of mouth, buccal mucosa , mucosa of lips and hard palate.

- **Lips**:[28] Oncologically, mucosal surface of the lip is included in buccal mucosa , It is a zone of transition from external skin to internal mucosal membrane that occurs at vermillion border. orbicularis oris act like oral sphincter.
- **Alveolar ridge**:[28] lateral aspect is formed by gingivobuccal sulcus created by transition of buccal mucosa. In lower alveolar ridge, medial margin is marked by transition to floor of mouth and on upper alveolar ridge is the horizontal orientation to hard palate. posterior margin of lower alveolar ridge is formed by ascending portion of ramus of mandible, whereas it is the superior aspect of pterygopalatine arch of upper alveolus.
- **Oral tongue:**[28] portion of tongue anterior to the linea terminalis form the oral tongue. bulk of the tongue is formed by 4 intrinsic and extrinsic muscles. extrinsic muscles are genioglossus, hyoglossus, styloglossus and palatoglossus.
intrinsic muscles are superior , inferior , transverse and vertical muscles.
- **Retro molar trigone:**[28] It is the mucosal layer of ascending portion of ramus of mandible and the coronoid process. It continues laterally as buccal mucosa and medially as anterior tonsillar pillar. Superior border is formed by maxillary tuberosity and anterior margin by posterior aspect of second maxillary molar tooth.
- **Floor of mouth:**[28] It is formed medially by mucosal surface of oral tongue, laterally

and anteriorly by inferior alveolar ridge, posteriorly by anterior tonsillar pillar. Lingual frenulum divides the region into two oral spaces.

- **Buccal mucosa**:[28] It is formed anteriorly by posterior aspect of lip, medially by alveolar

ridge and posteriorly by pterygomandibular raphe.

- **Hard palate**:[28] It is formed anteriorly and laterally by maxillary alveolar ridge and posteriorly joins soft palate.

THE BLOOD SUPPLY OF THE ORAL CAVITY.[28]

Oral cavity is mainly supplied by branches of External carotid artery. Blood supply to the tongue is provided by lingual artery, lips and the cheek mucosa is provided through the facial arteries and the internal maxillary artery. Whereas inferior alveolar arteries provide blood supply to the alveolar ridges.

THE NERVE SUPPLY OF THE ORAL CAVITY:[28]

The sensory component of oral cavity is provided by second and third division of trigeminal nerve, through superior & inferior alveolar and lingual nerves. Sensation of taste and secretomotor fibres to the salivary glands are provided through chorda tympani nerve traversing along the lingual nerve. Motor supply of the lips and cheek is provided by the facial nerve. The intrinsic and extrinsic muscles of the tongue are supplied by hypoglossal nerve and for the movements of the medial and lateral pterygoid muscles, and their actions are controlled by the motor components of the second and third divisions of the trigeminal nerve.[25]

LYMPH NODES IN NECK:[29]

The lymph nodes may be subdivided into specific anatomic subsites and grouped into seven levels.

Level I: Submental IA

Submandibular IB

Level II: Upper jugular sublevels IIA and IIB (anterior and posterior to the spinal accessory nerve respectively) Skull base to level of hyoid bone in anterior triangle of neck

Level III: Mid-jugular – Level of hyoid bone to level of lower border of cricoids cartilage.

Level IV: Lower jugular – Level of lower border of cricoids cartilage to clavicle.

Level V: Posterior triangle (along spinal accessory and transverse cervical) of neck

(upper, middle and lower corresponding to the levels that define upper, middle and lower jugular nodes)

Level VI: Prelaryngeal (Delphian)

Pretracheal

Paratracheal

Level VII: Upper mediastinal

Other groups: Sub-occipital

Retropharyngeal

Parapharyngeal

Buccinator (facial)

Preauricular

Periparotid and intraparotid.

The location of the lymph node levels is as follows：

Level I: Contains the submental and submandibular triangles bounded by the anterior belly and the posterior belly of the digastric muscle, and the hyoid bone inferiorly, and the body of the mandible superiorly.

Level II: Contains the upper jugular lymph nodes and extends from the level of the skull base superiorly to the hyoid bone inferiorly.

Level III: Contains the middle jugular lymph nodes from the hyoid bone superiorly to the level of the lower border of the cricoid cartilage inferiorly.

Level IV: Contains the lower jugular lymph nodes from the level of the cricoid cartilage superiorly to the clavicle inferiorly.

Level V: Contains the lymph nodes in the posterior triangle, which are bounded by the anterior border of the trapezius muscle posteriorly, by the posterior border of the sternocleidomastoid muscle anteriorly, and by the clavicle inferiorly.

For descriptive purposes Level V may be further subdivided into upper Va and lower levels Vb by inferior belly of omohyoid.

Level VI: Contains the lymph nodes of the anterior central compartment from the hyoid bone superiorly to the suprasternal notch inferiorly. On each side, the medial border of the carotid sheath forms the lateral boundary.

Level VII: Contains the lymph nodes inferior to the suprasternal notch in the superior mediastinum.

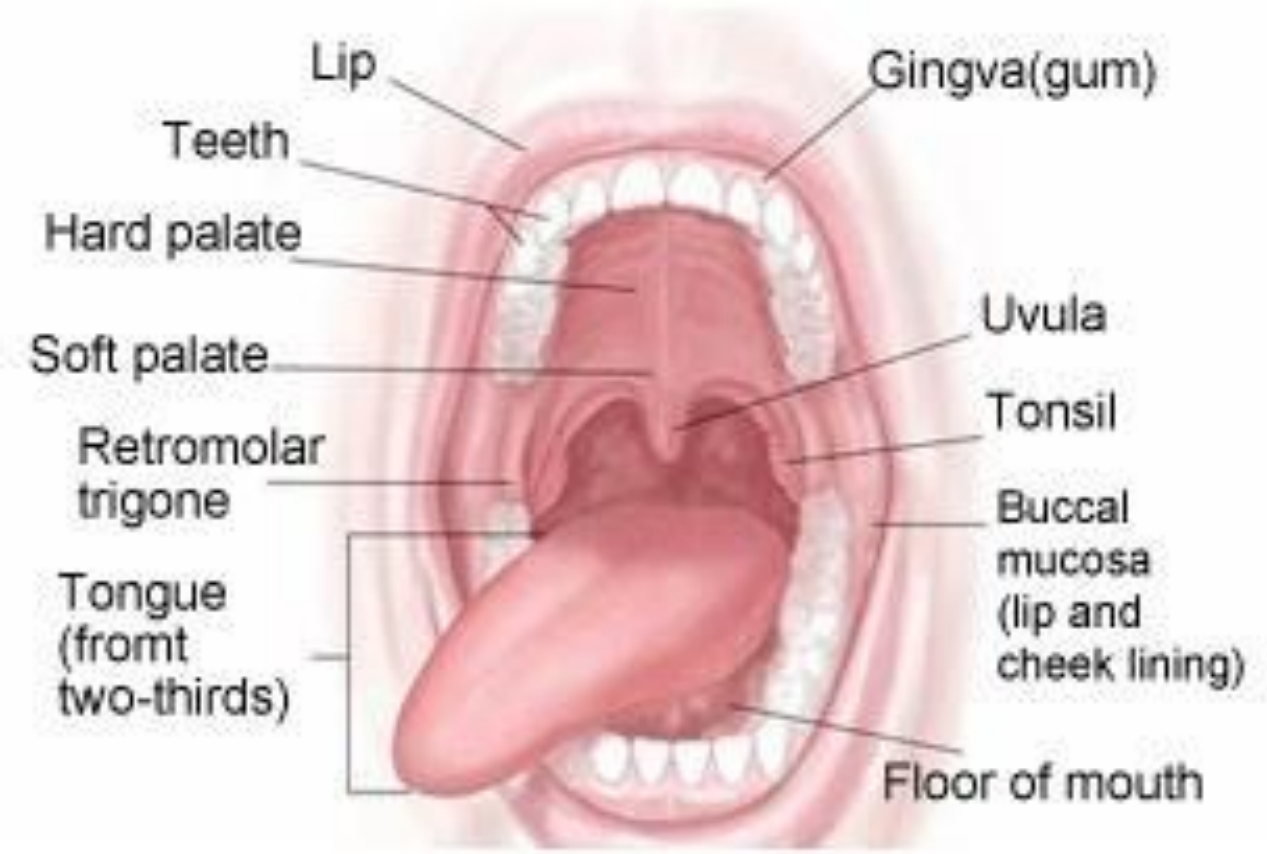


Figure 1: Sub sites of oral cavity

DEVELOPMENT AND GROWTH OF MANDIBLE

EMBRYOLOGY

During embryological development of foetus mandible is the second bone (next to the clavicle) to ossify. Its major portion is formed by dense fibro membranous tissue which lies lateral to inferior alveolar nerve and in the mesenchymal sheath of the lower parts of Meckel's cartilage.

At the sixth week, each half of the mandible is ossified from a centre appearing near the mental foramen . From this, ossification spreads medially and posterocranially to form the body and ramus, first below, then around the inferior alveolar nerve.

The parts ossifying in secondary cartilage include the incisive part below the incisor teeth, the coronoid and the condyloid process and the upper half of the ramus above the level of the mandibular foramen. At birth, the mandible consists of two halves connected at the symphysis menti by fibrous tissue. Ossification takes place during the first postnatal year.[30,31]

GROWTH OF THE MANDIBLE

The mandible grows by surface accretion and absorption. It grows in width between its angles as well as in length, height and thickness. Increase of thickness is brought about chiefly by addition of bone to the outer surfaces of the mandible. Increase in height of the body is mainly due to growth at the alveolar border. There is an associated continuous upward and forward movement of the teeth in the bone before, during and after their eruption. This is partly by addition to the posterior border and owing to the lateral slope of the body from before backwards, which accounts for increase in width also.[31,32]

The condyloid process differentiates from a cone shaped mass of cartilage. This zone of cartilage separates from the articular cartilage, which persists until the end of the second decade of life. Its continued proliferation and endochondral ossification is responsible for growth in length of mandible. Its growth is not only upwards but also backwards and sideways. It thus contributes to the total length as well as to the height and width of the mandible.[32]

Modelling maintains the shape of the condyle and also maintains the undulating curves of the anterior margin of the ramus and the coronoid process. During growth, the mandibular foramen maintains its relative position by a corresponding extension of its anterior lip to lengthen the canal of the mandible. The mental foramen also changes its position during growth by moving backwards relative to the teeth.[31,32]

THE MANDIBLE

The mandible, the largest and the strongest bone of the face, has a horizontally curved body, convex forwards and two broad rami ascending posteriorly upwards. It forms the skeleton of the lower part of the face. It supports the inferior teeth and articulates in the mandibular fossae with the skull.[30]

MANDIBULAR BODY:

Each half of the body has outer and inner surfaces and upper and lower borders. The symphysis menti is the line at which the right and left halves of the bone meet each other, which end inferiorly in the mental protuberance and inferolaterally, forms the mental tubercles. The oblique line extends from anterior border of the ramus of the mandible towards the mental tubercle from which the buccinator originates. In front of this origin, the depressor labii inferioris and the depressor anguli oris arise from the oblique line below the mental foramen. The incisive fossa lies just below the incisor teeth, which gives origin to the mentalis and the mental slips of the orbicularis oris. The mental foramen lies between the superior and inferior margins below the first or second premolar, transmitting the mental nerve and vessels.

The inner surface shows the mylohyoid line, which runs obliquely from third molar to genial tubercles from which the mylohyoid muscle originates. The superior constrictor muscle of the pharynx arises from an area above the posterior end of the mylohyoid line, The pterygomandibular raphe is attached behind mylohyoid line. The mylohyoid nerve and vessels lie in the mylohyoid groove, which extends on the inner surface of the body of the mandible,

below the posterior end of the mylohyoid line. Below the mylohyoid line, it forms the submandibular fossa, which lodges the submandibular gland, and above there is the sublingual fossa in which the sublingual gland lies. Parts of both the inner and outer surfaces of mandible just below the alveolar margin are covered by the mucous membrane of mouth.

The posterior surface of symphysis menti shows four small elevations of genial tubercles (two superior and two inferior) out of which the upper genial tubercles give origin to genioglossus and the lower tubercles to the geniohyoid. The upper alveolar border bears sockets for the teeth. Near the midline, the lower border of the mandible shows an oval depression called the digastric fossa from where the anterior belly of digastric muscle arises. The lingual nerve is related to the medial surface of the ramus in front of the mylohyoid groove.[30,31]

MANDIBULAR RAMUS:

The ramus is quadrilateral in shape and has two surfaces, lateral and medial; four borders upper, lower, anterior and posterior; and also has the coronoid and condyloid processes. The lateral surface is flat and provides insertion to the masseter muscle. The posterosuperior part of the lateral surface is covered by the parotid gland.

The medial surface: The mandibular foramen lies just above the centre of the ramus. It leads into the mandibular canal, which descends into the body of the mandible and opens at the mental foramen. The area above and behind the mandibular foramen is related to the inferior alveolar nerve and vessels and to the maxillary artery. The anterior margin of mandibular foramen shows a sharp tongue shaped projection, called as lingula, which is

directed towards the head of mandible and to which the sphenomandibular ligament is attached. The medial pterygoid muscle is inserted on the medial surface of ramus below and behind the mylohyoid groove. The upper border of the ramus is thin and is curved downwards forming the mandibular notch. The masseteric nerve and vessels pass through the mandibular notch. The lower border is the backward continuation of the base of the mandible. Posteriorly, it ends by becoming continuous with the posterior border at the angle of the mandible. The anterior border is thin, while the posterior border is thick. The deep cervical fascia is attached to the whole length of the lower border and the platysma is inserted into the lower border of the mandible.

The Coronoid process is a flattened triangular upward projection from the antero-superior part of the ramus. The temporalis is inserted into the apex and the medial surface of the coronoid process and downwards on the anterior border of the ramus.

The Condyloid process is a strong upward projection from the posterosuperior part of the ramus. The upper end is expanded from side to side to form the head. The head is covered with fibrocartilage and articulates with the temporal bone to form temporomandibular joint. The constriction below the head is the neck. Its anterior surface presents a depression called the pterygoid fovea; where the lateral pterygoid muscle is inserted. The lateral surface of the neck provides attachment to the lateral ligament of the temporo-mandibular joint. The auriculo-temporal nerve is related to the medial side of the neck of the mandible.[30,31]

THE BLOOD SUPPLY OF THE MANDIBLE

The mandible has a rich blood supply from the following sources:

1. The inferior alveolar artery supplies the medullary bone of the mandible and alveolus.
2. The blood supply to cortical plates of mandible is from muscles of mastication.
3. There is a significant blood supply to the condylar processes and parts of the ramus from the capsule of the temporo-mandibular joint.
4. There is also a significant blood supply from the buccinator and mentalis muscles.

An additional supply to the lingual aspect of the body of the mandible is derived from mylohyoid, geniohyoid and genioglossus muscles.

There is an extensive anastomosis between the inferior alveolar arteries, periosteal vessels and vessels derived from the muscles of mastication. With increasing age, the blood supply to the mandible from the inferior alveolar artery decreases progressively and is compensated by the vessels arising from muscles of mastication and the periosteum.

This rich blood supply makes it possible to section the mandible in three or more places for aesthetic or functional or oncological reasons. However, the extensive stripping of the periosteum and muscles of mastication should be avoided as, if this is done, avascular necrosis of the bone occurs.[33]

AGE CHANGES IN THE MANDIBLE

At birth, the mandible is present as two nearly parallel troughs of bone, lodging unerupted teeth and joining in the midline by a fibrous symphysis menti. The body is mainly alveolar; the basal part is very little developed. The mandibular canal is near the lower border; the mental foramen opens below the first deciduous molar, near the inferior margin of the mandible and directed forwards. The angle of the mandible is 175^0, so that the coronoid process is almost in line with the body of the mandible and projects above the condyle of the mandible.

During the second and third months after birth, osseous union of the two halves begins to take place from the base to the alveolar part. This union is completed in the second year. After the first dentition has erupted, the rami enlarge and the body becomes stronger and deeper. The posterior border of the ramus forms an angle of about 140^0 with the anterior border of the body .The mental foramen is situated midway between the anterior and posterior borders of the bone opposite the second deciduous molar and is directed posterosuperiorly.

The progressive increase in depth and elongation, especially behind the mental foramen, provides room for the permanent molars. The mental foramen assumes a horizontally posterior position in the adult. The angle becomes reduced to 110^0 or less.

In the adult, the angle formed by the ramus and body is nearer to a right angle, and the mental foramen is opposite to the second premolar and midway between the upper and lower borders of the mandible. The canal of the mandible is nearly parallel to the mylohyoid line.

In old age, after loss of the teeth and alveolar margin is resorbed and the mental foramen are nearer the superior margin. The chin appears prominent and the angle opens out again to about 140^0 by remodelling because of the change in pull of the masseter and medial pterygoid muscles in edentulous jaw. The condylar process is bent back so that the mandibular notch is widened.[31,32]

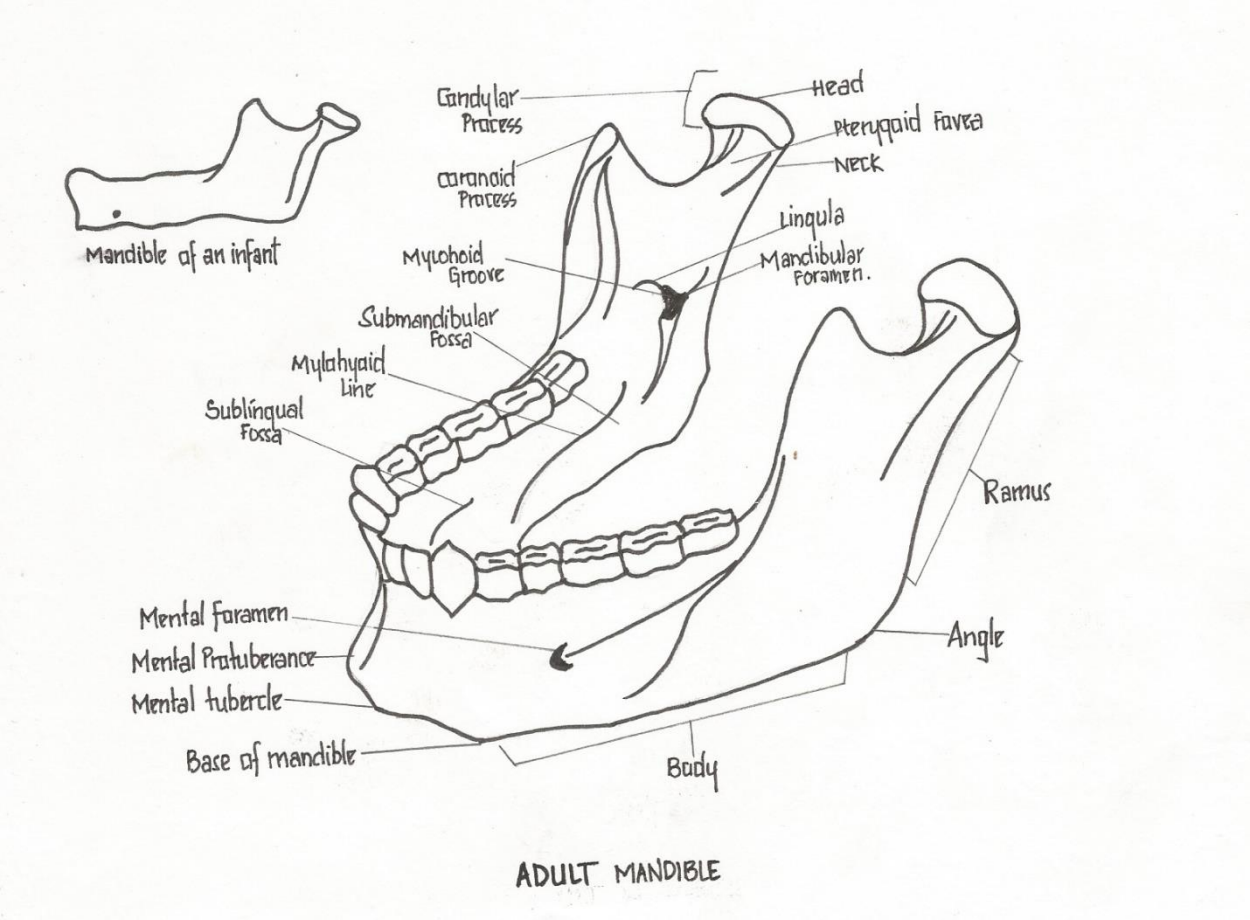


Figure 2: Adult Mandible

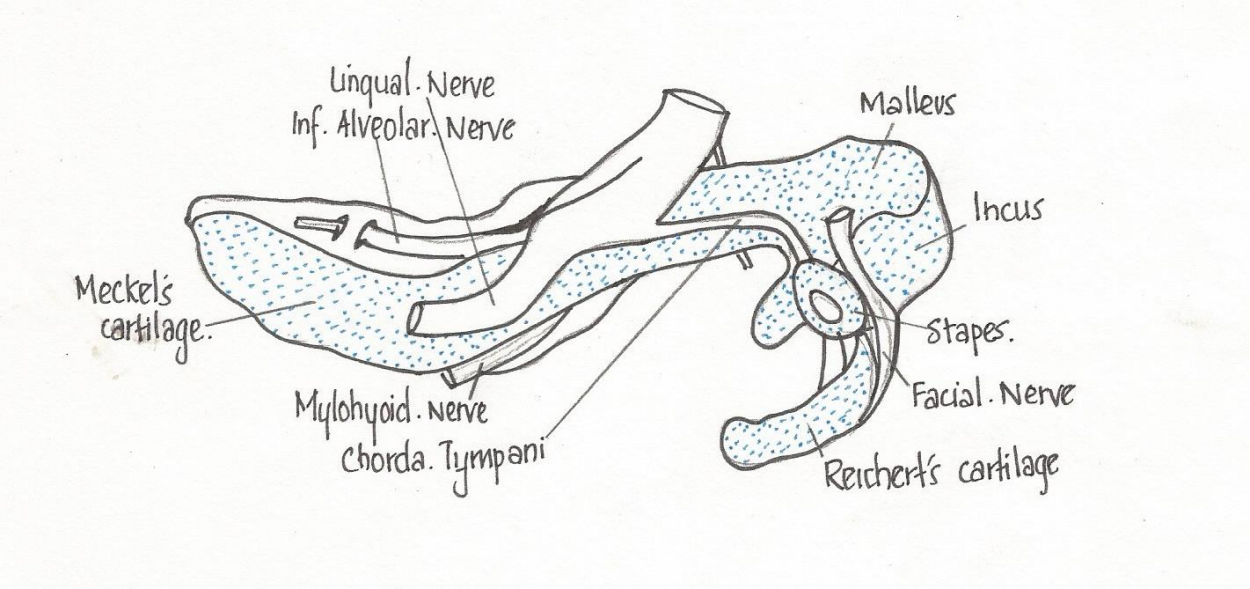


Figure 3:mandible of human embryo 24 mm long- inner aspect

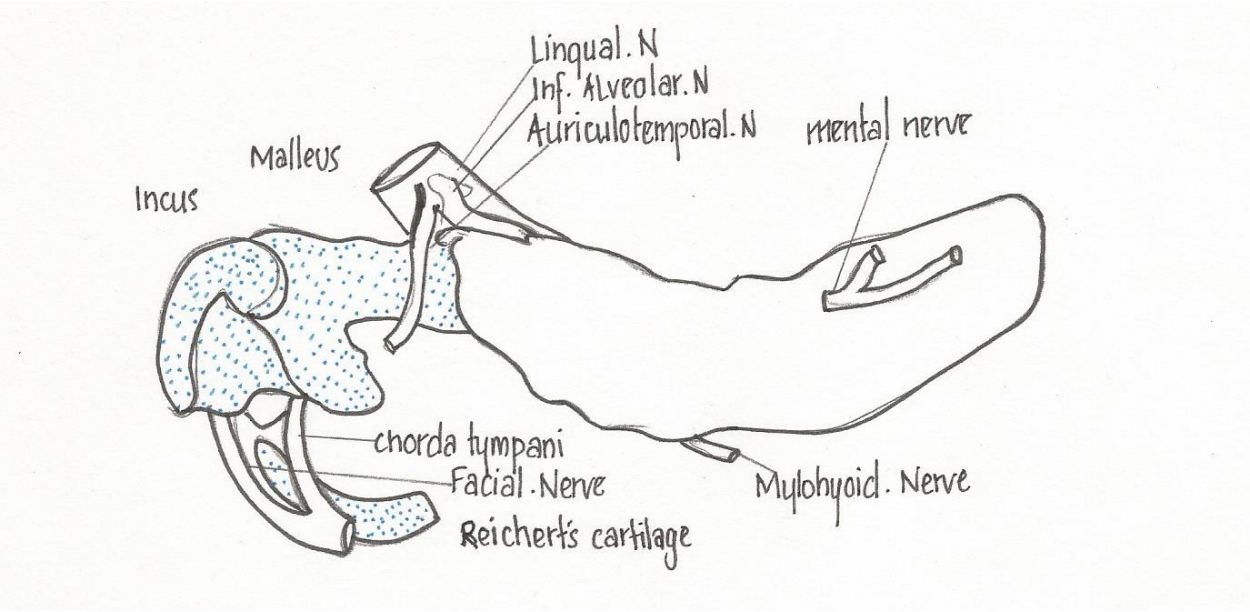


Figure 4: mandible of human embryo 24 mm long outer aspect

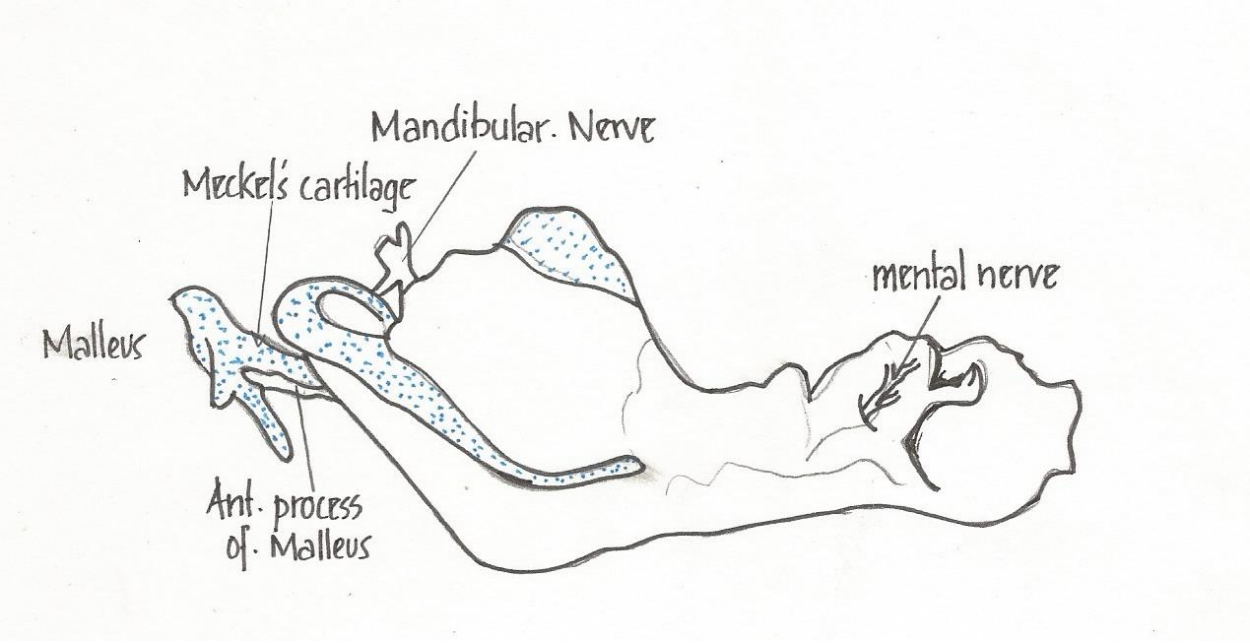


Figure 5: mandible of human embryo 95 mm long - outer aspect. Nuclei of cartilage stippled

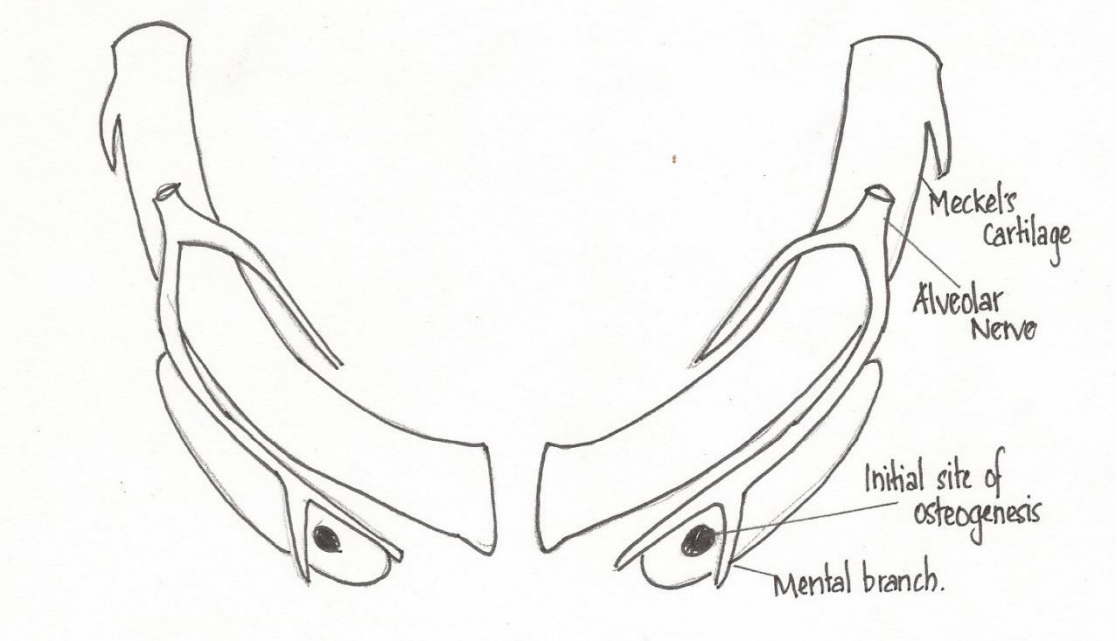


Figure 6: Ossification center of mandible

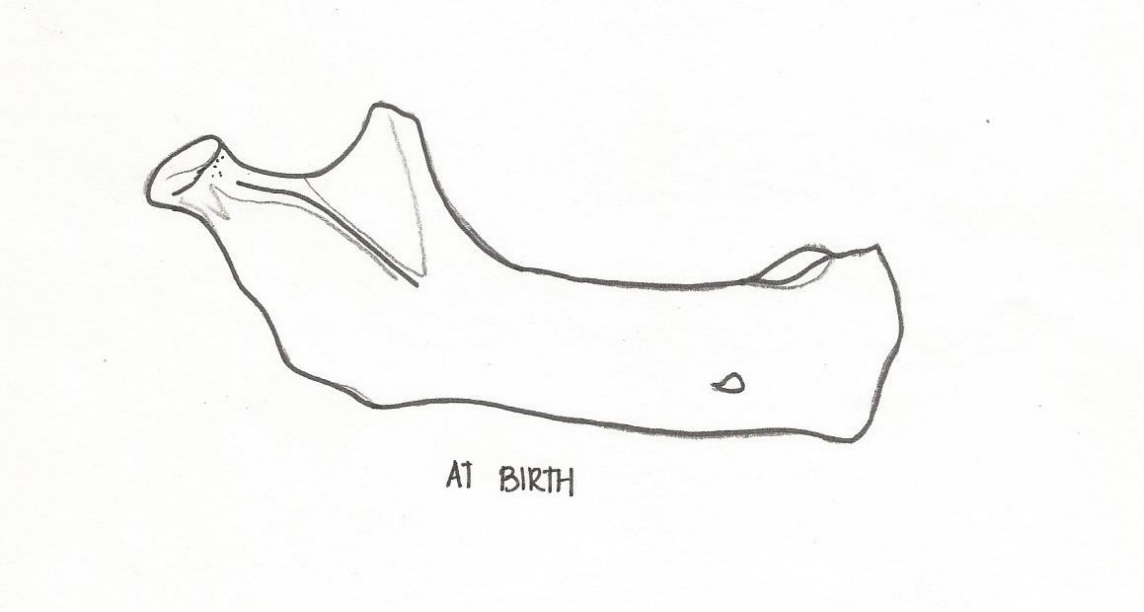


Figure 7: Mandible at birth

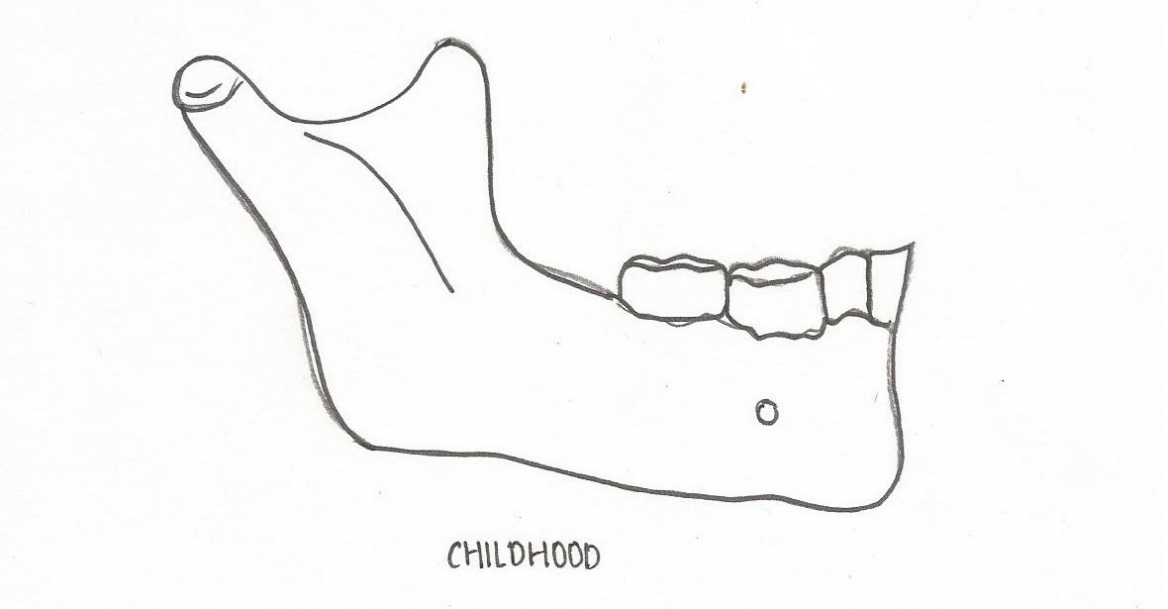


Figure 8: Mandible at childhood

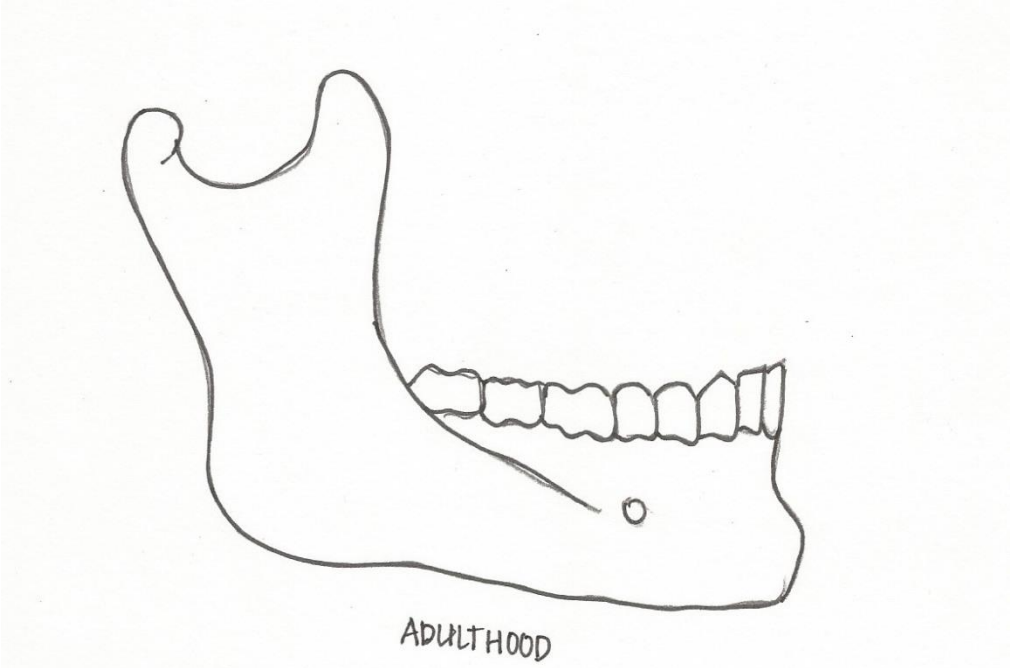


Figure 9: Mandible at adulthood

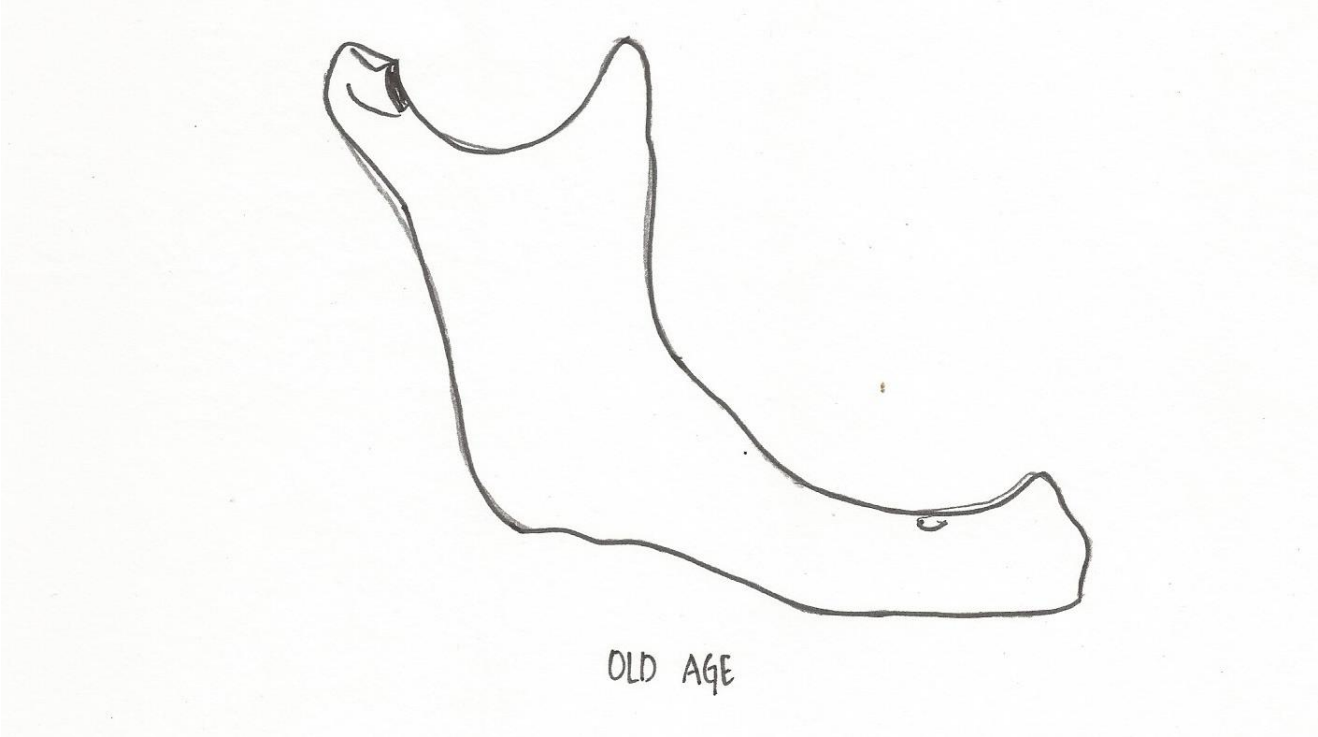


Figure 10: Mandible at Old age

FUNCTIONS OF MANDIBLE & PHYSIOLOGY OF MASTICATION

Mastication involves chewing and grinding food between the molar and premolar teeth in order to break down into small, soft, more manageable food bolus which can be swallowed easily. This requires movements of mandible which occur at the temporo-mandibular joint and it involves opening and closing of the mouth, together with protraction and retraction of the mandible.

The incisor teeth helps in biting the food by contraction of masseter, temporalis and medial pterygoid muscles. The food is chewed, under the control of the muscles of mastication. Chewing movements are produced by the alternate contraction of the pterygoid muscles on either side . If the food escapes into the vestibule, then it is returned by the contraction of the buccinator and if the food escapes medially then by action of the extrinsic and intrinsic muscles of tongue and is pushed back between the teeth. Mylohyoid keeps the tongue braced up towards the hard plate and the orbicularis oris contracts to prevent food escaping through the lips.

Opening of mouth during mastication is by the relaxation of the elevators and contraction of the lateral pterygoid and also from contraction of digastric, geniohyoid and mylohyoid against the fixed hyoid bone. Food is chewed and lubricated with saliva and converted into a bolus, propelled into pharynx by elevation of tongue against hard palate by contraction of superior longitudinal muscle of tongue, elevators of mandible, and mylohyoid and styloglossus.[34]

Table 1 : Muscles concerned in movements of the mandible [31]

MOVEMENT	MUSCLE	PRINCIPAL NERVE SUPPLY
Elevation	Temporalis(anterior fibres)	Anterior division of mandibular
	Masseter	Anterior division of mandibular
	Medial pterygoid	Main trunk of mandibular nerve
Depression	Lateral pterygoid	Anterior division of mandibular
	Digastric	Facial nerve, and mylohyoid branch of inferior alveolar nerve
	Mylohyoid Geniohyoid	Mylohyoid branch of inferior alveolar nerve C1 through hypoglossal nerve
	Infrahyoid group	Ansa cervicalis: thyrohyoid by C1 through hypoglossal nerve
Protraction	Lateral pterygoid	Anterior division of mandibular
	Medial pterygoid	Main trunk of mandibular nerve
	Masseter (superficial fibres)	Anterior division of mandibular
Retraction	Temporalis (horizontal fibres)	Anterior division of mandibular
	Digastric	Facial nerve: Mylohyoid branch of inferior alveolar nerve
Chewing	Medial pterygoid Lateral pterygoid Masseter Temporalis	Main trunk of mandibular nerve Anterior division of mandibular

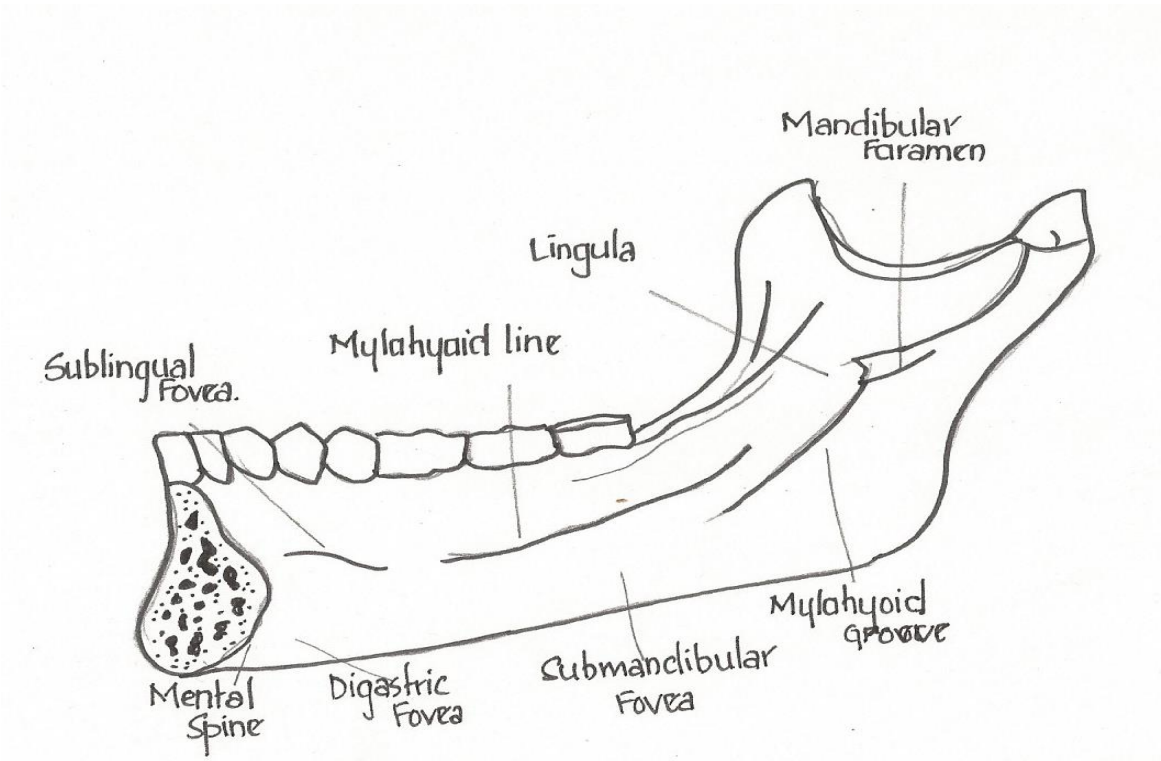


Figure 11: Mandible inner surface

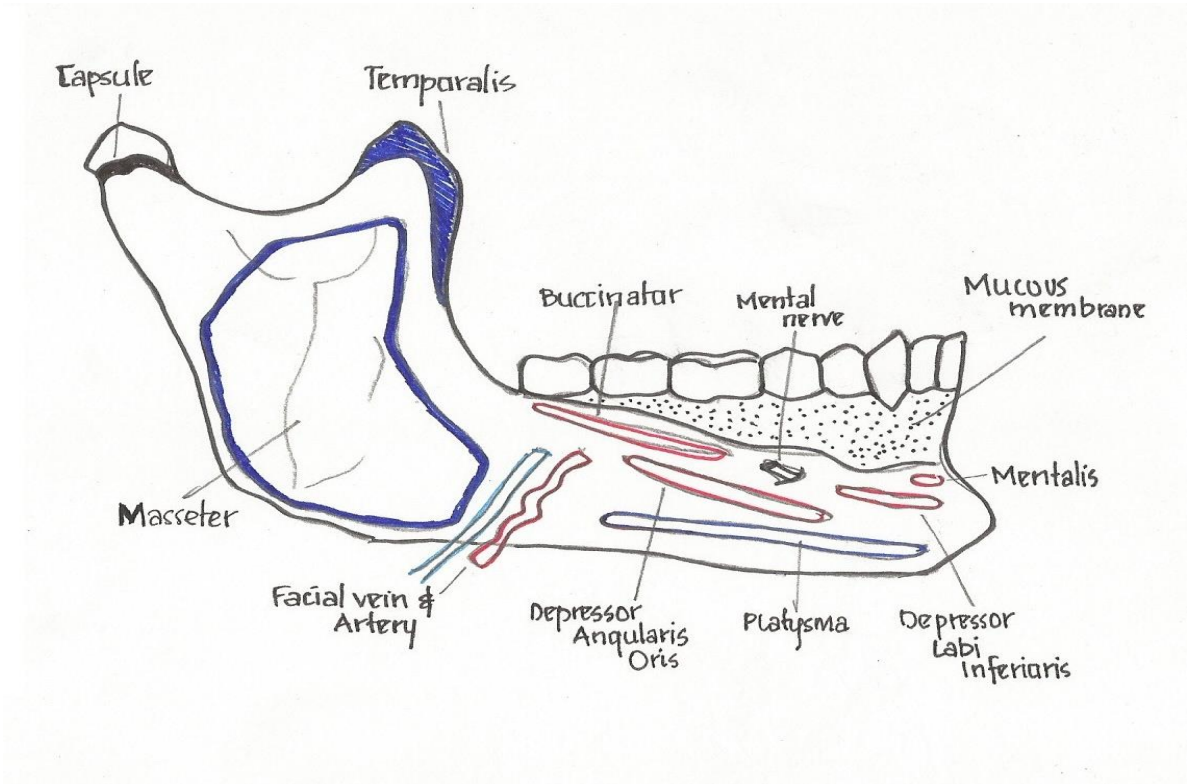


Figure 12: Mandible outer surface with line of attachment of muscles

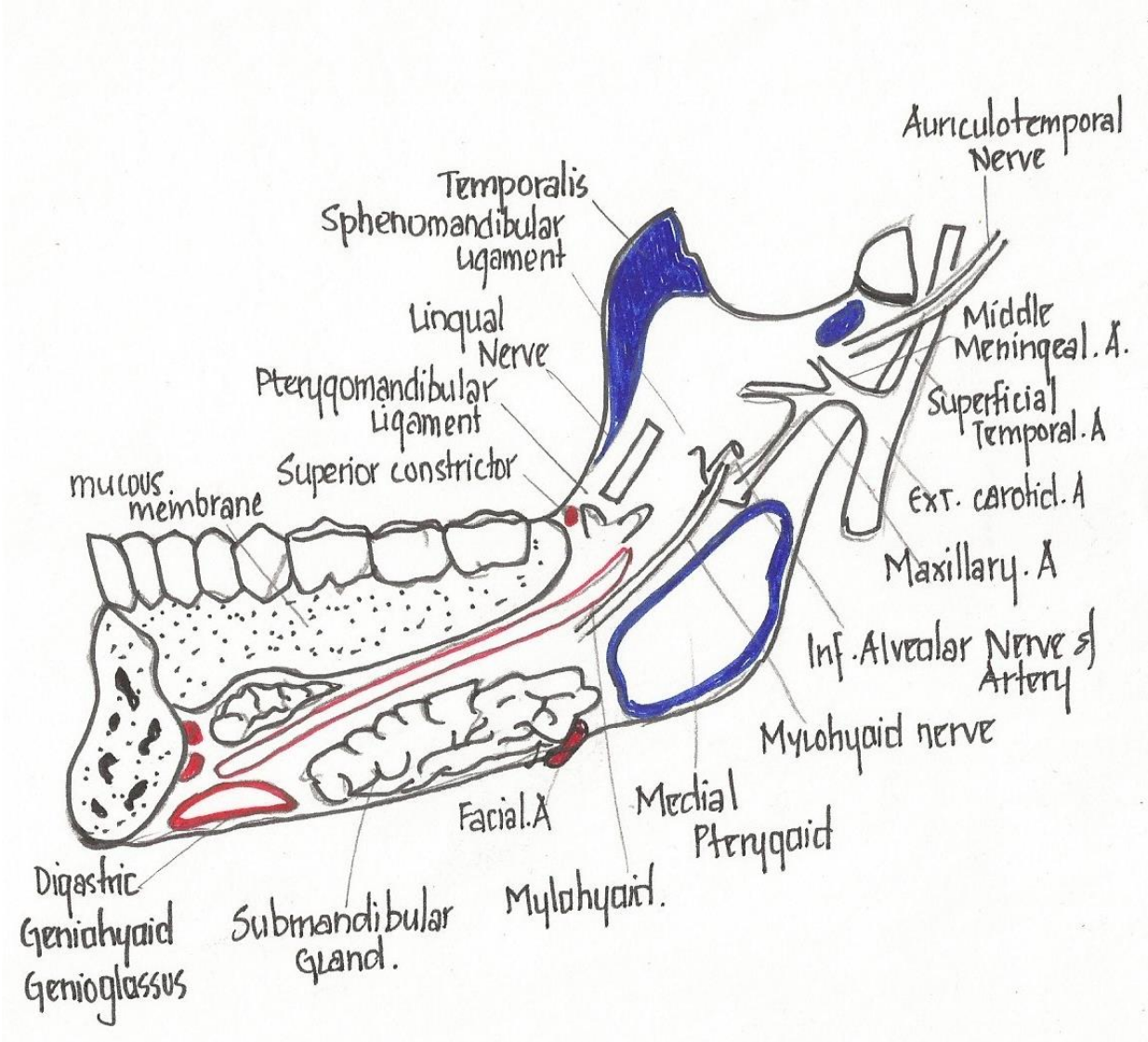


Figure 13: Mandible Inner surface showing vessels and nerve in relation to it.

ORAL CAVITY CANCER

ETIOLOGY:

Various risk factors have been implicated as a cause of oral cavity cancer but it is yet to be completely understood. The known risk factors are :-

1] Smoking:

Tobacco smoking can be done in various forms like cigarettes, cigars ,beedi, tobacco powder in pipes and hookah. Some people smoke a chutta (a cigar) with the burning end inside the mouth(reverse smoking). Chemical carcinogens in the burning tobacco or repeated thermal injury are the risk factors that cause oral cancer. Risk increases with quantity smoked and with the total cumulative lifetime smoking years. More commonly Tobacco is smoked in the form of bidi, a type of cheap cigarette made by rolling a rectangular dried piece of tendu leaf (Diospyros melanoxylon). As compared with cigarette smoke, bidi smoke has higher content of several toxic agents such as carbon monoxide, ammonia, hydrogen cyanide, phenol and carcinogenic hydrocarbons.

Tobacco may be used in raw or as processed mixtures and as a pyrolised form. The raw forms are used with lime and with areca nut (Mawa-smokeless tobacco). Khaini is a mixture of freshly powdered tobacco and slaked lime; a quid of the mixture is kept for hours in the lower gingivolabial sulcus and sucked, which is risk factor for khaini cancer (squamous cell carcinoma of the lower lip). The processed forms, for example zarda, gutkha, and

Manipuri tobacco are industrial products. The pyrolised (roasted) forms of tobacco (mishri, bajjar, etc) are used as dentifrice. Oral use of snuff is also practised in specific areas.[35] When this chewing habit is combined with smoking habit, the risk increase by 20 to 30 times

2] Spirits: - Consumption of calvados {a pot distilled spirit}

3] Sharp teeth: - Poor oral hygiene, faulty restorations, and ill-fitting dentures.

4] Spices

5] Syphilis

6] Snuff dipping and other tobacco products

7] Alcohol: Alcohol consumption has a synergistic local effect of dissolving the carcinogen in the sump area of the mouth and a systemic downward effect on the immune system. Alcoholics often have nutritional problems.[36]

8] Industrial chemicals

9] Viruses: Herpes simplex virus and the Human papilloma virus (subtype 16)

10] Immune status: - Immune deficient due to low cell mediated immunity.

11] Genetic factors: - Most sporadic tumours are due accumulated genetic alterations which are a result of multi-step process. These result in alteration of epithelial cell behaviour by loss of chromosomal heterozygosity, which in turn leads to ultimate stage of invasive squamous cell carcinoma. The corresponding genetic alterations result in clinical and microscopic pathology from hyperplasia to invasiveness of the tumour. Over expression or under expression of P53, P16 and other genes may predispose to development of cancer and

recurrence following treatment. Over expression of c-erbB-2 has shown correlation with lymph nodal disease and metastasis and poor prognosis

The syndromes that are characterized by mutagen sensitivity which includes Xeroderma pigmentosum, Fanconi's anaemia and Ataxia telangiectasia, have all been associated with oral cavity cancers.[37] Other relevant genetic markers may include inducibility of cytochrome p450 enzyme system.[38]

12] Social status: - Related to social habits and to low socio-economic status

13] Diet

15] Occupation: Employment in textile industries

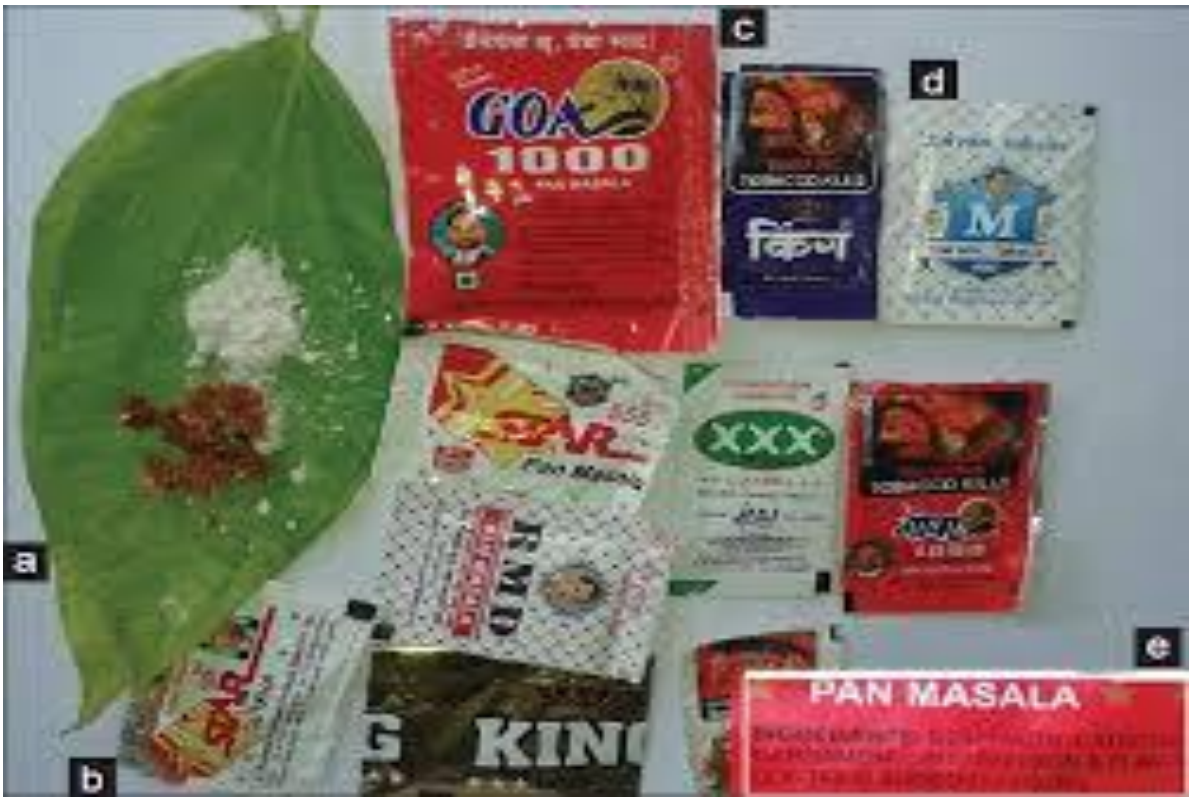


Figure 14: various forms of smokless tobacco

PRE-MALIGNANT CONDITIONS:

Definition:

A morphologically altered tissue in which cancer is more likely to occur than in its apparently normal counterparts.

1) **Leukoplakia:**

Definition: It is defined as a clinical white patch in the oral mucosa that cannot be characterized clinically or pathologically as any other disease.

Rates of malignant transformation ranges from less than 2% to 17.5%. [39]

Types of Oral Leukoplakia [39]

According to Sugar L and Banoczy J:

1) Leukoplakia simplex – White, homogeneous keratinised lesion, slightly elevated, shows lowest frequency of malignancy.

2) Leukoplakia verrucosa – White, verrucous lesion with wrinkled surface, exhibits the high rates of transformation to carcinoma.

3) Leukoplakia erosiva – White, lesion with erythematous areas, erosions, fissures, exhibit the highest rate of association with carcinoma.

According to Pindborg et al (clinical types):

1) Homogeneous: White patch with a variable appearance, smooth or wrinkled; smooth areas may have small cracks or fissures. It shows lowest frequency of malignancy.

2) Speckled or nodular: White patches with erythematous base or nodular excrescences. It shows highest rate of association with carcinoma.

According to Burkhardt (microscopic types):

1) Plain form, corresponding clinically to leukoplakia simplex.

2) Papillary endophytic, corresponding clinically to verrucous leukoplakia.

3) Papillomatous exophytic, corresponding clinically to erosive leukoplakia.

Proliferative verrucous leukoplakia:

It is high-risk type of leukoplakia. It has a tendency to be extensive or multifocal. Verrucous carcinoma evolves from this form of leukoplakia. They are associated with a high risk for malignant transformation and dysplasia .[39]

2) Erythroplakia:

These are oral mucosal lesions that appear as red, velvety plaques that cannot be clinically or pathologically ascribed to any other pre-determined condition. About 30 to40% of erythroplakia exhibits either carcinoma or severe epithelial dysplasia.

3) Melanoplakia

4) Oral submucous fibrosis

5) Sideropenic dysphagia

6) Oral lichen planus: Rate of malignant transformation is about 4%. [40]

7) Discoid lupus erythematosis

8) Hyperkeratosis

9) Dyskeratosis congenita

10) Syphilis

MALIGNANT CONDITIONS OF ORAL CAVITY[39]

1.Squamous cell carcinoma: It is the most common epithelial malignancy of the oral cavity.

Variants of squamous cell carcinoma:

a) Verrucous carcinoma: It is a low-grade highly well differentiated carcinoma with keratinising exophytic or warty appearance. The cellular response is usually prominent.

b) Sarcomatoid carcinomas/Pseudo sarcoma/Pseudosarcomatous squamous cell carcinomas / pleomorphic carcinoma/metaplastic carcinoma/ epidermoid carcinoma–spindle cell variant

c) Adenosquamous cell carcinoma
d) Adenoid squamous cell carcinoma
e) Basaloid squamous carcinoma
f) Basal cell carcinoma

2.Malignant oral salivary gland tumours[40]

a) Adenoid cystic carcinoma

b) Adenocarcinoma

c) Mucoepidermoid carcinoma

3.Melanoma of oral cavity

TUMOUR BIOLOGY[41]

The development of a tumour involves three phases:

a) Initiation

b) Promotion

c) Progression

Initiation phase : characterized by the series of mutations that occur in sequence.

Promotion Phase : For initiated cells to transform into tumour cells, exposures to promoting agents or conditions are required. The end of the promotion phase is characterized by the appearance of the first neoplastic cells. Before the appearance of neoplastic cells, the abnormal cells are called pre-neoplastic or premalignant cells.

Progression phase: It is characterized by invasive growth of the transformed cells and progression of the tumour into a highly aggressive & metastatic tumour that may ultimately kill the host.

TUMOUR ESCAPE MECHANISMS[41]

A) Tumour related:

a) Tumour is not immunosensitive

1) No expression of tumour-specific antigens

2) No or low expression of major histocompatibility complex molecules correlated with tumour aggressiveness and metastatic potential

3) No antigen processing or presentation (masked/modulated)

4) Resistance to immune cell-mediated killing, such as induction of apoptosis through the apoptosis-inducing molecule F_{as}

b) Tumour is not immunogenic

1) Lack of co-stimulatory molecules, therefore does not induce an immune response

2) Secretion of immunosuppressive factors that inhibit T-cell functions or defects in T-cells

3) Shedding of tumour antigens that down regulate T-cell molecules

4) Induction of T-cell tolerance

5) Induction of T-cell apoptosis (programmed cell death)

B) Host related:

1) Tumour grows too fast for the immune system

2) Inherited or acquired immunodeficiency

3) Treatment (radiation, chemotherapeutic drugs) or chemical or physical carcinogens related immunosuppression

4) Deficiency in antigen presentation by antigen-presenting cells

5) Lack of access of effector cells to the tumour

6) Expression of immunodominant antigens on parental tumour that prevents stimulation with other tumour antigens

7) Age- long latent period of carcinogens

- Failure of an antitumour immune response related to age

CARCINOGENESIS[42]

Tumour develop as a result of loss of normal signalling mechanisms involved in controlled cell growth. As a result of loss of ability of cancer cells to undergo apoptosis (programmed cell death) leads to accumulation and clonal expansion of cells that otherwise might have died if their cell death machinery were preserved and functional. Tumour growth represents the sum of cell proliferation minus cell death. Carcinogensis causes DNA damage and mutated cells progress through the cell cycle called as initiation and promotion.

Around 6-10 independent genetic mutations are required for the development of malignancies in head and neck. Over expression of mitogenic receptors, loss of tumour suppressor proteins and expression of oncogene-derived proteins that inhibits apoptosis and over expression of proteins that derive the cell cycle, allow the unregulated cell growth.

Important genetic mutations occurring as a result of DNA damages are at 9p, 3p, 11q, 8p, and 17p region. Rate of p53, p16 mutation is greater in smokers, which contributes to oral cancer and shows high incidence of recurrence after any treatment.

SPREAD OF MALIGNANT TUMOR

The characteristic of metastasis is the single most important features of the malignant tumor. The initial step in the process of metastasis is the breach in the basement membrane at the site of primary tumour, which occurs through hydrolytic enzymes secreted by tumour namely urokinase type plasminogen activator, collagenase and stereomelysins.[43] This enzymes degrade the basement membrane proteins such as collagen IV, laminin and proteoglycans, which allow the spread of tumour cells.[44]

Apart from the direct spread, squamous cell carcinoma of head and neck region spread mainly through the lymphatics, in which tumour cells disseminate as emboli. This tumour emboli are carried to the afferent lymphatic vessels of first echelon of lymph nodes of each primary site. The tumour cells first get localized in the subcapsular sinus then grow progressively to replace the cortex and medulla. Eventually tumour invades the capsule of the node heralding extra capsular spread.[44] Usually extra capsular spread may occur in much smaller lymph nodes where tumour emboli first lodge in the capsular lymphatic sinuses and then focal destruction of capsular collagen take place by type I Collagenase. From the first level of lymph nodes tumour cells metastasises through the afferent lymphatics to the second and third level of nodes. As the result of increasing obstruction in the lymphatics and intranodal sinuses it eventually leads to reversal of lymphatic flow and retrograde spread of tumour cells to the unpredictable nodal groups.

Lympho-hematogenous spread can occur by invasion of tumor cells tumour cells into the bloods vessels within the lymph node or by small lymphatico-venous communication. Once the tumour cells reach the draining lymph node, it can either proliferate, die, remain dormant or enter the blood stream through blood vessels in the node. The pattern of lymphatic spread follows a predictable pattern. In general, well-localized

tumours spread to ipsilateral first or second echelon lymph nodes but in some case where tumour is located at or near midline may spread to both sides of neck.

In patients with clinically positive ipsilateral neck nodes are at risk for contra lateral lymph node metastasis. This shunting may occur mainly through anastomotic channels in the midline at the submental and submandibular triangles.

In the study by Lindberg, he defined the nodal groups for each primary tumor and the pattern of subclinical microscopic metastasis.[45] Malignant tumors of the anterior oral cavity spreads most commonly to the submental and submandibular lymph nodes, followed by the upper jugular nodes. And posteriorly located malignant tumor spread mostly to the upper jugular nodes and less frequently to the submandibular nodes. Shah reported a comprehensive histopathological study, which confirmed Lindberg's clinical findings.[46] The level I, II and III were at highest risk for metastasis from oral cavity cancer. Thus first echelon of lymph nodes for oral cavity lies in level I, II and III.

The incidence of detecting metastatic lymph nodes by clinical examination is about 60%.[45] The overall incidence of occult metastasis in patients with clinically negative neck node is around 30%.[47] The relative risk of nodal metastasis depends on site, size, thickness, histological features and the immunological and biological factors of the primary tumour.[44] Tumors with Poorer differentiation are more likely to metastasize early. The tumour with infiltrative marginare more likely to metastasise than those with pushing margin.

MANDIBULAR INVASION :

Progressive cytological changes manifest as dysplasia and carcinoma insitu . Local invasion of primary oral SCC's may occur to adjacent structure and, extension of this tumor cells in depth to the underlying tissues may cause proliferation of tumor in the underlying structure like tongue, floor of mouth, buccinator muscles, ,alveolus and mandible respectively.

The routes of tumor spread into the mandible and pattern of spread within the mandible is important for logical approaches for mandibulectomy in oral cancer surgery. The tumour doesn't extend directly through intact periosteum and cortical bone since the periosteum acts as a significant protective barrier. Instead, the tumour advances through alveolar sockets and from attached gingiva to alveolar sockets.[4,26]

There are seven possible routes of tumour entry into the mandible.[48]

1) From the oral cavity through the upper surface of the mandible (occlusal route)
2) Through the mental foramen
3) Secondary tumours in the neck through the lower border
4) Through mandibular foramen
5) Cortical bone defects in the edentulous mandible
6) Periodontal membrane in the dentate mandible
7) The attached gingiva

The preferential routes of tumour entry and spread of cancer after tumour erodes into the mandible are

1) Along the bone marrow space
2) Along the inferior alveolar nerve
3) Entry through the occlusal surface
4) Entry through named foramina and periodontal membrane in the dentate jaw.[48]

In patients with teeth, the tumour extends through the dental socket into the cancellous part of the bone and invades the mandible in that fashion. Hence, even in patients with early invasion of mandible, marginal mandibulectomy is feasible since the cortical part of mandible inferior to the roots of the tooth remains uninvolved and can be often safely spared.

There is perineural spread along dental nerve within mandibular canal in 30% of patients with oral squamous cell carcinoma. Also, the tumour extends along the last two molars which cross the mylohyoid line.

In edentulous patients, the tumour extends upto the alveolar process and then infiltrates the dental pores in the alveolar process and extends to the cancellous part of the mandible. The resorption of alveolar process eventually leads to a “pipe stem” mandible in very elderly patients. The feasibility to perform a satisfactory marginal mandibulectomy in such patients is almost impossible since the probability of iatrogenic fracture or post-surgical spontaneous fracture of remaining portion of the mandible is high.[49]

Marginal mandibulectomy should be performed with caution in case of old fracture line. Similarly, in patients who have received previous radiotherapy, marginal

mandibulectomy should be performed with extreme caution as there will be high risk of osteoradionecrosis. The probability of pathological fracture at the site of marginal mandibulectomy and soft tissue recurrence in a previously irradiated mandible is very high.[24]

There are two main types of spread:[27]

1. Invasive pattern

2. Erosive pattern.

In invasive pattern of spread , island of tumor cells metastasize into cancellous bone with out involving the connective tissue which results in subperiosteal and new bone formation and osteogenesis

In the erosive pattern, the tumour metastasizes in broad front with in connective tissue layer and activates osteoclasts separating the tumour from the bone.

Over past century pathophysiology of oral cavity tumor has evolved gradually. From the study by Polya'o in 1902, it was believed that oral cavity tumor spread to cervical lymph nodes via periosteal lymphatics**.** Based on this study routine segmental or hemimandibulectomy was performed in all cases suspected for bone invasion and all so in cases , in which tumor is close to the mandible with intervening normal tissue**.**

Later in 1964, in a study by Marchetta et al, it became apparent that there are no lymphatics metastasis through the mandibular periosteum in oral cavity tumor and that tumor spreads to bone by direct extension. This remarkable study changed the phase of aggressive surgical of mandible sparing surgery to mandible preserving surgery in selected cases. Now recent trend is, marginal mandibulectomy is recommended for those tumors that encroach the

mandible but fail to provide a clear resection margin of 1-2 cm of normal tissue, and those with superficial invasion of the mandible. Following this several studies have been conducted regarding oncological efficacy of marginal and segmental mandibulectomy surgeries and most study found local control of disease and survival to be similar in both modality of treatment in carefully selected patients with mandibular invasion.

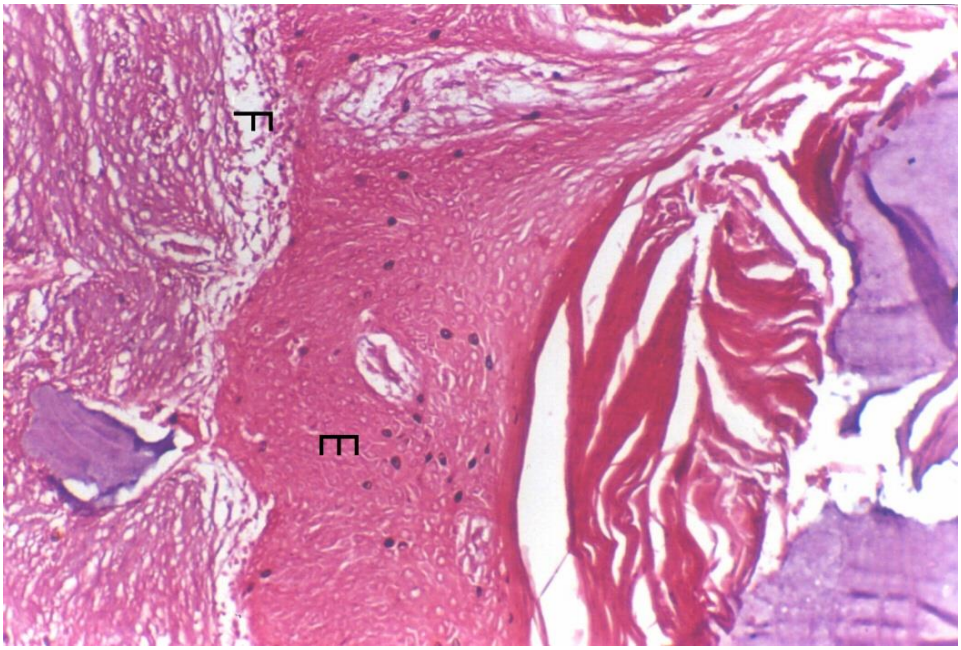


Figure 15:Microscopic picture showing erosive pattern of bone involvement

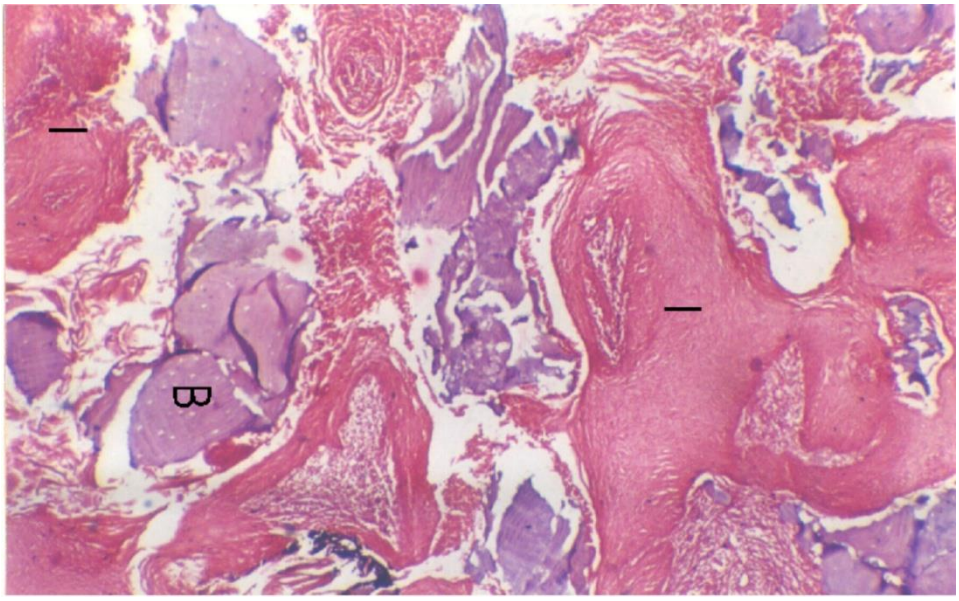


Figure 16: Microscopic picture showing invasive pattern of bone involvement

TYPES OF MANDIBULECTOMY:[50]

1. Segmental mandibulectomy
2. Middle third mandibulectomy
3. Posterior segment mandibulectomy
4. Hemimandibulectomy-including arch saving hemimandibulectomy.
5. Extended hemimandibulectomy
6. Subtotal mandibulectomy

DIFFERENT TYPES OF MARGINAL MANDIBULECTOMY

1. A coronal mandibulectomy / vertical mandibulectomy – consists of the removal of the inner or lingual table of the mandible.
2. A marginal mandibulectomy consists of the removal of the alveolar ridge and varying portions of the upper edge of mandible.
3. A combined coronal–marginal mandibulectomy.
4. A reverse marginal mandibulectomy saves the alveolar process and removes lower part of body of the mandible.

IMAGING OF MANDIBULAR INVASION

Mandibular invasion in oral cancers can be detected by following methods.

1) Plain radiograph

2) Orthopantomography

3) Computerized tomography

4) Denta scan

5) MRI

6) PET/CT - scan

7) SPECT/CT - scan

8) Intraoperative assessment

PLAIN RADIOGRAPH:

study by Close et al showed that positive predictive value for detection of mandibular invasion was 64% with 12.5% rate of false positive results.[51]

ORTHOPANTOMOGRAPHY:

panorex – negative radiology is useful for excluding cortical invasion and is one of real value in excluding periosteal invasion. A study in 2000 showed panoramic radiograph has

100% sensitivity and 86% specificity.[52,53] However a positive orthopantomograph accurately predicts invasion at least into the cortex of mandible.

COMPUTERIZED TOMOGRAPHY:

Study by Close et al determined the diagnostic sensitivity of computed tomography is 100 % with false positive rate of 8.3%.[51,55] whereas study by Mukerji et al showed diagnostic accuracy 96% sensitivity and 81 % specificity with positive predictive values of 89% and negative predictive value of 95%.[54,55]

DENTAL COMPUTED TOMOGRAPHIC SOFTWARE PROGRAMME (DENTA-SCAN) : It is a extension of CT technology. It has 95% sensitivity and 79% specificity and positive and negative predicts values of 87% and 92% respectively.[56] Drawbacks of dentascan are the difficulty in resolving the difference between cortical irregularities and true tumor invasion, The highly curved areas such as the parasymphysis are more difficult to evaluate.

MAGNETIC RESONACE IMAGING (MRI):

A study by Ator et al suggested that MRI might be superior to CT and other modalities. They stress the superior resolution of tumor and soft tissue interface by MRI and enhanced ability to evaluate the mandibular medullary space.[57]

RADIONUCLIDE BONE SCANNING:

study by Weisman and Kimmelman on radionuclide bone scanning has low sensitivity with false positive rate of 53%.[58]

SINGLE POSITRON EMISSION CT

:A study by Imola et al showed 95% sensitivity and 72% specificity for detecting mandibular invasion in oral cancer by single positron emission bone scanning.[59]

PET/CT:

Study shows positron emission tomography/CT has 100%sensitivty and 85 % specificity for assessing mandibular invasion by oral cancer.[60]

INTRAOPERATIVE ASSESMENT:

Intraoperative assessment by an experienced Surgeons is a useful adjuvant to imaging study for mandibular invasion by oral cancer. the sensitivity of clinical examination is 91% and 80 % specificity. With positive predictive value 75% and negative predictive value 93% and the clinical findings are an accurate method of predicting invasion of mandible.[52]

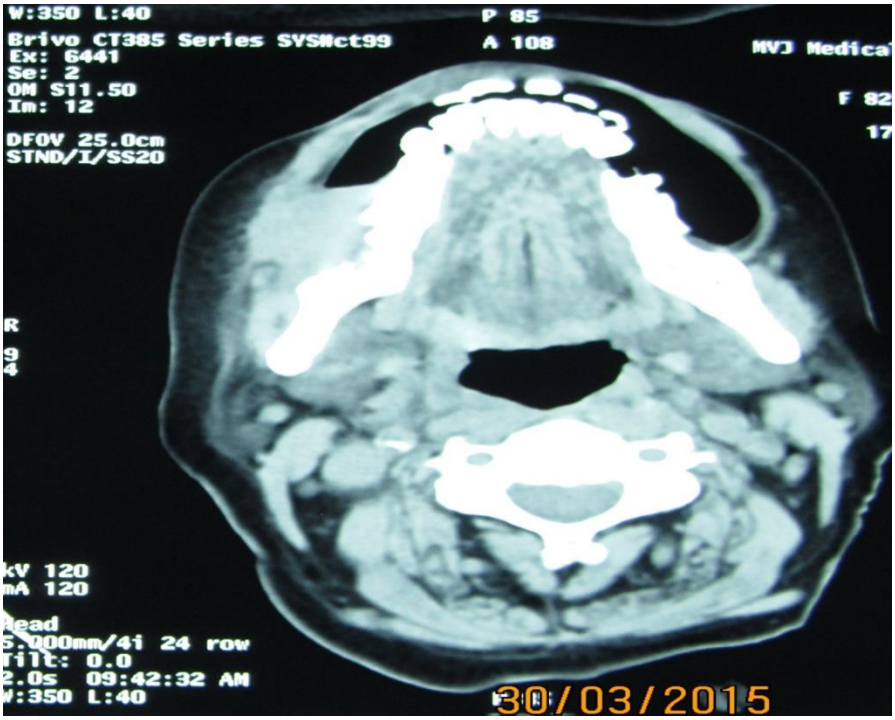


Figure 17:CECT showing the mandibular erosion by tumor

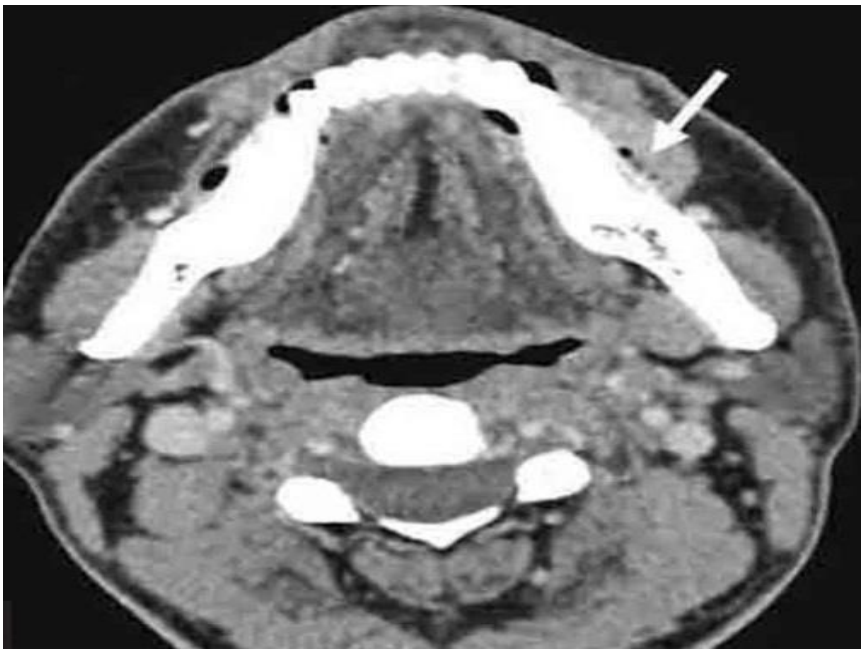


Figure 18:CECT showing tumour abutting the mandible

TNM STAGING (AJCC, 2010):[61]

PRIMARY TUMOR

T_x - Primary tumor cannot be assessed.

T_0 - No evidence of primary tumor.

T_{is} - Carcinoma is in situ.

T_1 - Tumor is 2 cm or less in greatest dimension.

T_2 - Tumor is > 2 cm but < 4 cm in greatest dimension.

T3 -Tumor is > 4 cm in greatest dimension. In gingiva/alveolus,superficial erosion of bone or tooth socket is also T_3

T4 - Moderately advanced local disease.

Lip, vermilion border - Tumor invades through cortical bone, inferior alveolar nerve, floor of mouth, or skin of face.

Oral cavity: Tumor invades deep [extrinsic] muscle of tongue,cortical bone, maxillary sinus or skin of face.

T_{4b} - Very advanced local disease. Tumor invades masticator space, pterygoid plates, or skull base and/or encases internal carotid artery.

REGIONAL LYMPH NODES:

N_x - Regional LN cannot be assessed

N_0 - No regional LN metastasis

N_1 - Ipsilateral Single node of < 3cm in its greatest dimension

N_{2a} - Ipsilateral Single node of 3-6cm in its dimension greatest

N_{2b} - Ipsilateral multiple nodes of <6cm in its greatest dimension

N_{2c} - Bilateral/Contralateral nodes of <6cm in its greatest dimesnion

N_3 - Lymph node > 6cm

METASTASIS:

M_x- Distant metastasis cannot be assessed

M_0- No distant metastasis

M_1- Distant metastasis

STAGE GROUPING:

Table 2: Staging of oral cancers

Stage 0	T0	N0	M0
Stage I	T1	N0	M0
Stage II	T2	N0	M0
Stage III	T3	N0	M0
	T1	N1	M0
	T2	N1	M0
	T3	N1	M0
Stage IV A	T4a	N0	M0
	T4a	N1	M0
	T1	N2	M0
	T2	N2	M0
	T3	N2	M0
	T4a	N2	M0
Stage IV B	Any T	N3	M0
	T4b	Any N	M0
Stage IV C	Any T	Any N	M1

Histological Grade (G)

GX Grade cannot be assessed

G1 Well differentiated

G2 Moderately differentiated

G3 Poorly differentiated

Residual tumour(R)

Rx	Presence of residual tumour cannot be assessed
Ro	No residual tumour
R1	Microscopic residual tumour
R2	Macroscopic residual tumour

RESEARCH HYPOTHESIS:

Mandible can be preserved in selected patients with oral squamous cell carcinoma involving lower gingivo buccal sulcus

RESEARCH QUESTION:

Can the mandible can be preserved in selected patients with oral squamous cell carcinoma involving lower gingivo buccal sulcus.

MATERIALS & METHODS

MATERIALS AND METHODS:

Source of data:

All patients with lower gingivo buccal sulcus squamous cell carcinomas admitted in Department of Otorhinolaryngology and Head & Neck Surgery of R.L.JALAPPA HOSPITAL AND RESEARCH CENTRE attached to SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR undergoing surgical treatment from December 2014 till June 2016.

Thirty eight patients with buccal mucosa or lower alveolus or retromolar trigone area cancer are selected for the study material :

The following data were obtained for each patient:

a. History
b. Addiction habits
c. Clinical examination
d. Biopsy report
e. Radiological investigation
f. Surgery details
g. Histopathological evaluation
h. Follow up to evaluate oncological outcome.

INCLUSION CRITERIA

All patients with operable squamous cell carcinoma (except T1) involving buccal mucosa, gingivo buccal sulcus, lower gingiva and retro mandibular trigone.

EXCLUSION CRITERIA

1. Patients undergoing neoadjuvant chemotherapy.
2. Patients with oral cancer medial to mandible (Floor of mouth and tongue).
3. Patient with inoperable (Stage-T4b) lower gingivo buccal complex tumour.
4. Patient with recurrent tumour.
5. Patient with history of radiotherapy to head and neck region.
6. Patients not giving consent for the treatment and drop outs.

METHOD

Detailed clinical history was elicited with special emphasis on:

- Habit profile
- Symptoms of mandibular involvement such as:
    - (a)Swelling in the mandibular region,
    - (b)Loose tooth
    - (c)Paresthesia of cheek.
- Site of tumor
- Distance from mandible
- Anterior-posterior extent
- Spread to the surrounding area.
- Bimanual palpation of the tumor
- Mobility/ fixity of tumor over the mandible.

Biopsy of the tumor was done and the histopathological findings was noted. Radiological examination such as x-ray mandible / CT scan was done and all these details was documented in a pre-formed profoma.

Intraoperatively periosteal involvement was assessed by periosteal stripping.

All the resected mandibles were decalcified and section was taken to study the proximity of tumour, tumour bone infiltration, pattern of spread of tumor, involvement of cortical bone, marrow, canal and nerve involvement and was documented.

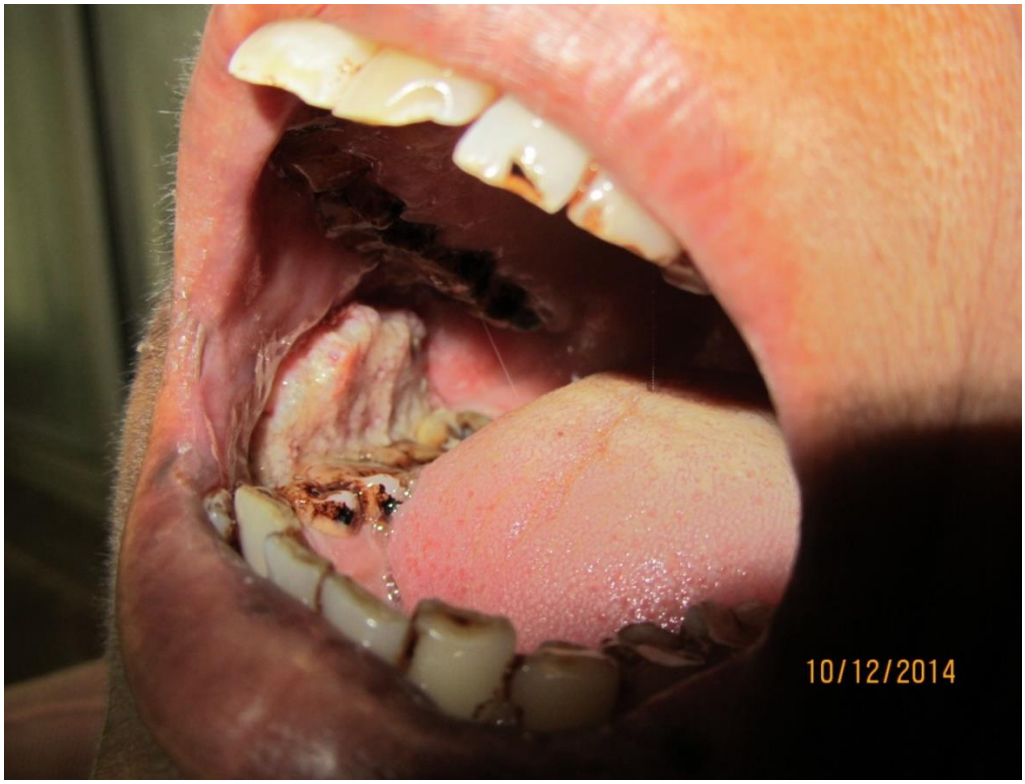


Figure 19: Showing tumor in the Lower Gingivo buccal complex

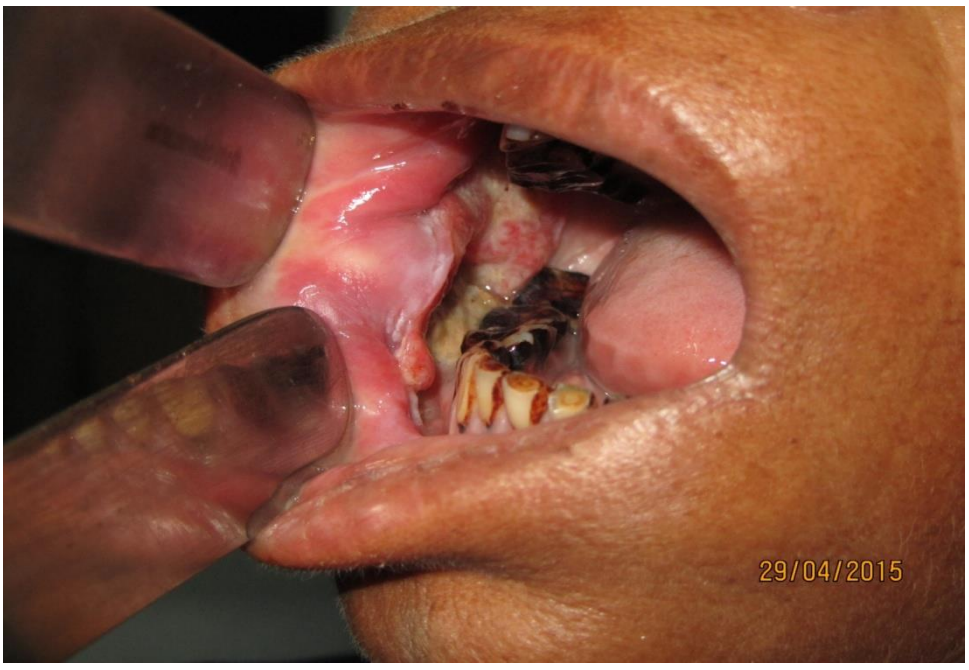


Figure 20 : Showing tumor in the Lower Gingivo buccal sulcus complex

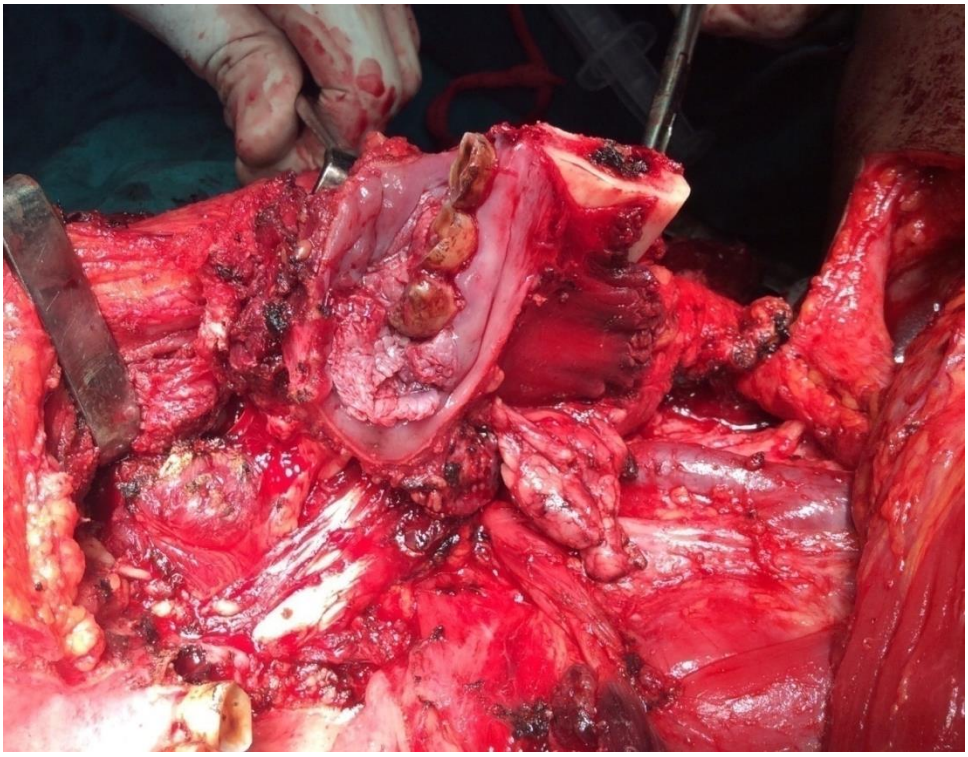


Figure 21:Intraoperative picture showing mandibulectomy

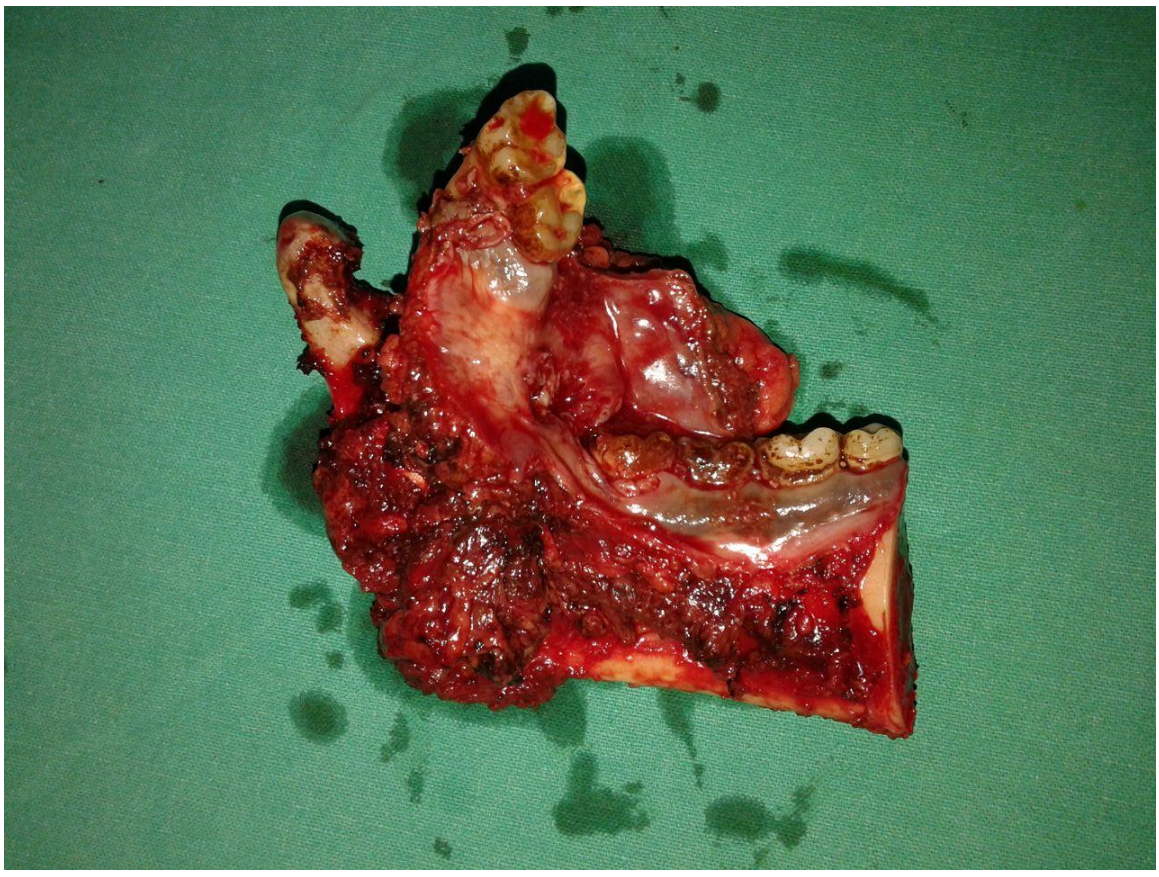


Figure 22: Image showing mandible specimen in composite resection

RESULTS

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation.

ANOVA (Analysis of Variance) or Kruskal Wallis test was the test of significance to identify the mean difference between more than two groups for quantitative and qualitative data respectively.

Pearson correlation or Spearman's correlation was done to find the correlation between two quantitative variables and qualitative variables respectively.

Table 3 Correlation Coefficient and Interpretation

Correlation coefficient (r)	Interpretation
0 - 0.3	Positive Weak correlation
0.3-0.6	Positive Moderate correlation
0.6-1.0	Positive Strong correlation
0 to (-0.3)	Negative Weak correlation
(-0.3) to (-0.6)	Negative Moderate Correlation
(-0.6) to – (1)	Negative Strong Correlation

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram and Scatter plots.

P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data. EPI Info (CDC Atlanta), Open Epi, Med calc and Medley's desktop were used to estimate sample size, odds ratio and reference management in the study.

RESULTS:

Table 4 Age distribution of subjects

		No of patients	%
Age	<40 years	8	21.1%
	41 to 50 years	13	34.2%
	51 to 60 years	8	21.1%
	>60 years	9	23.7%
	Total	38	100.0%

Majority of subjects were in the age group 41 to 50 years (34.2%), followed by >60 years (23.7%), and 21.1% each in <40 years & 51 to 60years age group respectively.

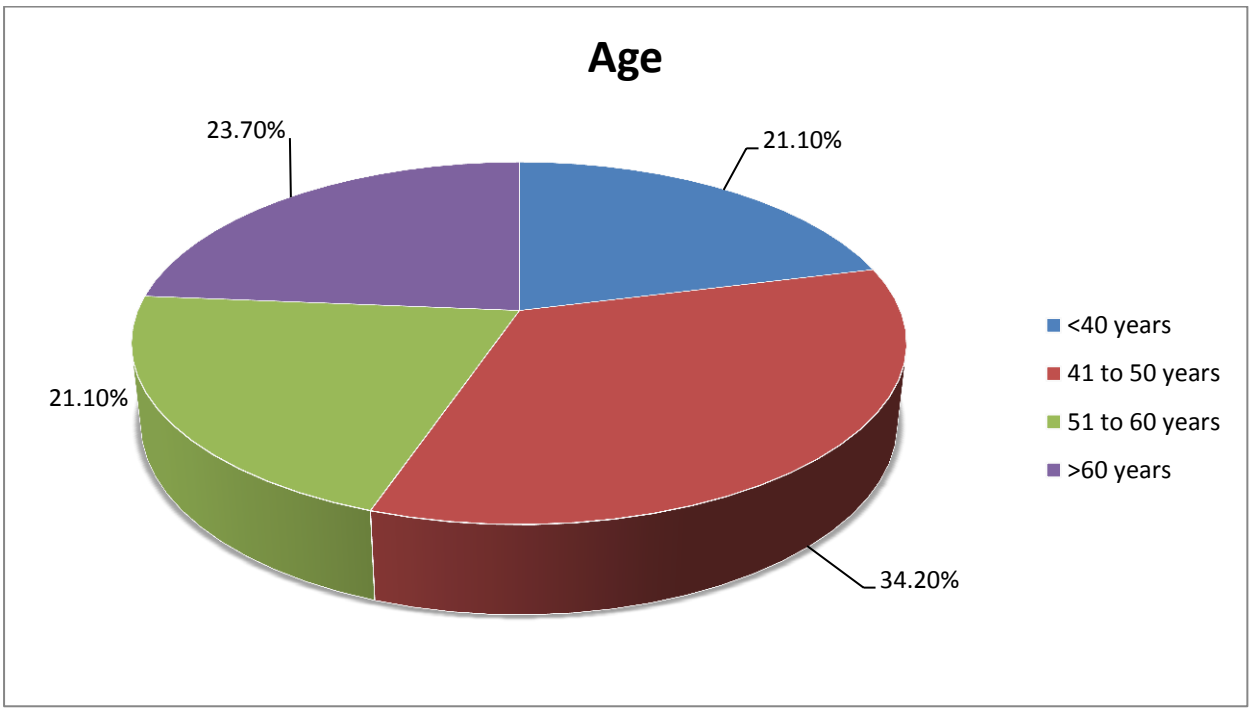


Figure 23 Pie diagram showing Age distribution of subjects

Table 5 Gender distribution of subjects

		No of patients	%
Gender	Female	29	76.3%
	Male	9	23.7%
	Total	38	100.0%

Majority of subjects were females (76.3%) and 23.7% were males.

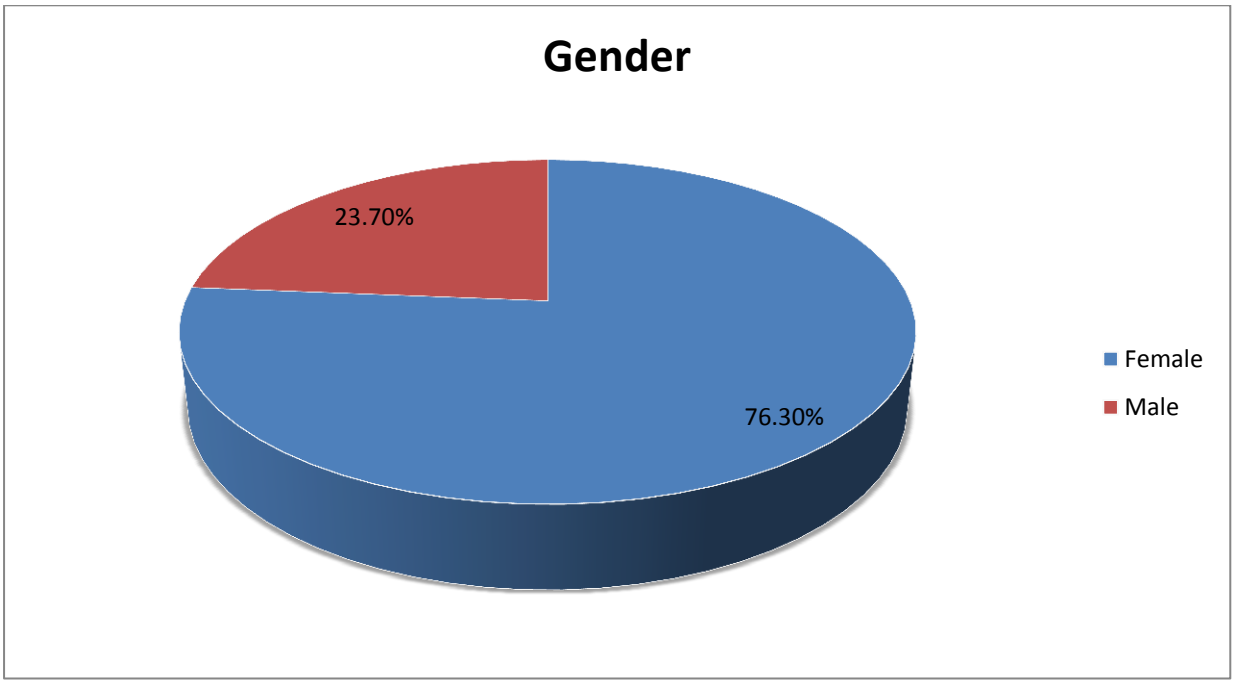


Figure 24 Pie diagram showing Gender distribution of subjects

Table 6 Side of tumor among subjects

		No of patients	%
Side	Left	20	52.6%
	Right	18	47.4%
	Total	38	100.0%

52.6% of tumors were on left side and 47.4% were on right side.

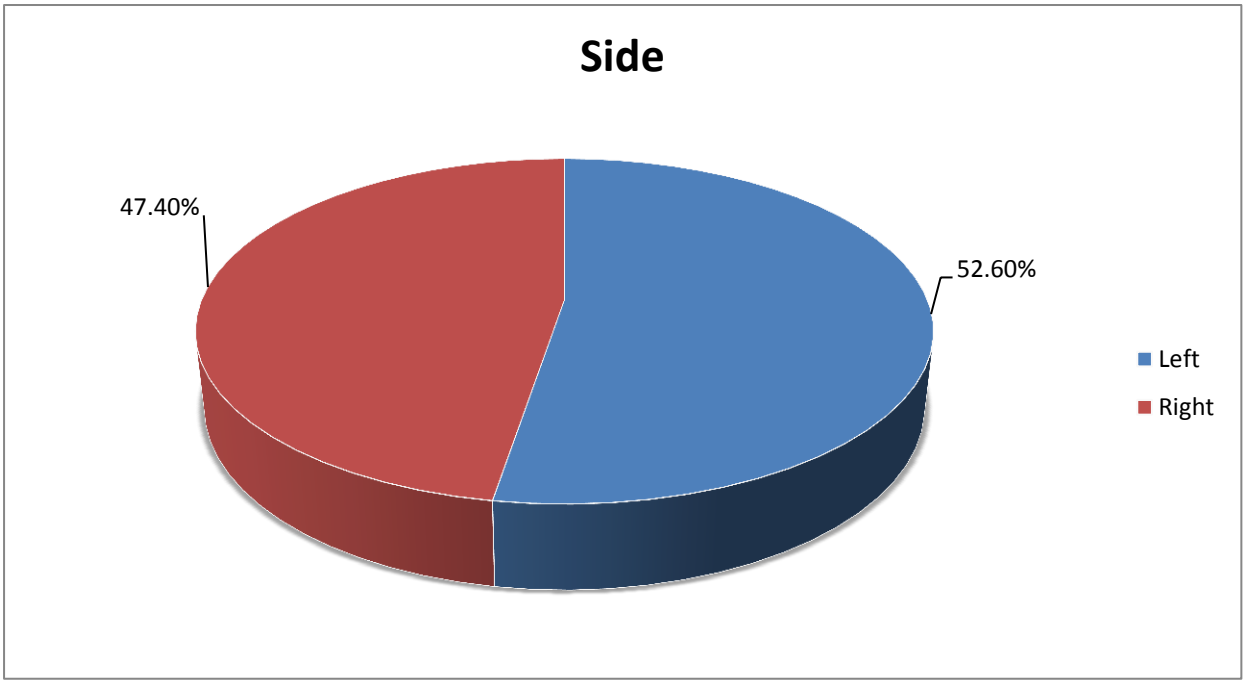
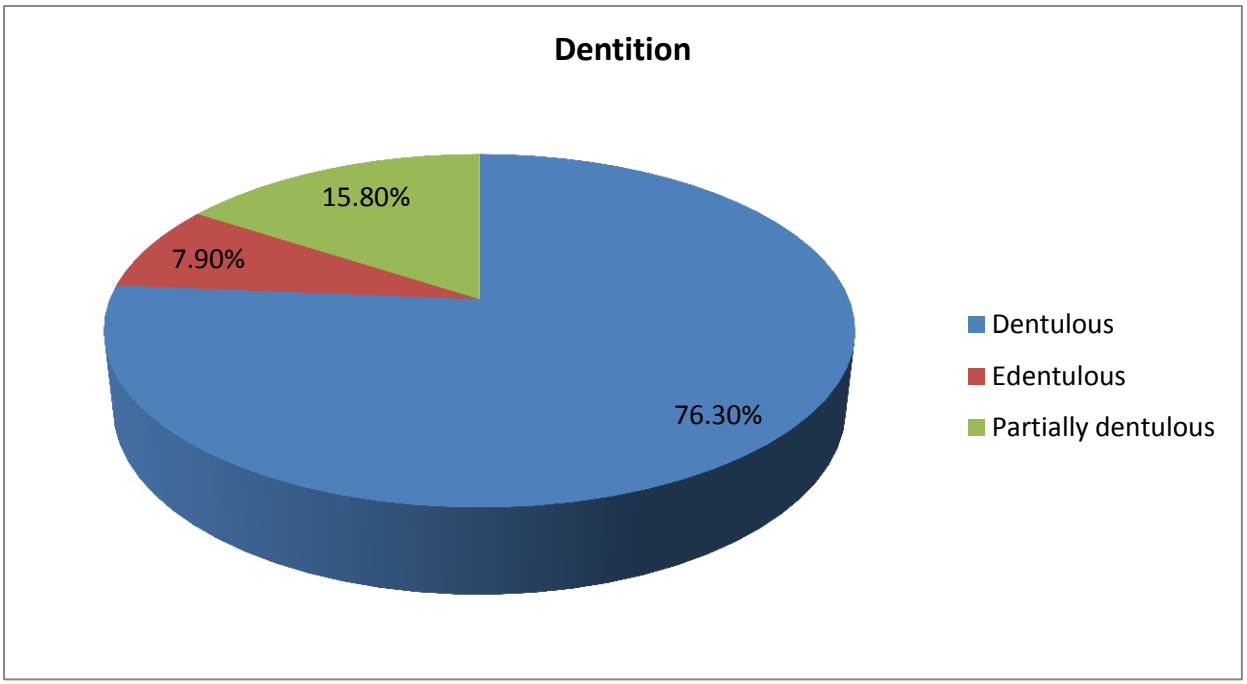


Figure 25 Pie diagram showing Side of tumor among subjects

Table 7 Dentition distribution among subjects

		No of patients	%
Dentition	Dentulous	29	76.3%
	Edentulous	3	7.9%
	Partially Edentulous	6	15.8%
	Total	38	100.0%

76.3% of subjects had dentulous dentition, 7.9% had edentulous and 15.8% of subjects had



partially edentulous.

Figure 26 Pie diagram showing Dentition distribution among subjects

Table 8 Site of tumor among subjects

		No of patients	%
Site	BM	1	2.6%
	BM/GBS	21	55.3%
	BM/GBS/LG	5	13.2%
	BM/GBS/RMT	6	15.8%
	BM/RMT	1	2.6%
	GBS	1	2.6%
	GBS/LG	3	7.9%
	Total	38	100.0%

Most common site of tumor was Buccal mucosa and Gingivo Buccal sulcus in 55.3% of subjects.

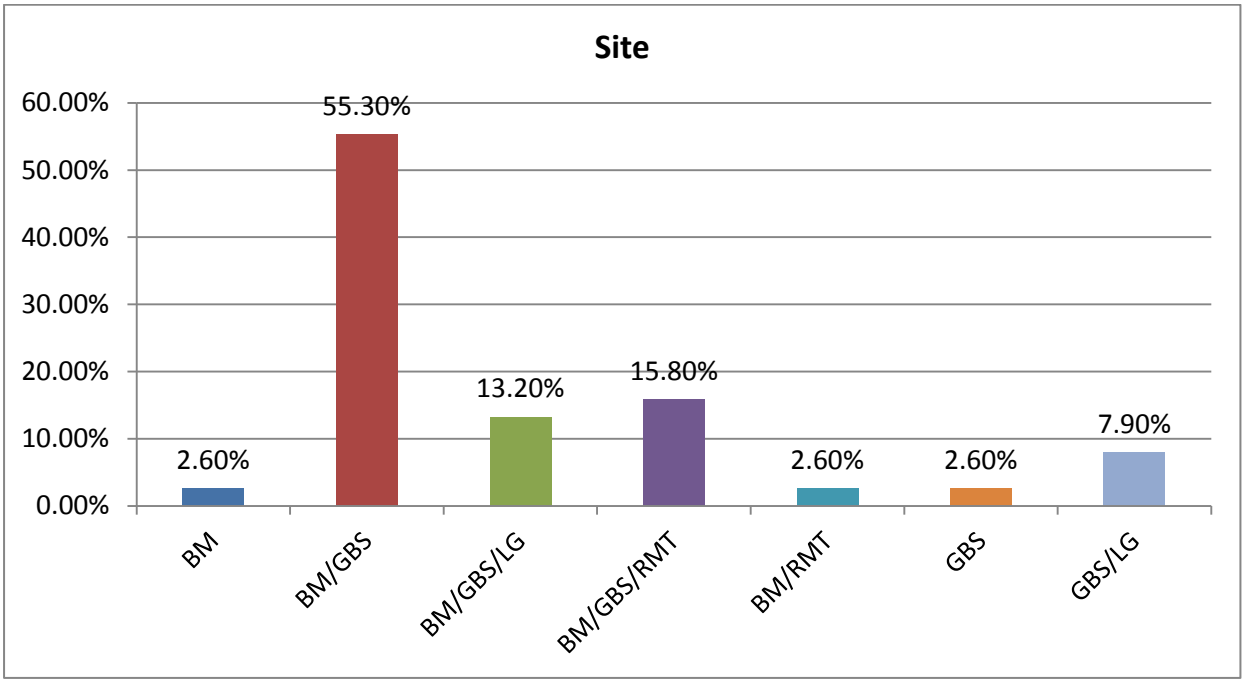


Figure 27 Bar diagram showing Site of tumor among subjects

Table 9 Type of Lesion among subjects

		No of patients	%
Type of Lesion	Ulcerative	6	15.8%
	Ulceroproliferative	31	81.6%
	Verrucous lesion	1	2.6%
	Total	38	100.0%

Most common lesion was Ulceroproliferative in 81.6%, 15.7% of lesions were ulcerative and 2.6% were verrucous lesion.

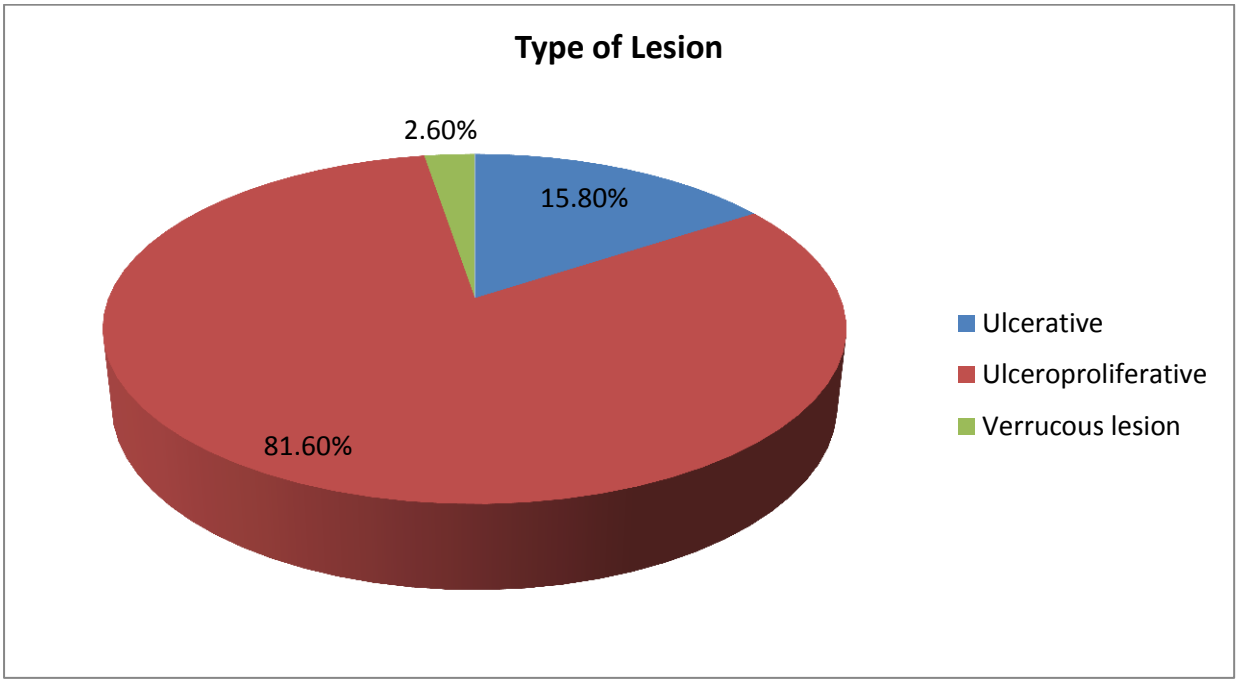


Figure 28 Pie diagram showing Type of Lesion among subjects

Table 10 Tumor TNM staging among subjects

		T					
		T2		T3		T4a	
		No of patients	%	No of patients	%	No of patients	%
N	N0	0	0.0%	6	54.54%	2	8.33%
	N1	1	33.3%	5	45.45%	11	45.83%
	N2a	2	66.7%	0	0.0%	4	16.5%
	N2b	0	0.0%	0	0.0%	5	20.83%
	N2c	0	0.0%	0	0.0%	2	8.33%

Most common TNM stage was T4aN1Mx (45.83%)

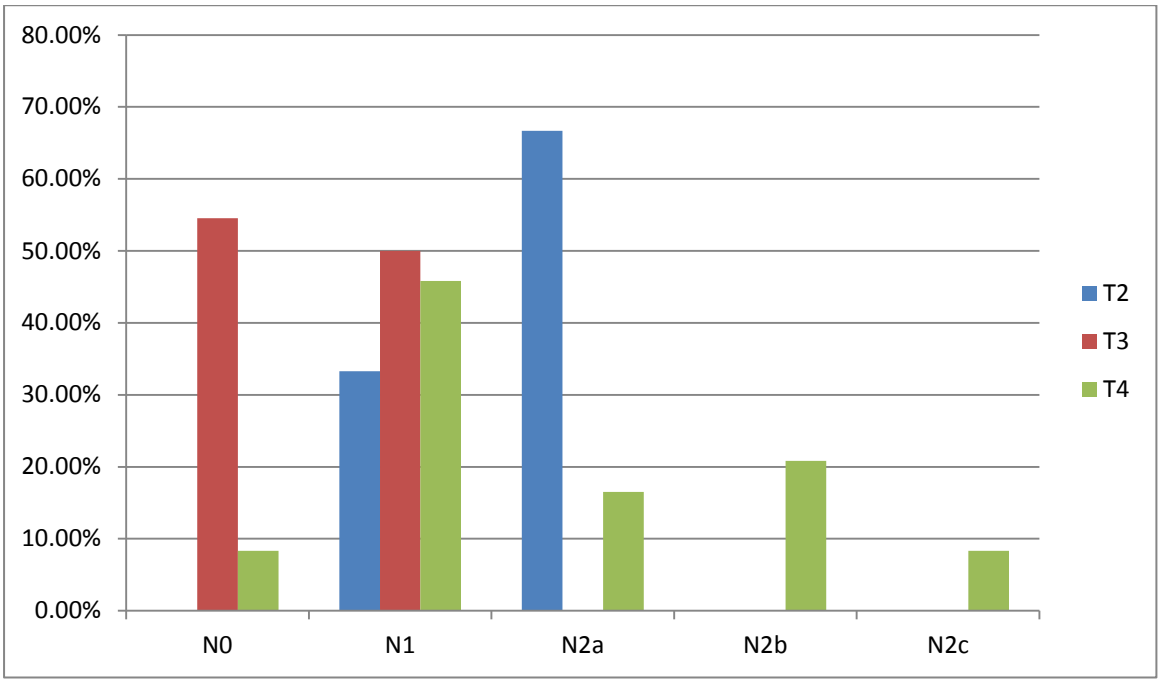
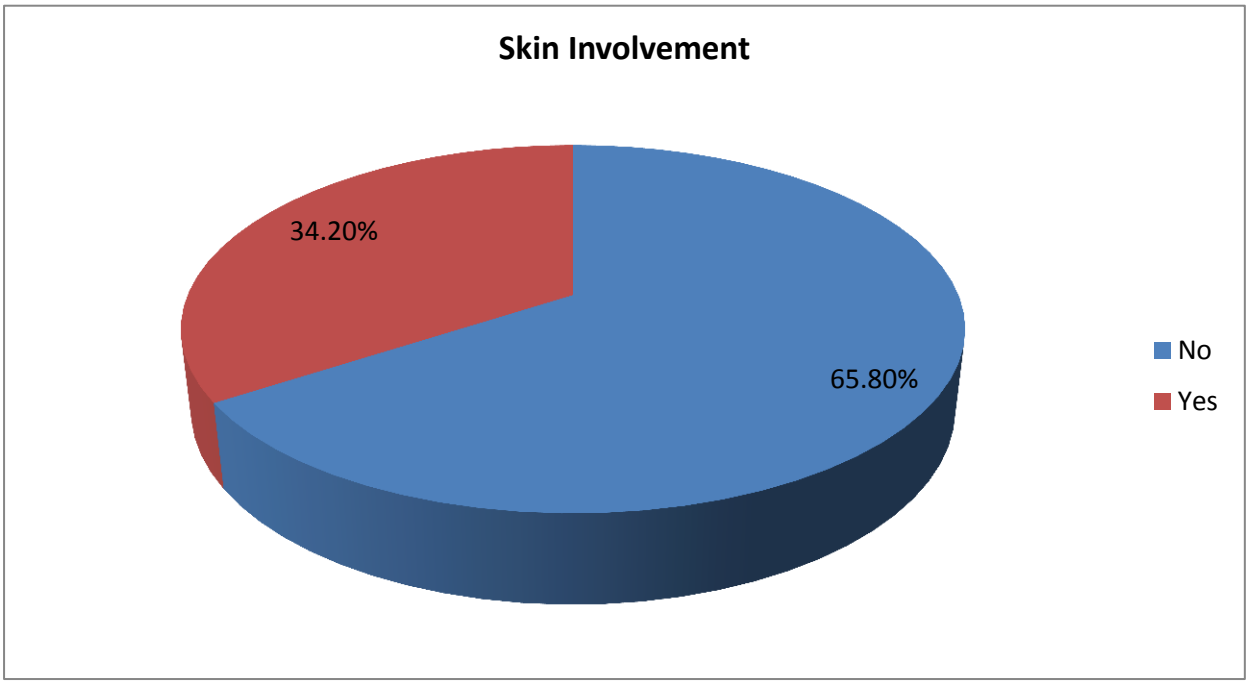


Figure 29: Bar diagram showing Tumor TNM staging among subjects

Table 11 Skin involvement among subjects

		No of patients	%
Skin Involvement	No	25	65.8%
	Yes	13	34.2%
	Total	38	100.0%



In 34.2% of subjects skin was involved.

Figure 30 Pie diagram showing Skin involvement among subjects

Table 12 Bony Erosion in CT

		No of patients	%
Bony Erosion in CT	Absent	24	63.2%
	Abutting	4	10.5%
	Erosion	10	26.3%
	Total	38	100.0%

In the study 26.3% had bony erosion on CT and in 10.5% of subjects abutting was observed.

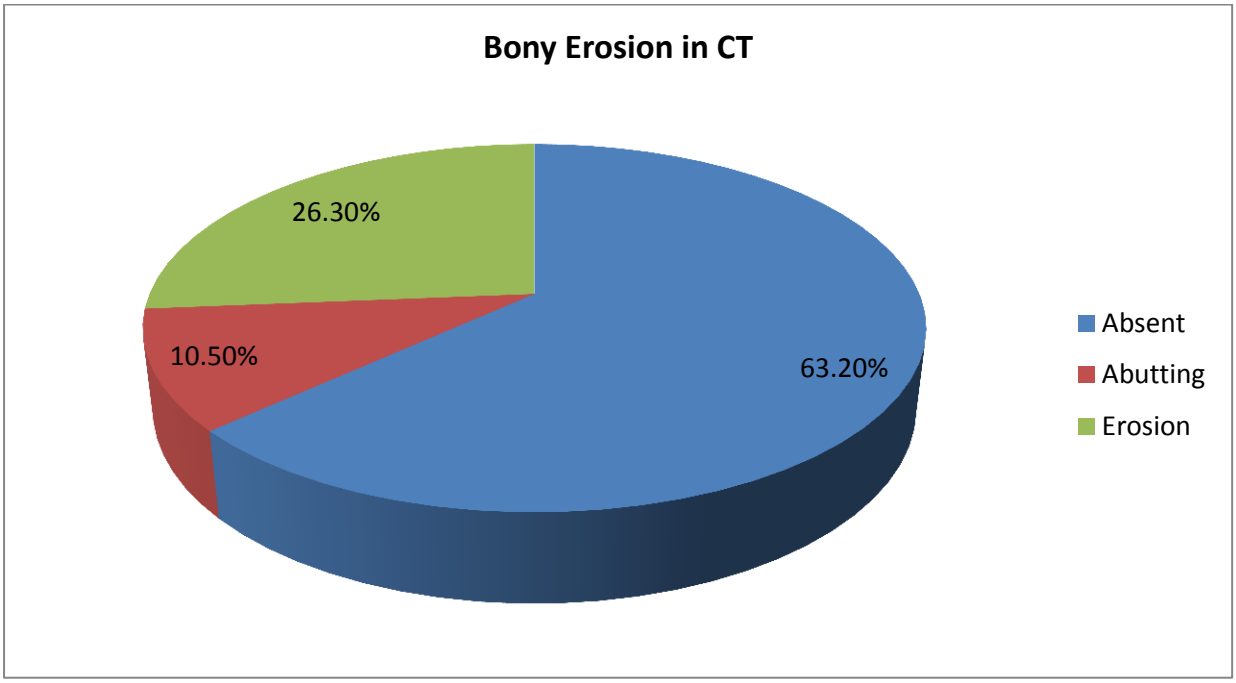


Figure 31 Pie diagram showing Bony Erosion in CT

Table 13 Stage of Tumor among subjects

		No of patients	%
Stage	III	13	34.2%
	IV A	25	65.7%%
	Total	38	100.0%

Most common stage of tumor was IVA (65.7%) and 34.2% were in stage III.

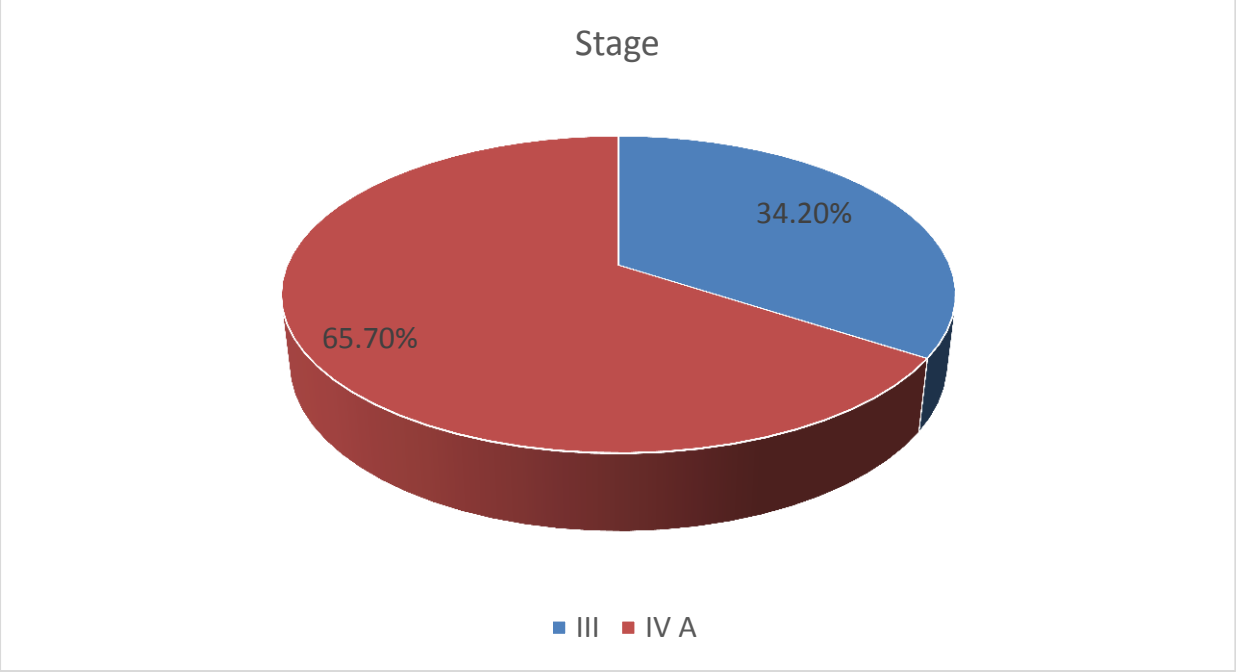


Figure 32 Bar diagram showing Stage of Tumor among subjects

Table 14 Histological type among subjects

		No of patients	%
Histological type	Well differentiated squamous cell carcinoma	29	76.3%
	Moderately differentiated squamous cell carcinoma	7	18.4%
	Squamous cell carcinoma with liquefaction and suppurative degeneration	1	2.6%
	Verrucous squamous cell carcinoma	1	2.6%
	Total	38	100.0%

In the study 76.3% had well differentiated squamous cell carcinoma, 18.4% had moderately differentiated squamous cell carcinoma and 2.6% had SCC with liquefaction and suppurative degeneration and verrucous squamous cell carcinoma respectively.

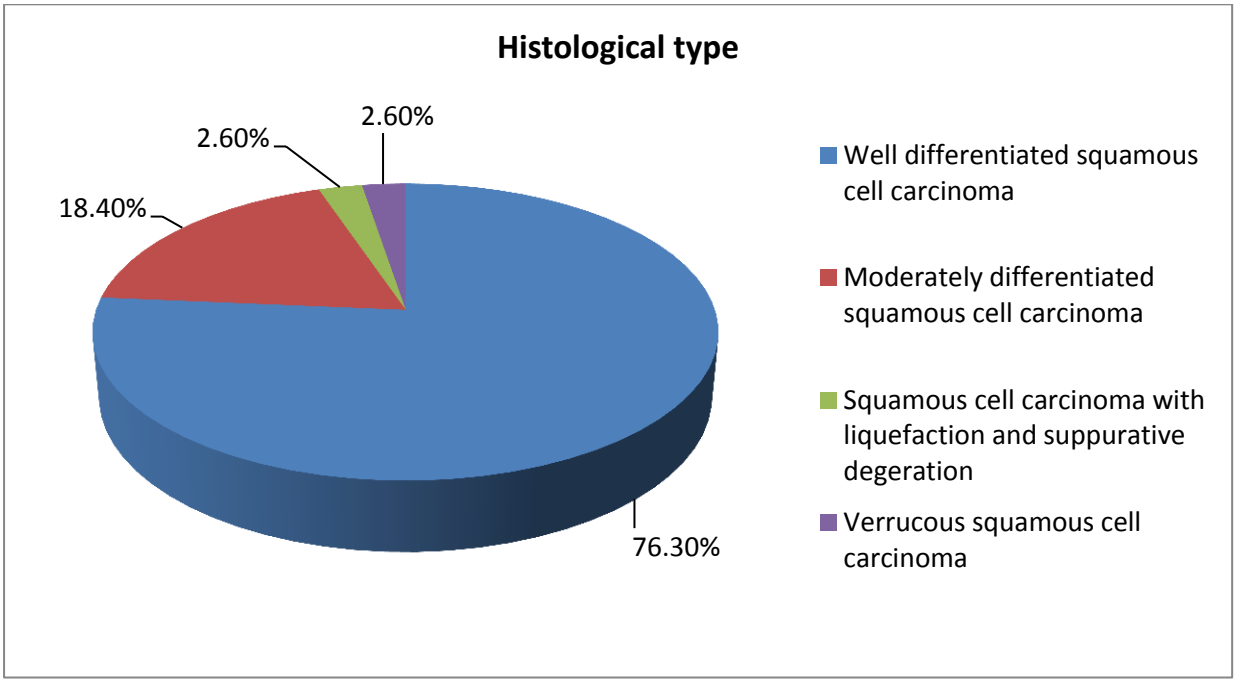


Figure 33: Pie diagram showing Histological type among subjects

Table 15 Type of Mandibulectomy among subjects

		No of patients	%
Type of Mandibulectomy	Hemimandibulectomy	35	92.1%
	MarginalMandibulectomy	3	7.9%
	Total	38	100.0%

In the study 92.1% of subjects underwent Hemimandibulectomy, 7.9% had marginal Mandibulectomy.

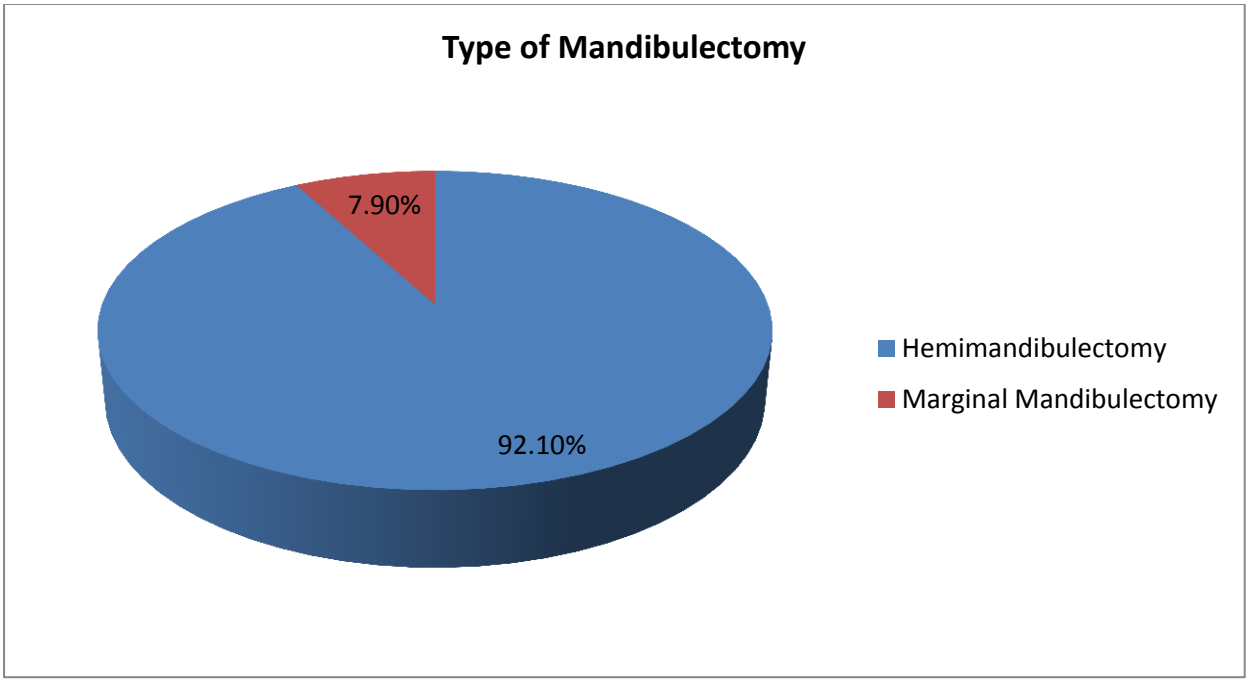


Figure 34 Pie diagram showing Type of Mandibulectomy among subjects

Table 16 Invasive Front among subjects

		No of patients	%
Invasive front	Cohesive	34	89.47%
	Noncohesive	4	10.52%
	Total	38	100.0%

Among 89.47% of subjects cohesive type of invasive front was seen and in 10.52% of subjects non cohesive type of invasion front was seen.

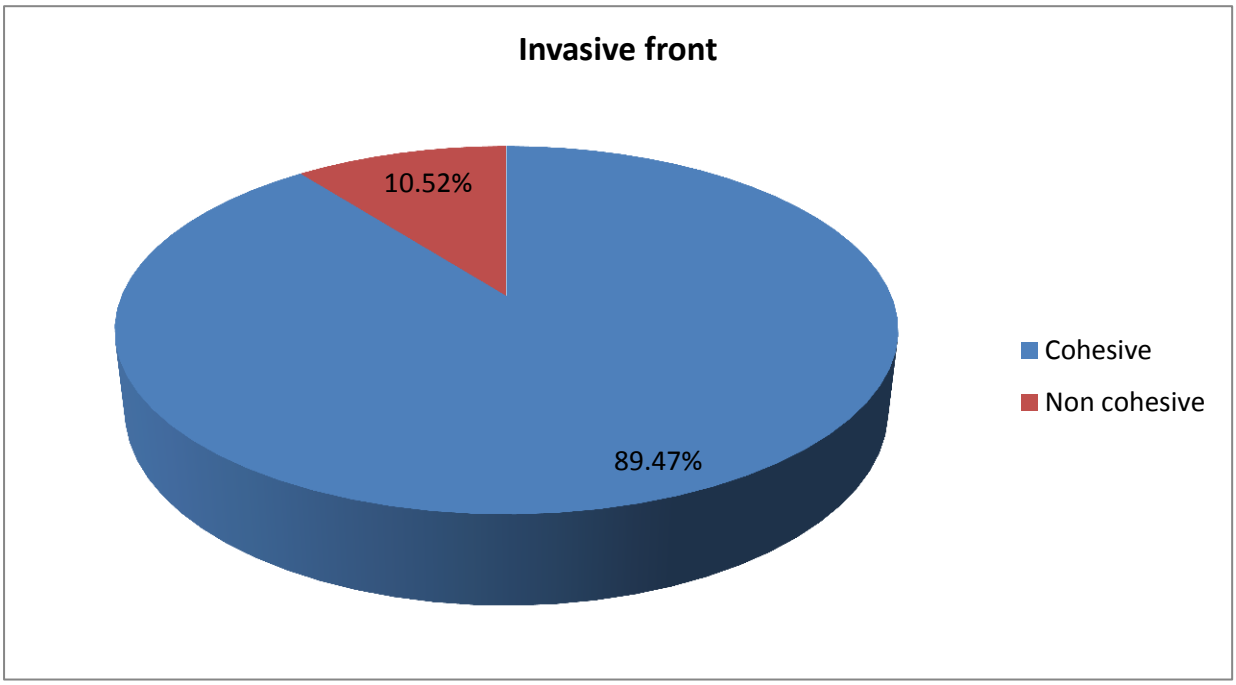


Figure 35 Pie diagram showing Invasive Front among subjects

Table 17 pTNM staging among subjects

		No of patients	%
pTNM	pT1N0M0	2	5.26%
	pT1N1M0	1	2.6%
	pT2N0M0	12	31.57%
	pT2N1M0	2	5.26%
	pT2N2bM0	1	2.63%
	pT3N0M0	8	21.05
	pT3N1M0	2	5.26%%
	pT4aN0M0	3	7.89%
	pT4aN1M0	2	5.26%
	pT4aN2aM0	2	5.26%
	pT4aN2bM0	3	7.89%

Among pTNM, most common was pT2N0M0 (31.57%).

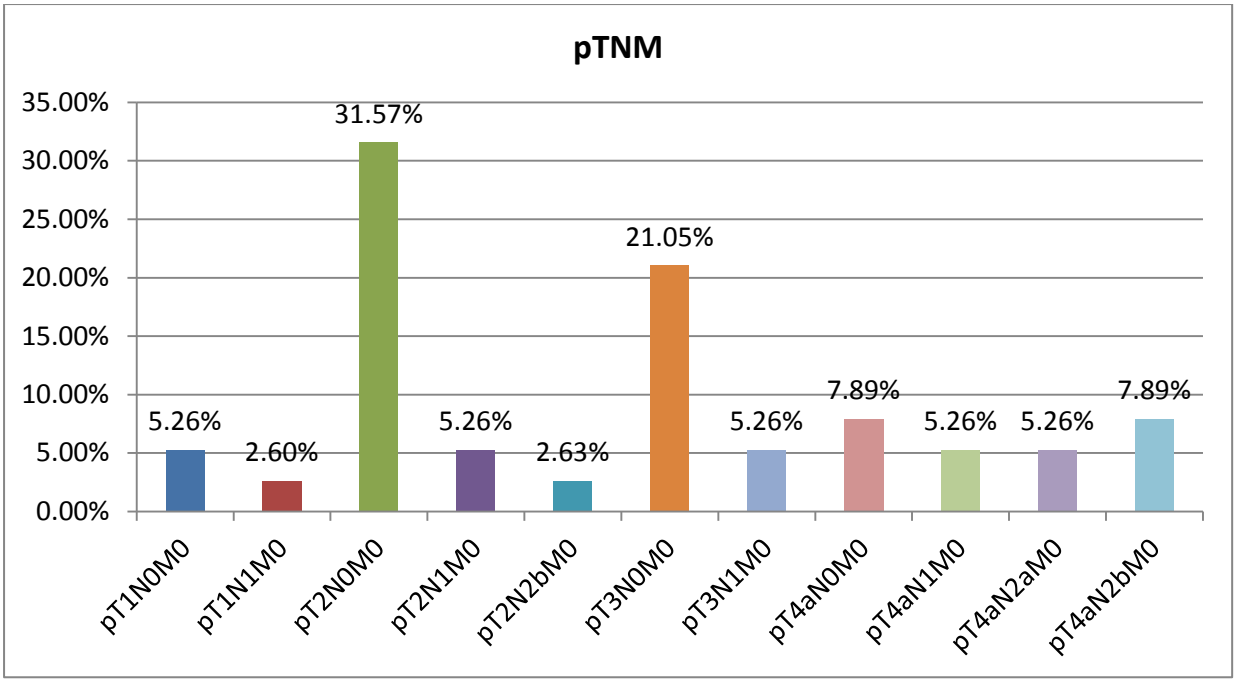


Figure 36 Bar diagram showing pTNM staging among subjects

Table 18: No of Positive lymph nodes in HPE

		No of patients	%
No of Positive Nodes	0	25	65.7%
	1	10	26.30%
	2	2	5.2.%
	3	1	2.6%
	Total	38	100.0%

In 26.30% of subjects one Lymphnode was involved, in 5.2% of subjects 2 lymphnodes was involved and 2.6% had 3 lymph nodes were involved.

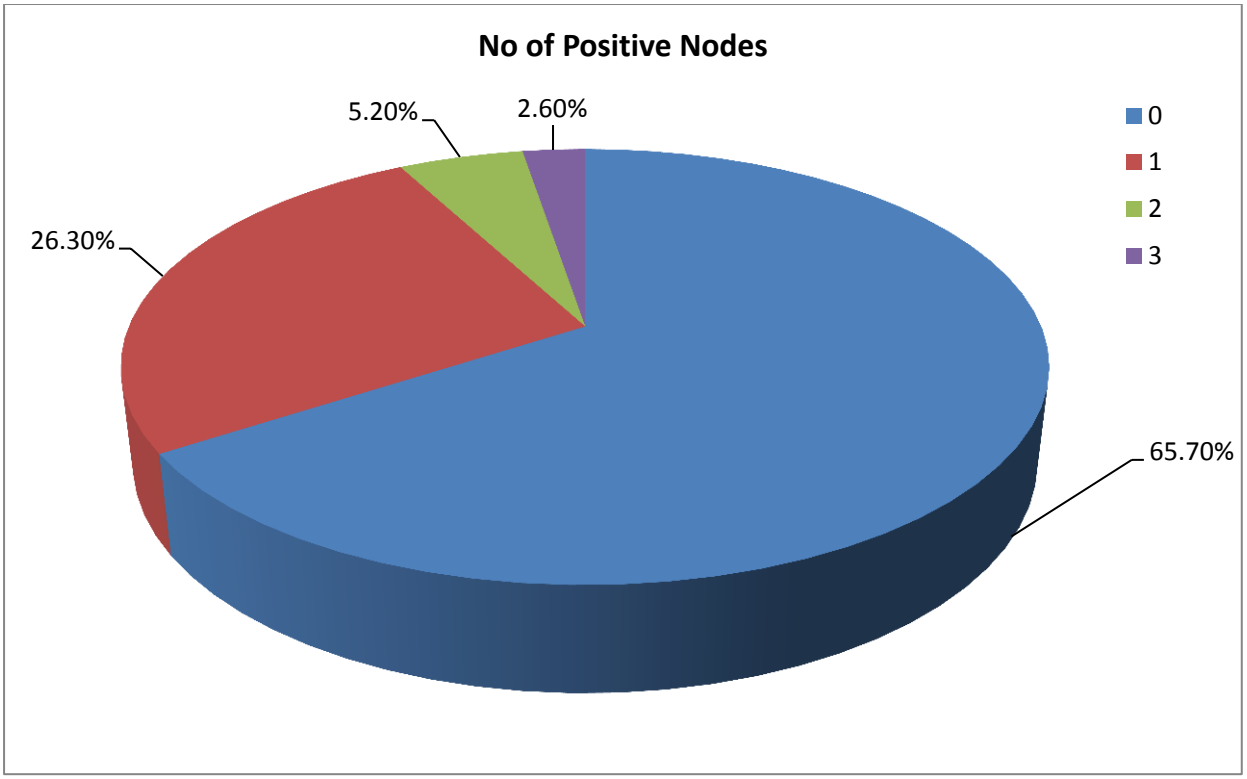


Figure 37 Pie diagram showing No of Positive lymph nodes

Table 19 Bone involvement in HPE among subjects

		No of patients	%
Bone involvement	Bone involved	8	21.1%
	Negative	30	78.9%
	Total	38	100.0%

On HPE 21.1% of subjects had bone involvement.

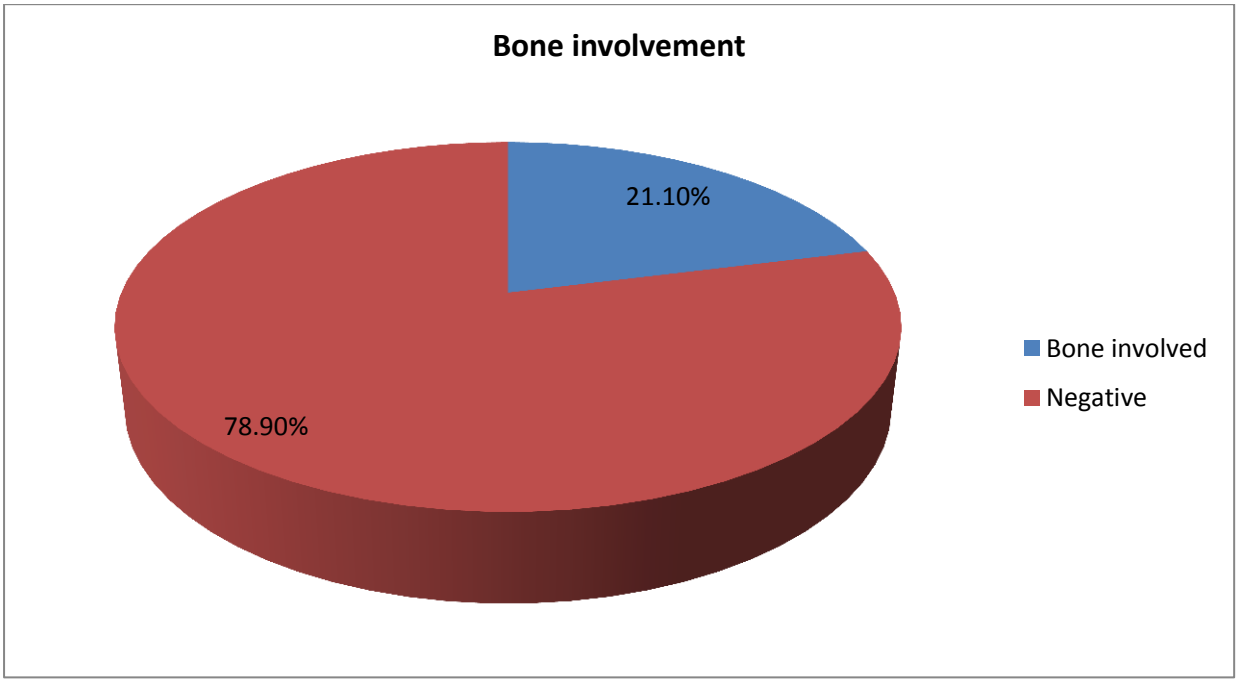


Figure 38 Pie diagram showing Bone involvement among subjects

Table 20 Type of bone involvement among subjects

		No of patients	%
Type of bone involvement	Invasive type	8	21.1%
	No Involvement	30	78.9%
	Total	38	100.0%

In HPE, 21.1% of them had invasive type of bone involvement.

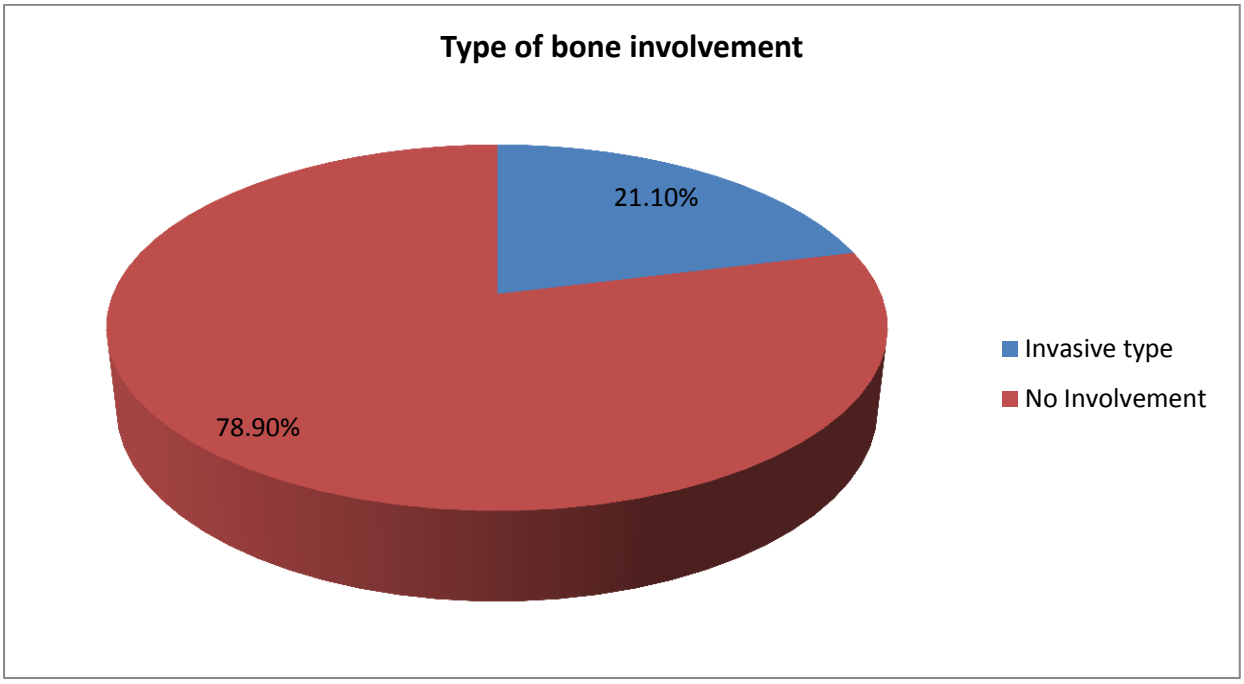


Figure 39 Pie diagram showing type of bone involvement among subjects

Table 21 Maximum thickness of tumor with respect to Stage of tumor

		Max Tx Thickness	
		Mean	SD
Stage	Stage III	14	6.54
	Stage IVA	21.5	3.3
P value		0.001	

Stage IVA had highest tumor thickness of 30 ± 3.3mm. There was significant difference in tumor thickness with respect to stage.

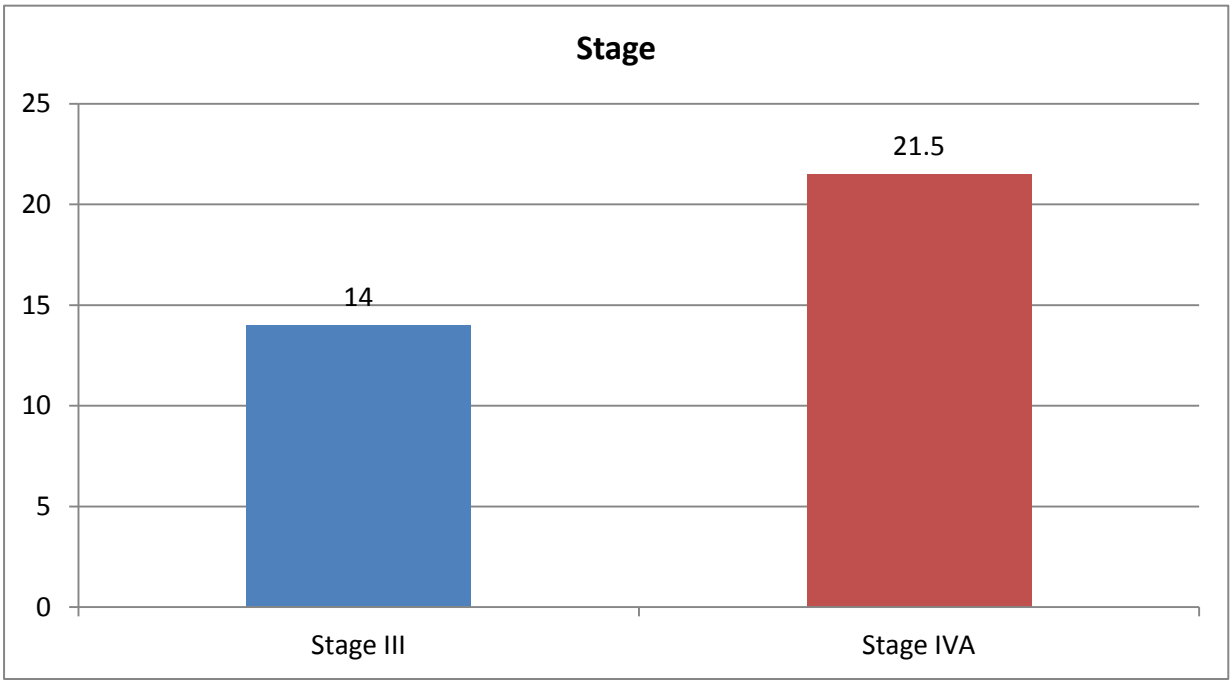


Figure 40 Bar diagram showing Maximum thickness of tumor with respect to Stage of tumor

Table 22 Maximum depth of invasion with respect to the Stage of tumor

		Maximum Depth of Invasion	
		Mean	SD
Stage of Tumor	III	6.07	2.2
	IV A	11.96	5.9
	P value	0.014	

Stage IVA had highest depth of invasion 25 ± 5.9mm. There was significant difference in Depth of Invasion with respect to stage of tumor.

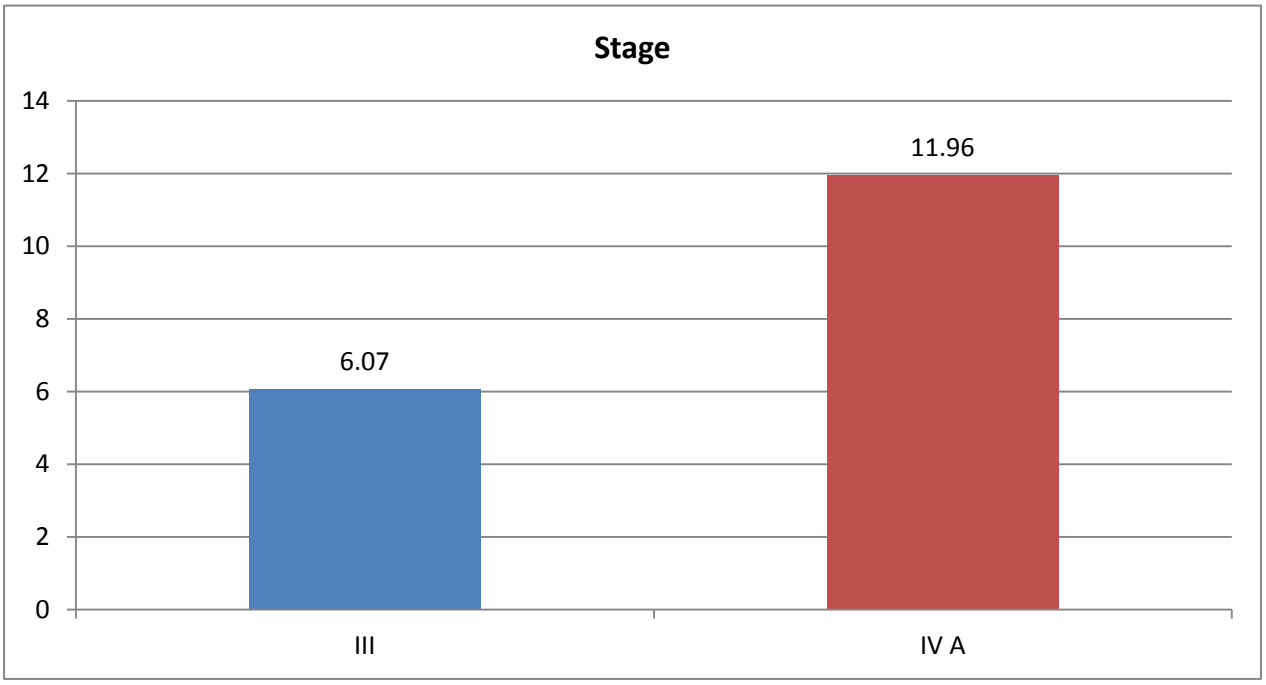


Figure 41 Bar diagram showing Maximum thickness of tumor with respect to Stage of tumor

Table 23 Association between CECT findings and HPE findings among subjects

		CECT bone erosion					
		Absent		Abutting		Erosion	
		No of patients	%	No of patients	%	No of patients	%
Bone Involvement in HPE	Bone Involvement	1	20.8%	1	25.0%	6	80.0%
	No Bone Involvement	23	79.2%	3	75.0%	4	20.0%
	Total	24	100.0%	4	100.0%	10	100.0%

Out of 10 subjects with erosion in CECT, 80% were found to have bone involvement in HPE and out of 4 subjects with abutting, 25% were found to have bone involvement and out of 24 subjects with no bone involvement in CECT 20.8 % showed bone involvement in HPE.

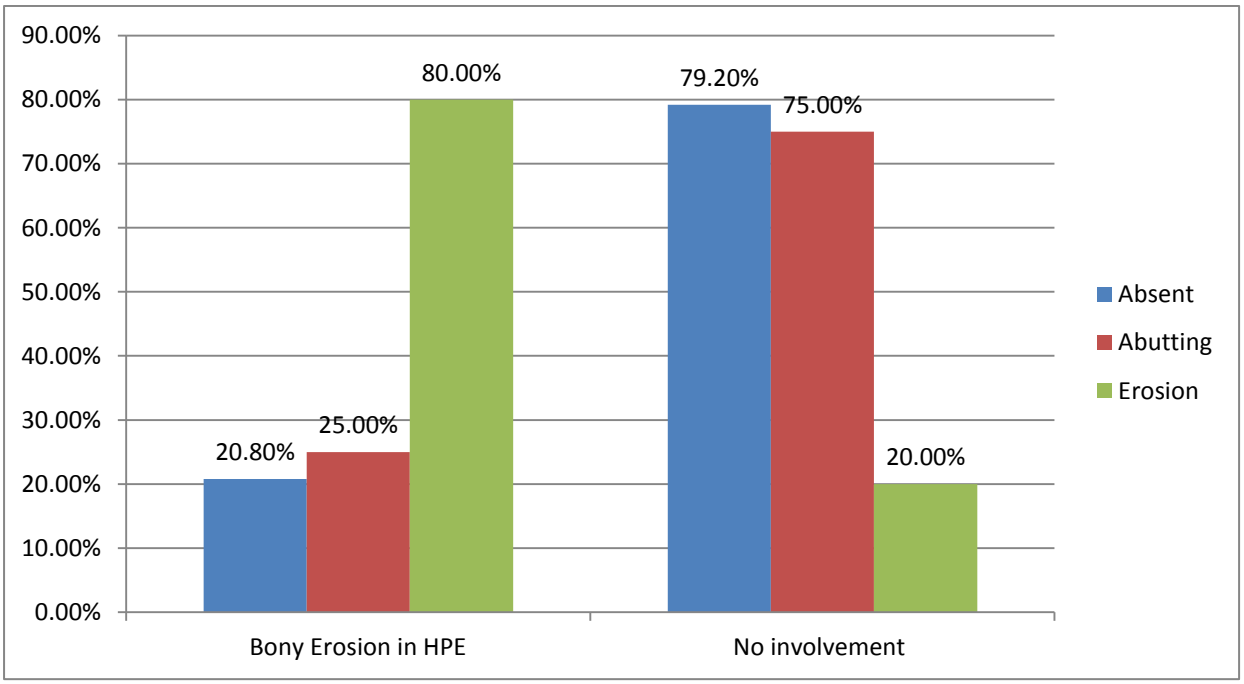


Figure 42 Bar diagram showing Association between CT findings and HPE findings among subjects

Table 24 Comparison of Tumor thickness and depth of invasion between HPE findings

	HPE bone involvement				P value
	Invasive(n=8)		No involvement (n=30)		
	Mean	SD	Mean	SD	
Max Tumor Thickness	20.75	2.86	9.3	5.53	0.001
Maximum Depth of Invasion	14.8	6.95	9.8	5.50	0.0373

There was significant difference in tumor thickness and depth of invasion between subjects with bone involvasion and no bone invasion in HPE. However mean tumor thickness and depth of invasion was higher in invasive group and clinically this difference is significant.

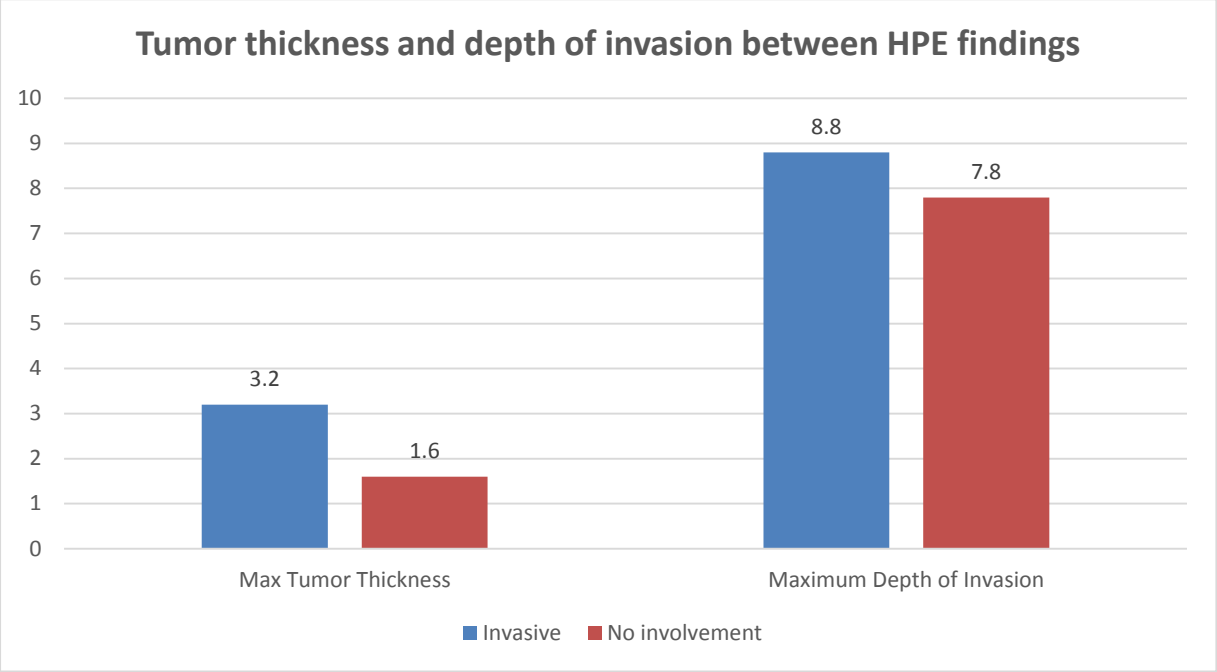


Figure 43: Bar diagram showing Comparison of Tumor thickness and depth of invasion between HPE findings

Table 25: Association between Bone invasion and Skin involvement

SKIN INVOLVEMENT		HPE bone involvement			
		Invasive		No involvement	
		No of patients	%	No of patients	%
	No	3	37.5%	22	73.3%
	Yes	5	62.5%	8	26.6%
		8	100.0%	30	100.0%

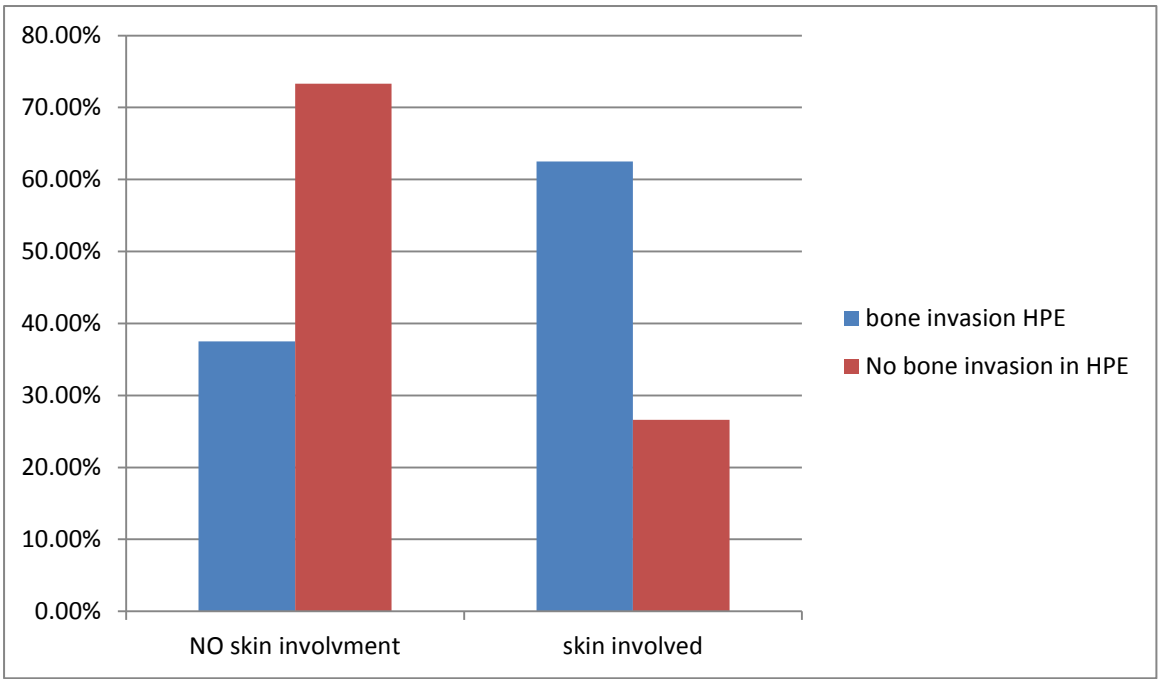


Figure 44 Bar diagram showing Association between Bone invasion and Skin involvement

Table 26 Association between Histological type and bone involvemet in HPE

		HPE Bone involvement			
		Invasion		No involvement	
		No of patients	%	No of patients	%
Histological type	Moderately differentiated squamous cell carcinoma	1	12.5%	6	20.0%
	Squamous cell carcinoma with liquefaction and suppurative degeneration	0	0.0%	1	3.3%
	Verrucous squamous cell carcinoma	0	0.0%	1	3.3%
	Well differentiated squamous cell carcinoma	7	87.5%	22	73.3%

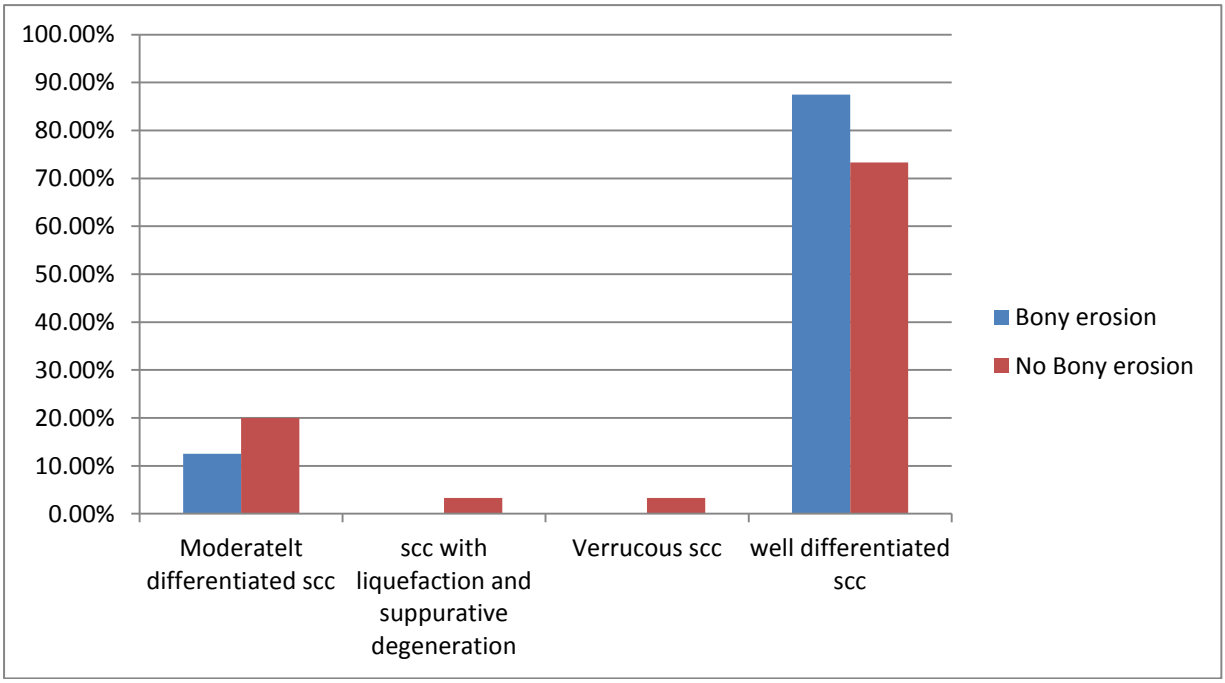


Figure 45: Bar diagram showing Association between Histological type and bone invasion

Figure 25

Table 27 Association between Invasive Front and bone invasion

		HPE bone involvement			
		Invasive		No involvement	
		No of patients	%	No of patients	%
Invasive front	Cohesive	8	100.0%	26	90.0%
	Non cohesive	0	0.0%	4	10.0%

In the study out of 8 subjects with bone involvement in HPE , 100% of them had cohesive invasive front and out of 30 subjects without involvement 90.0% had cohesive invasion and 10.0% had non cohesive invasive front. This observation was not statistically significant.

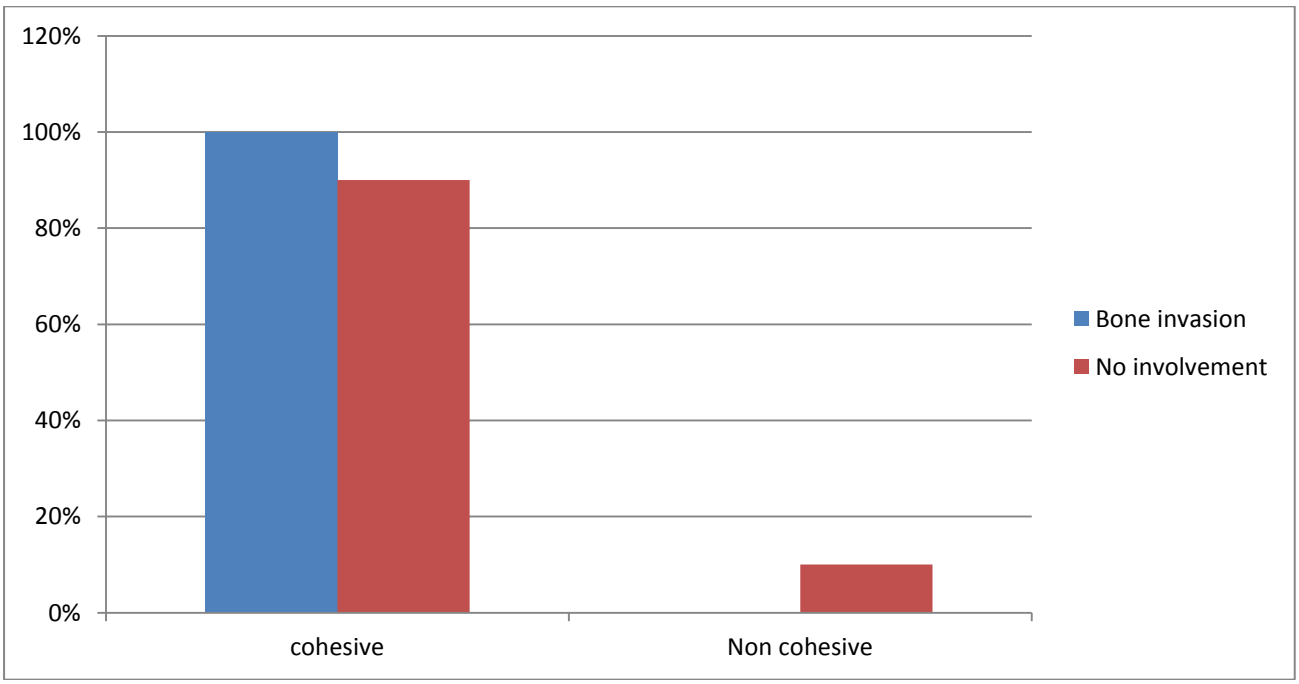


Figure 46 Bar diagram showing Association between Invasive Front and bone invasion

Figure 26:

Table 28 Association between bone involvement and Lymphnode positivity in HPE

No of Positive Nodes in HPE		HPEboneinvolvement			
		Invasion (n=8)		No involvement (n =30)	
		No of patients	%	No of patients	%
	0	3	37.5%	22	73.3%
	1	4	50%	6	20.0%
	2	1	12.5%	1	3.3%
	3	0	0.0%	1	3.3%

There was significant association between No of positive nodes and bone invasion. I.e. among subjects with bone invasion, 37.5% had no positive Lymphnodes, 50% had single positive lymphnode and 12.5 % had 2 positive metastatic lymphnode,. Among subjects with no bone invasion, 73.3% had no Lymphnode involvement, 20% had single metastatic lymphnodes, 3.3% had 2 and 3 metastatic lymphnodes each respectively.

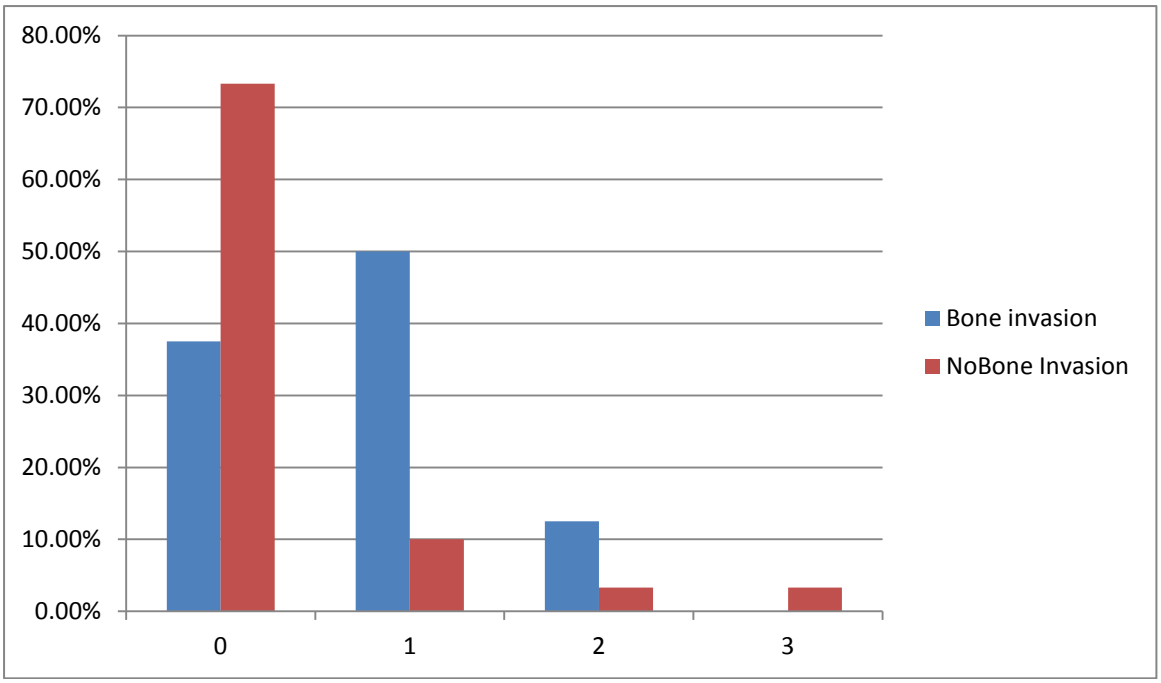


Figure 47 Bar diagram showing Association between bone invasion and Lymphnode positivity

Table 29 :Outcome at follow up

		No of patients	%
Follow up	Not significant	35	92.1%
	Death (other cause)	1	2.6%
	Local recurrence	1	2.6%
	Death (Spinal Metastasis)	1	2.6%
	Total	38	100.0%

Two subjects died during follow-up, one due to spinal metastasis and one subjects due to other cause and one subjects had local recurrence.

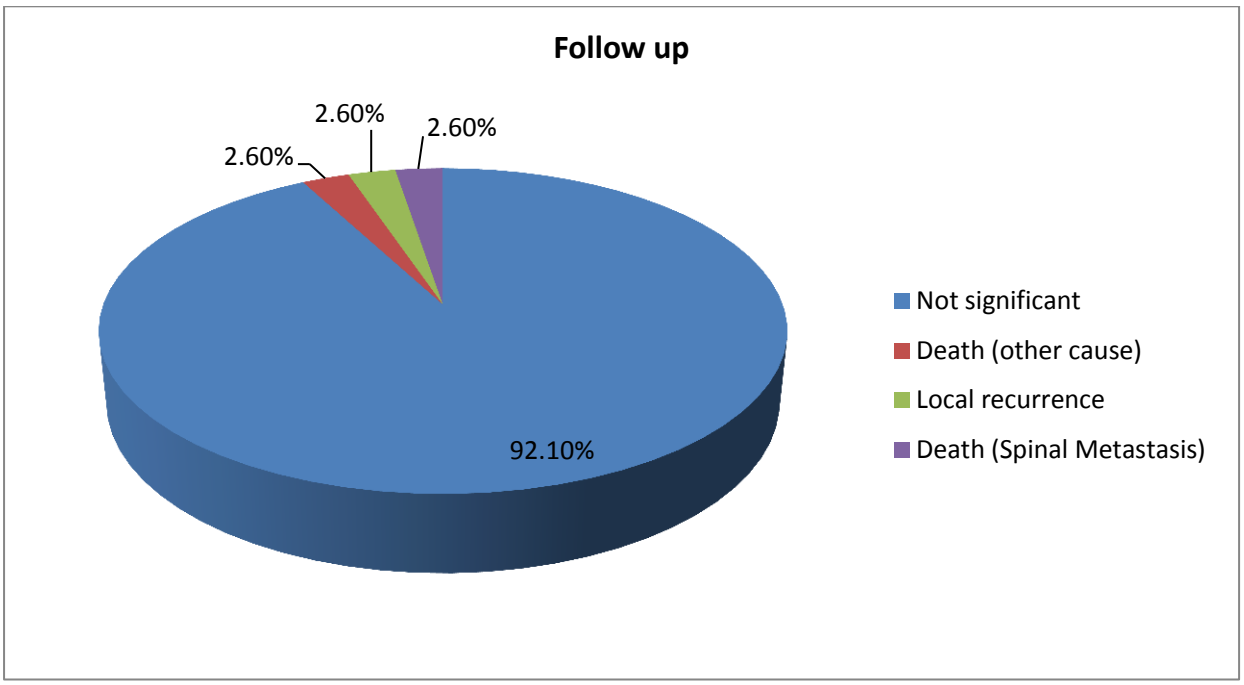


Figure 48 Pie diagram showing Outcome at follow up

Table 30 Association between bone invasion and Followup

	Recurrence		**No** Recurrence	
	No of patients	**%**	No of patients	%
Bone involved in HPE (n=8)	1	12.5%	7	87.5%
Bone not involved in HPE (n=30)	2	6.66%	28	93.3%

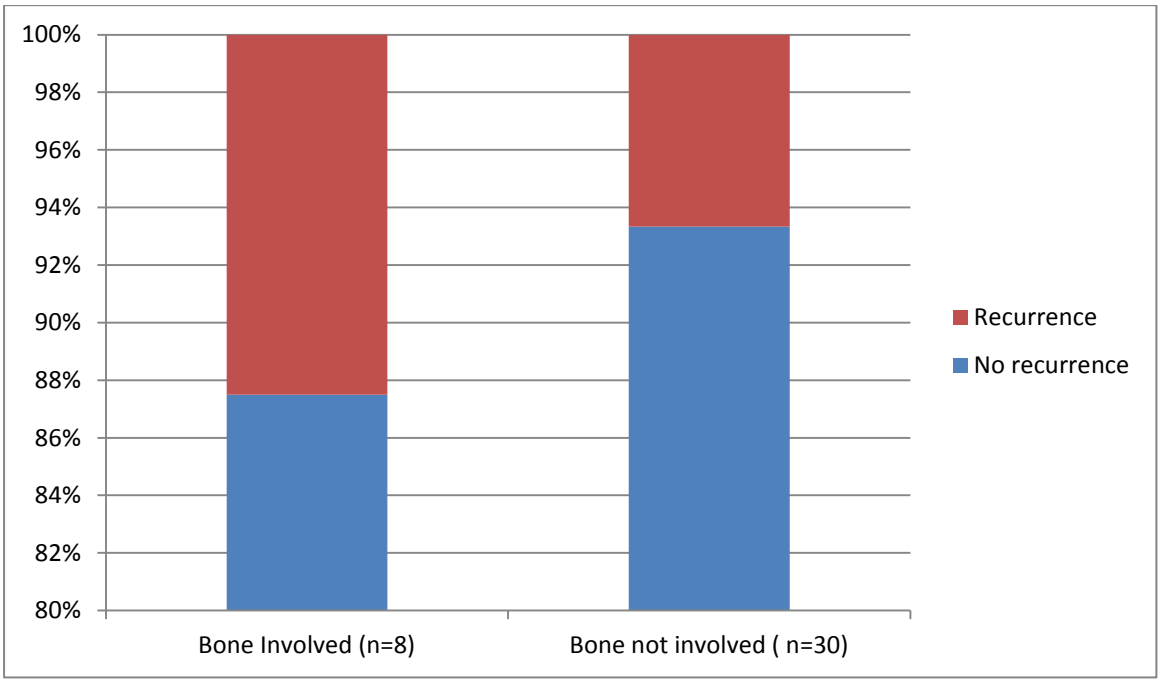


Figure 49:Bar diagram showing Association between bone invasion and Followup

DISCUSSION

DISCUSSION

This study involving 38 patients with locally advanced (T3 & T4a) oral SCC either involving or reaching Lower GBS was done between Dec 2014 to June 2016 at R.L.Jalappa Hospital and research centre attached toSri Devaraj Urs Medical College, Kolar.

76% of patients in this study were females and majority of them were of 41 to 60 age group. This can be explained by the fact that there are rural women in and around Kolar who have the habit of chewing tobacco quid which they sometimes keep in the cheek (lower GBS) over night.

An epidemiological study done in the same area had shown prevalence of head and neck cancer to be 30% in this region with majority of this patients being buccal mucosa.[62] Similar study were reported in an epidemiological study by ICMR.[63] Lower GBS cancer is called Indian oral cancer because it is common in Indian subcontinent due to over carcinogen chewing habits.

In our study the lesion was ulceroexophytic in majority of patients (31/38) and only ulcerative in 6 patients and 1 patients had verrucous carcinoma. Various study in literature had quoted that lower GBS cancer to be aggressive as they are in close proximity to mandible. This cancer also metastasis early to submandibular lymphnodes.[64]

In our study 13/38 patients had palpable lymphnodes at level Ib(sub mandibular) at the time of presentation. This can also be explained by the fact that the oral dental hygiene among rural population is poor in this region and reactive lymphnode is very common.

In this study 11 patients were Stage T3, 24 patients stage T4a clinically. Among this 24 T4a patients, 13 patients found to have skin involvement by the tumor. In majority of the patients the tumor involve BM and LGBS complex was extending posteriorly (adjacent to last two molars) , 12 patients appear to have bone involvement clinically (in oral cavity examination and palpation of mandible).

29 patients in our study were dentulous and 3 were completely edentulous the remaining 6 patients were partially edentulous (adjacent to tumor area). Most of them had undergone tooth extraction by local dental surgeons before presentation. Literature shows that edentulous mandible in elderly (pipe steam mandible) have higher chance of bone invasion by oral cancer.[65,66] The various modes of bone involvement (mandible) by oral cancer include ligament extension of the tumor along periodontal, along the alveolar sockets, erosion of the lingual cortex of mandible just below line of abutment in the tumor abutting mandible, along perimandibular soft tissue and along the inferior alveolar nerve.[4,5,27]

In our study 9 patients were found to have loss of teeth adjacent to the tumor, there by exposing the risk of invasion along alveolar sockets,3 of them were completely edentulous .On imaging (CECT) 10 patients appeared to have mandibular involvement. All these patients appeared to have mandibular invasion on palpation also. In 4 patients the disease was abutting the mandibular cortex without erosion. In literature various imaging studies have been suggested to look for mandibular involvement in oral cancer. The most reliable among this are OPG along with intraoral view of CECT, MRI, bone scan, etc. MRI has high sensitivity particularly when the early marrow is involved, however MRI & Bone scan have higher percentage of false positives due to shifting of fat , inflammation, etc. CECT has good

sensitivity and specificity however it cannot detect early cortical involvement and early marrow involvement. OPG cannot detect bone invasion till demineralization is at least 30%. Literature suggest combination of clinical examination by an experience surgeon, intraoperative periosteal stripping of mandible and imaging preferably by CECT to be the best approach in evaluation of bone invasion by oral cancer.[52,54,55] In our study we relied on clinical examination (palpation), intraoperative periosteal stripping and preoperative CECT to identify early bone involvement. The clinical and imaging results were very close, with clinical assessment showing 12 and CECT showing 10 patients with erosion and 4 patients with abutment.

In our study 35 patients (92%) underwent segmental mandibulectomy (Hemimandibulectomy).In all these patients mandibulotomy was done medial to ipsilateral mental foramen. 3 patients underwent marginal mandibulectomy , all patients had modified radical neck dissection and post operative radiotherapy. Post operative chemotherapy and radiotherapy was given to 3 patients as they all had lymphnode metastasis in HPE. Hemimandibulectomy was done in 35 patients (92%), as 9 patients had loss of teeth adjacent to tumor,10 patients showed bone involvement on CECT and 4 patients has abutment of the disease(line of abutment being lower part of the alveolar plate)

In majority of the patients (23) the disease in lower GBS was extending posteriorly (adjacent to last two molars) and in them marginal mandibulectomy could have been oncologically unsafe and as the lower last two molars crossing the mylohyoid line of mandible.[7,20,21] Various literature suggest that the mandibular remnant should be at least one centimetre in height to avoid pathological fracture.[20,21]

In our study 25 Patients (65.7%) were stage IVA pre operatively and 13 patients (34.2%) were stage III .

On HPE of the specimen 29 patients (76.3%) were found to have well differentiated squamous cell carcinoma and 7 patients (18.4%) had moderately differentiated squamous cell carcinoma, Only one patient had verrucous carcinoma and in one patient the tumor had liquefaction and suppurative degeneration.

The invasive front could be cohesive or non cohesive . In our study 89.4% had cohesive invasive front.

The pathological staging down staged a significant number of patients, 12 patients (31.57%) were stage pT2N0,8 patients were stage pT3N0 (21.0%) 3 patients were stage pT4N0(7.89%), 2 patients were stage pT1N0 (5.26%), 1 patient was stage pT1N1(2.6%), 2 patients were in stage pT2N1(5.26%), 1 patient with pT2N2b (2.63%) , 2 patients (5.26%) with stage pT3N1 and 2 patients with stage pT4aN1 & pT4aN2a each and 3 patients (7.89%) with stage pT4aN2b. Therefore the pathological stage showed 2 patients with stage I , 12 patients with stage II , 13 patients with stage III and 11 patients with stage IV cancer .This down staging in HPE can be explained by the fact that the tumor shrinks (tissues) up to 40 % on formalin fixation (surgical margin) and the rural population in this area has poor oral hygiene. Therefore the lymph nodes in submandibular and upper deep jugular region could be reactive lymohadenopathy.[67]

In our study 8 patients (21.1%) showed bone involvement on HPE (decalcified sections) , 6 of them had showed evidence of bone involvement in CECT. Four patients who had showed evidence of bone involvement in clinical and imaging did not show bone involvement in HPE. 2 patients who did not have bone erosion on CECT were found to have bone involvement in HPE (1of these patient's tumor abutting the lower most part of alveolar plate medially) .The small variation between CECT and HPE regarding bone involvement can be explained by the fact that demineralization of the bone or loss of teeth can show as irregularity on imaging. Further poor oral hygiene can have gingivitis which show enhancement on CECT and occasionally very early cortical involvement may be missed by CECT.[51,54,55,68]

In our study among 8 patients who had bone involvement the mean tumor thickness was 20.75mm with SD of 2.86mm . In the same group the mean depth of invasion was 14.8mm with SD of 6.95mm. Among the patients who didn't show bone involvement in HPE , the mean tumor thickness was 9.3mm with SD of 5.53mm, in this group the mean depth of invasion was 9.8mm with SD of 5.5 mm. In literature 4mm or more depth of invasion has been associated with aggressive nodal disease in tongue cancer.[69] However there are only few studies which have addressed the depth of invasion in buccal mucosa and lower alveolar cancer.

On HPE 13 patients were found to have lymphnode metastasis , 10 patients had only one metastatic lymphnode (26.3%). 2 patients had two metastatic lymphnode each (all ipsilateral lymphnodes) and only 1 patient had 3 metastatic lymphnode. Various studies and literature have shown variation between imaging and HPE findings with regard to the bone

invasio. The sensitivity and specificity of detection of bone involvement in various imaging studies varies between 75 to 90%.[70] .

In our study 13 patients had skin involvement on clinical examination , but only 11 patients had skin involvement in HPE , among these 5 patients also had bone involvement .The clinical skin involvement in 2 patients, was negative in HPE which could be due to inflammation. Among 8 patients who had bone involvement in HPE , 3 did not have lymph node metastasis, 5 patients found to have lymphnode metastasis(62.5%). Among the patients who didn't have bone involvement (30 patients) , 22 patients (73.3%) did not have metastatic lymph node s and only 8 patients (26.6%) had lymphnode metastasis . The above findings shows positive correlation between bone involvement and lymphnode metastasis . Similar findings have been quoted in various studies in literature.[68]

After a mean follow-up of 11 months with minimal follow-up of 6 months 35 patients (92%) are alive and diseases free .3 patients had recurrence (7.8%). Two of these patients with recurrence expired(1 due to spinal metastasis and 1 as complication of chemotherapy). 1 patient is alive with local recurrence, in which disease is inoperable and on palliative treatment. A large study involving 500 patients with mean follow-up of 47 months done at TATA memorial hospital showed long term survival among oral cancer patients in stage III and stage IVA was around 60 to 65%. In our study 2 patients stage I on HPE ,12 patients stage II (31.5%), only 11 patients were stage IV and therefore, follow-up was relatively short. Therefore, the higher disease survival is seen in our study. The patients need to be followed up long term (at least 3 years) to know the loco -regional control. Among 3 patients who had recurrence, all had T4a disease as two of them had multiple metastatic lymphnode. 1 patient among these 3 with recurrence had bone involvement. Therefore, 12.5

% who had bone involvement and 2 patients without bone involvement (6.6%) had recurrence in short period. The poor prognostic factor in our study was bone erosion , multiple metastatic lymphnode and extranodal capsular spread in lymphnodes , similar findings have been quoted in literature and NCCN guidelines.71

CONCLUSION

CONCLUSION

1. The high prevalence of oral cancer among the ladies in Kolar district is due to the habit of betel quid chewing.

2. Patient in rural India presents with locally advanced disease which is in close proximity to mandible.

3. The lower GBS cancer are common in oral cancer and are termed as Indian oral cancer.

4. In spite of having locally advanced cancer in the lower GBS , the majority of these patients don't have bone involvement as only particular pathways helps to spread tumor to the bone.

5. The periosteum is an important barrier to the tumor spread.

6. A combination of clinical examination by experienced surgeon , periosteal stripping during surgery and Pre- operative CECT helps to identify the bone involvement.

7. HPE is the gold standard to confirm bone involvement (decalcified section).

8. Marginal mandibulectomy and periosteal stripping are oncologically safe procedures in patients with oral cancer having anterior disease (not abutting last two molars) and adequate thickness of mandible .

9. In patients with oral cancer extending posteriorly abutting last two molars segmental mandibulectomy is required, even if bone is not involved for oncological safety

10. Bone involvement by tumor , multiple lymphnode metastasis and extra capsular spread from lymphnodes are poor prognostic factors

11. With proper clinical and radiological assessment pre operatively , a large number of patients with oral cancer involving lower GBS can be subjected to mandibular conserving surgeries (Dentulous mandible without bone erosion and not abutting last two molars) and thereby reducing morbidity and post operative cosmetic defect.

12. Large multi institutional studies addressing , mandible conserving surgeries and their long term outcome are required to formulate definitive protocols for mandible conservation in lower GBS cancer.

SUMMARY

SUMMARY

The study was conducted at R.L.Jalappa Hospital and Research Centre, Tamaka attached to Sri Devaraj Urs medical college which is serving rural population. Depending on inclusion criteria and exclusion criteria of the study, 38 patients with oral cancer either reaching or involving lower GBS were included in this study. Appearance of lesion was found to be ulceroproliferative (ulceroexophytic) in majority of the patients(31/38). On imaging (CECT) mandibular erosion was seen in 10 patients (26.3%), in 4 patients(10.5%) the disease was abutting mandible. Disease was not extending to bone in 24 patients(63.2%). The clinical staging in our study shows 25 patients(65.7%) with stage IVA and in 13 patients(34.2%) with stage III cancer. 92.1% of patients in this study underwent hemimandibulectomy as part of composite resection of tumor and 7.9% patients underwent marginal mandibulectomy. 8/38 patients had bone involvement (21.1%) on decalcified section. In all patients with mandibular involvement with tumor the type of involvement was invasive.

On correlation between CECT and HPE regarding bone invasion, 10 patients showed bone involvement in CECT, of which only 6 had bone involvement in HPE, and 1 patient who had only abutment of disease to mandible showed bone involvement in HPE. 1 patient who had no signs of bone involvement in CECT showed evidence of bone involvement on HPE. Among 8 patients who had bone involvement on HPE, 7 were well differentiated squamous cell carcinoma & 1 was moderately differentiated squamous cell carcinoma. Among 8 patients who had bone involvement on HPE, 5 patients were found to have metastatic lymphnode (4 patients with single metastatic lymphnode and 1 patients with two metastatic lymphnodes)

On minimum follow up of 6 months and mean follow up of 11 months, 35 patients (92%) are alive and disease free. One patient is alive with local recurrence. 2 patients expired due to the disease. All patients with recurrence had locally advanced disease (T4a) and metastatic lymphnodes(1 patients with single metastatic lymphnode and 2patients with multiple metastatic lymphnodes).

We conclude that CECT is the one of the best imaging modalities to rule out mandibular invasion in lower GBS squamous cell carcinoma. Along with proper Clinical examination and radiological assessment preoperatively, a large no of patients with lower gingivo buccal sulcus cancer can be subjected to mandible conserving surgery and thereby, reducing the post operative morbidity and cosmetic defect.

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ANNEXURES

ANNEXURE

EVALUVATION OF MANDIBLE FOR TUMOR INVOLVEMENT

IN THE LOWER GINGIVO BUCCAL CANCER

PROFORMA

PERSONAL DETAIL

Name : Age : Sex : M F

Address : Date : Occupation :

Telephone : Hospital no:

E-mail ID :

PRESENTING COMPLAINT

CHIEF COMPLAINTS	YES/NO	SINCE
Presence of ulcer/mass in oral cavity		
Presence of burning sensation in oral cavity upon taking spicy food		
Restricted mouth opening		

Excessive salivation		
Difficulty in swallowing		
Pain in cheek		
Loose of tooth		
Others (specify) • • •		

Lesion Site : Buccal mucosa/ Gingivobuccal sulcus/ Retromolar Trigone/lower gingiva

Side : Right/ Left

HISTORY OF PRESENT ILLNESS

Onset : Progression :

Aggravating factors :

Relieving factors :

H/O trauma : Y/ N

H/O difficulty in swallowing : Y/ N

H/O difficulty in breathing : Y/ N

H/O change in voice : Y/ N

H/O weight loss : Y/ N

PAST HISTORY

H/O Diabetes mellitus, Hypertension, Tuberculosis, Bronchial asthma, Drug allergy

H/O previous surgery: Y/ N

Treatment History (if any): Surgery/ Radiotherapy/ Chemotherapy

FAMILY HISTORY

Contributory ☐ Not contributory ☐

PERSONAL HISTORY

Loss of appetite: Y/ N

Disturbed sleep: Y/ N

Bowel and bladder disturbances: Y/ N

Habits –

- Tobacco chewing :

  Type – Betel nut/ Pan masala/ Gutka

  Duration - Frequency –

  Side – Right/ Left/ Both Leaves overnight – Y/ N

  Tobacco – Y/ N Lime – Y/ N

  Stopped since –

  (if stopped)

- Smoking :

  Type – Filtered Cigarette/ Unfiltered Cigarette/ Beedi/ Hookha/ Pipe

  Duration - Packs/Day -

  Reverse smoking :Y/ N Stopped since –

  (if stopped)

- Alcohol :

  Duration - Type -

Amount/ day - Stopped since –

(if stopped)

EXAMINATION

GENERAL PHYSICAL EXAMINATION

Built: Poor/ Medium/ Well-built Nutritional status: Poor/ Satisfactory

Temperature: Pulse: BP: RR:

Pallor: Y/ N Icterus: Y/ N Cyanosis Y/ N

Clubbing: Y/ N Lymphadenopathy: Y/ N Oedema: Y/ N

E.N.T EXAMINATION

- **Oral Cavity :**

  Mouth opening: Adequate/ Trismus Grade of Trismus (if any):

  Oro – dental Hygiene: Poor/ Satisfactory Nicotine stains: Y/ N

  Site: Buccal mucosa/ Retromolar Trigone/Gingivo-buccal Sulcus/lower gingiva

  Side: Right/ Left/ Both

Type of Lesion: Leukoplakia/ Erythroplakia/ Erythroleukoplakia/ Lichen planus/

Oral Submucous Fibrosis/ Verrucous/ Ulceroproliferative/ Ulcerative

Bimanual palpation of tumour:

Tumour mobility over mandible: Y/N

Fixity of tumour over mandible: Y/N

Dimension:

Extent – Superior:

Inferior:

Medial:

Lateral:

Edge:

Tender: Y/ N

Skin involvement: Y/ N

Bleeds on touch: Y/ N

Level/ s involved: Number:

Size:

Mobile/ Fixed Consistency: Hard/ Firm

- **Nose :**

- **Ear :**

SYSTEMIC EXAMINATION

Cardio vascular system :

Respiratory system :

Abdomen :

Central nervous system :

CLINICAL DIAGNOSIS

INVESTIGATIONS

Hb: RBC: TC: Platelets: DC: N: L: M: E: B: Others:

BT: CT: HIV: Y/ N HbsAg: Y/ N RBS:

CT SCAN/USG NECK

BIOPSY REPORT

FNAC

TREATMENT

Surgery done:

☐ Wide excision

☐ Hemimandibulectomy

☐ Marginal mandibulectomy

☐
SOND MR☐ RND ☐

Date of surgery:

Intra-operative findings:

Histo-pathological report:

Of the primary tumour:

Histological type: squamous cell carcinoma

Histopathological garde:

☐ Well differentiated

☐ Moderately differentiated

☐ Poorly differentiated

Proximity of tumour:

Tumour bone infiltration:

Pattern of spread of tumour:

Involvement of cortical bone:

Involvement of marrow:

Bone Margins: Positive Negative

Surgical margins: Positive Negative

Lymph node status:

Total no of lymph node:

No of positive nodes:

Micro-metastasis (<2mm in diameter): Present Not identified

Extra-capsular spread: Present Not identified

pTNM staging :

INFORMED CONSENT FORM

I, Mr/Mrs have been explained in a language I can understand, that I will be included in a study which is evaluation of mandible for tumour involvement in the lower gingivo buccal sulcus squamous cell carcinoma.

I have been explained that my clinical finding, investigations, intraoperative findings and post-operative specimen will be assessed and documented for the study purpose.

I have been explained that my participation in this study is entirely voluntary and I can withdraw from the study anytime and this will not affect my relation with my doctor or the treatment for my ailment.

I have understood that all my details found during the study are kept confidential and while publishing or sharing of the findings, my details will be masked.

I, in my sound mind give full consent to be added in the part of this study.

Signature of the patient:

Name:

Signature of the witness:

Name:

Date: Place:

No	H.No :	age	sex	side	dentition	site	type of lesion	Diagnosis	T	N	M	skin involvement	type of mandibulectomy	Anterior Bony margin	Ant soft tissue margin	posterior soft tissue margin	Superior soft tissue margin	inferior soft tissue margin	Bony erosion in CT	Stage	Histological type	Invasive front	pTNM	Tumor Size	Max Tumor Thickness in HPE	Max depth of tumor invasion on HPE	No Of Positive Nodes on HPE	Bone involvement on HPE	Type of bone involvement onHPE	Follow up
1	254303	55	F	R	partialy edentulous	GBS/LG	ulceroproliferative	Ca Right Lower alveolus	T4a	N1	M0	yes	hemimandibulectomy	1.7cm	0.2cm	0.6cm	0.2cm	1.2cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	PT2N1M0	6.5x2.5x2cm	20mm	12mm	1	bone involved	Invasive type	-
2	302291	45	F	R	dentulous	BM/GBS/RMT	ulceroproliferative	Ca right Buccal Mucosa	T4a	N2b	M0	NO	hemimandibulectomy	1cm	2cm	4cm	1cm	1.8cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT4aN2bM0	2.5x1.5x0.8cm	8mm	5mm	3	Negative	NA	Death/other cause
3	209944	35	F	R	dentulous	BM/GBS/LG	ulceroproliferative	Ca right lower alveolus	T4a	N2b	M0	NO	hemimandibulectomy	2cm	0.3cm	3cm	2.5cm	1.9cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN2aM0	3x1x2cm	20mm	22mm	1	Negative	NA	-
4	207968	56	F	L	dentulous	Bm/GBS/LG	ulceroproliferative	Ca right Buccal Mucosa	T4a	N1	M0	NO	hemimandibulectomy	2.2cm	0.8cm	2cm	1.5cm	3.5cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT3N1M0	4.5x 2.5x3cm	30mm	12mm	1	Negative	NA	-
5	77216	45	F	L	dentulous	BM/GBS	ulceroproliferative	Ca left Buccal Mucosa	T3	N0	M0	NO	hemimandibulectomy	0.2cm	0.6cm	2cm	1.5cm	3.5cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	4.5x3x1cm	10mm	8mm	0	Negative	NA	-
6	290502	40	F	R	dentulous	BM/GBS/RMT	ulceroproliferative	Ca right Buccal Mucosa	T4a	N2c	M0	NO	hemimandibulectomy	2cm	1.2cm	3.8cm	1.4cm	1cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN2bM0	4x3x0.5x2cm	22mm	25mm	2	bone involved	Invasive type	-
7	102724	75	F	L	edentulous	BM/GBS	ulceroproliferative	Ca left Buccal Mucosa	T2	N1	M0	NO	marginalmandibulectomy	1.7cm	1cm	0.3cm	0.7cm	0.5cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	2.2x2x1.5cm	15mm	7mm	0	Negative	NA	-
8	84111	60	F	L	dentulous	BM/GBS	ulceroproliferative	Ca left Buccal Mucosa	T3	N0	M0	NO	hemimandibulectomy	4cm	0.3cm	1.8cm	4cm	1cm	Absent	III	Moderately differentiated squamous cell carcinoma	Noncohesive	pT1N0M0	1X1x0.3cm	3mm	3mm	0	Negative	NA	-
9	133670	60	F	L	dentulous	BM/GBS	ulceroproliferative	Ca left Buccal Mucosa	T4a	N2c	M0	YES	hemimandibulectomy	0.8cm	0.8cm	4.5cm	0.5cm	0.9cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	PT2N0M0	3x2x2.5cm	25mm	8mm	0	Negative	NA	-
10	89014	45	F	L	dentulous	GBS	ulceroproliferative	Ca left Buccal Mucosa	T2	N2a	M0	NO	marginalmandibulectomy	2cm	0.5cm	0.5cm	0.5cm	1.3cm	Absent	IVA	Moderately differentiated squamous cell carcinoma	Cohesive	pT1N1M0	1.5x1x2.cm	20mm	5mm	1	Negative	NA	-
11	98125	40	M	L	dentulous	BM/GBS/LG	ulceroproliferative	Ca left Buccal Mucosa	T4a	N1	M0	NO	hemimandibulectomy	1.5cm	2cm	2.5cm	1.5cm	2.2cm	EROSION	IVA	Moderately differentiated squamous cell carcinoma	Cohesive	pT2N0M0	3x2x1.5cm	15mm	8mm	0	bone involved	Invasive type	-
12	107768	65	F	L	partialy edentulous	BM/GBS	ulceroproliferative	Ca left Buccal Mucosa	T3	N0	M0	NO	hemimandibulectomy	1.1 cm	0.8cm	0.5cm	0.2cm	1.6cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT3N0M0	5x3x0.5cm	5mm	2mm	0	Negative	NA	-
13	146868	45	F	R	dentulous	BM/GBS	ulceroproliferative	Ca right Buccal Mucosa	T2	N2a	M0	NO	marginalmandibulectomy	1.5cm	0.9mm	2cm	1.6cm	2.7cm	Absent	IVA	liquefaction and suppurative degeration	Cohesive	pT2N0M0	3x4x2cm	22mm	5mm	0	Negative	NA	-
14	106142	45	F	L	dentulous	BM/GBS/RMT	ulceroproliferative	Ca left Buccal Mucosa	T4a	N2a	M0	Yes	hemimandibulectomy	2.5cm	0.5cm	0.8cm	0.8cm	1.6cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	2.2x1.5x2.2m	22mm	10mm	0	Negative	NA	-
15	76003	45	F	R	dentulous	BM/GBS	ulceroproliferative	Ca right Buccal Mucosa	T4a	N2a	M0	YES	hemimandibulectomy	0.7cm	0.3cm	3cm	1cm	3.5cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	3.2x2.4x1.5cm	15mm	9mm	0	Negative	NA	-
16	127365	82	F	R	edentulous	GBS/LG	ulceroproliferative	Ca Right Lower alveolus	T3	N1	M0	NO	hemimandibulectomy	2.7cm	0.7cm	1cm	1.8cm	0.5cm	ABUTS	III	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	2.6x1.7x1.5cm	15mm	22mm	0	Negative	NA	-
17	134922	35	M	L	dentulous	BM/GBS	ulcerative	Ca Left Buccal mucosa	T3	N1	M0	NO	hemimandibulectomy	2cm	2cm	6.8cm	1.4cm	1.4cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	1.5x1x1.8cm	18mm	21mm	0	Negative	NA	-
18	192406	46	F	L	dentulous	BM/GBS/RMT	ulceroproliferative	Ca left Buccal Mucosa	T3	N1	M0	NO	hemimandibulectomy	2cm	2cm	0.8cm	0.2cm	0.8cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT3N0M0	4.5x4.5x2.0cm	20mm	12mm	0	Negative	NA	-
19	132753	62	F	R	edentulous	BM/GBS/RMT	ulceroproliferative	Ca right lower gingivobuccal sulcus	T3	N0	M0	NO	hemimandibulectomy	1.5cm	1 cm	5cm	0.7cm	2.5cm	ABUTS	III	Moderately differentiated squamous cell carcinoma	Cohesive	pT3N0M0	3.5x2x1.5cm	15mm	5mm	0	Negative	NA	-
20	149637	45	F	L	dentulous	BM/GBS	ulceroproliferative	Ca left buccal mucosa with gingivobuccal sulcus	T4a	N1	M0	YES	hemimandibulectomy	2cm	2cm	1.5cm	2cm	2.2cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT3N1M0	4.3x4x2.5cm	25mm	8mm	1	Negative	NA	-
21	154812	65	F	L	partialy edentulous	BM/GBS	ulceroproliferative	Ca left buccal mucosa	T3	N0	M0	NO	hemimandibulectomy	2cm	0.5cm	2cm	0.5cm	1.2cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT3N0M0	4x3x1.0cm	10mm	5mm	0	Negative	NA	-
22	233148	43	F	R	dentulous	GBS/LG	ulcerative	Ca right lower alveolus	T3	N1	M0	NO	hemimandibulectomy	3cm	0.3cm	1.5cm	0.8cm	0.5cm	ABUTS	III	Moderately differentiated squamous cell carcinoma	Cohesive	pT3N0M0	4x3x2.5cm	25mm	8mm	0	Negative	NA	-
23	195419	63	F	L	partialy edentulous	BM/GBS/LG	ulceroproliferative	Ca Left lower alveolus	T4a	N1	M0	NO	hemimandibulectomy	1.2cm	1.8cm	2cm	1cm	2.7cm	Absent	IVA	Moderately differentiated squamous cell carcinoma	Cohesive	pT2N0M0	3x2x2cm	20mm	10mm	0	Negative	NA	-
24	175050	42	F	R	dentulous	BM/GBS	ulceroproliferative	Ca Right buccal mucosa	T4a	N1	M0	YES	hemimandibulectomy	4.56cm	0.2cm	1cm	2.5cm	3.1cm	Absent	IVA	well differentiated squamous cell carcinoma	Noncohesive	pT2N0M0	2.5x1.5x1.8cm	18mm	13mm	0	Negative	NA	-
25	202488	65	M	L	dentulous	BM	ulceroproliferative	Ca left buccal mucosa	T4a	N0	M0	YES	hemimandibulectomy	2cm	1.2cm	1.1cm	1.5cm	1cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN0M0	2x1.5x2.5cm	25mm	20mm	0	Negative	NA	-
26	210128	70	M	R	partialy edentulous	BM/GBS	ulceroproliferative	Ca right lower gingivo buccal sulcus	T4a	N2b	M0	YES	hemimandibulectomy	1.1cm	5cm	4cm	1.5cm	2.1cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN2aM0	3.5x3.5x2cm	20mm	24mm	1	bone involved	Invasive type	Local recurrence
27	137704	49	F	R	dentulous	BM/GBS	ulceroproliferative	involving gingivobuccal sulcus	T4a	N2a	M0	YES	hemimandibulectomy	1.5cm	2cm	2.7cm	2cm	2.2cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT2N1M0	3x2x2cm	20mm	15mm	1	Negative	NA	-
28	172342	50	M	R	dentulous	BM/GBS	ulcerative	Ca right buccal mucosa	T4a	N2b	M0	YES	hemimandibulectomy	1 cm	1.4cm	3.5cm	2cm	2cm	Absent	IVA	Moderately differentiated squamous cell carcinoma	Cohesive	pT4aN2bM0	4x3x2.5cm	22mm	15mm	1	Negative	NA	-
29	245886	40	M	L	dentulous	BM/RMT	ulcerative	Ca left buccal mucosa	T4a	N0	M0	NO	hemimandibulectomy	4cm	3.5cm	2.5cm	1cm	1.7cm	Absent	IVA	well differentiated squamous cell carcinoma	Cohesive	pT3N0M0	2.1x0.5x2.5cm	25mm	9mm	0	Negative	NA	-
30	242458	40	M	L	dentulous	BM/GBS	ulceroproliferative	Ca left lower alveolus	T4a	N1	M0	NO	hemimandibulectomy	3cm	3cm	1cm	0.8cm	0.5cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN0M0	1x0.8x2.2cm	22mm	10mm	0	bone involved	Invasive type	-
31	190010	38	F	L	dentulous	BM/GBS/LG	ulcerative	Ca left gingivo buccal sulcus	T4a	N2a	M0	NO	hemimandibulectomy	4cm	1.6cm	4cm	2cm	1cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT1N0M0	1x0.5x2.5cm	25mm	7mm	0	Negative	NA	-
32	207968	56	F	L	dentulous	BM/GBS	ulceroproliferative	Ca Left lower alveolus	T4a	N1	M0	NO	hemimandibulectomy	2cm	1.4cm	3.5cm	2 cm	0.5cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT2N0M0	2.5x1.4x2cm	20mm	8mm	0	Negative	NA	-
33	187119	45	F	R	dentulous	BM/GBS	ulcerative	Ca right buccal mucosa	T3	N0	M0	NO	hemimandibulectomy	2.8cm	1.5cm	2.5cm	0.2cm	1.5cm	Absent	III	well differentiated squamous cell carcinoma	Cohesive	pT3N0M0	5x3x2.2cm	22mm	7mm	0	Negative	NA	-
34	200982	58	M	R	dentulous	BM/GBS	ulceroproliferative	Ca right buccal mucosa	T4a	N1	M0	NO	hemimandibulectomy	0.5cm	0.8cm	0.3cm	1.8cm	0.2cm	Absent	IVA	well differentiated squamous cell carcinoma	Noncohesive	pT2N2bM0	3x2x1.8cm	18mm	9mm	2	Negative	NA	Metastasis/death
35	225949	65	M	R	partialy edentulous	BM/GBS	ulceroproliferative	Ca right lower gingivobuccal sulcus	T4a	N1	M0	YES	hemimandibulectomy	2.5cm	2cm	3.5cm	2cm	2cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN1M0	3.5x3.5x2cm	20mm	10mm	1	bone involved	Invasive type	-
36	247143	55	F	L	dentulous	Bm/GBS	verrucous lesion	Ca left buccal mucosa	T3	N1	M0	NO	hemimandibulectomy	1.5cm	1cm	1.4cm	0.6cm	1cm	Absent	III	verrucous squamous cell carcinoma	Noncohesive	pT3N0M0	4.5x3x1cm	10mm	5mm	0	Negative	NA	-
37	227014	35	F	R	dentulous	BM/GBS	ulceroproliferative	Ca right lower alveolus	T4a	N2b	M0	yes	hemimandibulectomy	2.5cm	2cm	4cm	0.8cm	0.5cm	ABUTS	IVA	well differentiated squamous cell carcinoma	Cohesive	pT4aN1M0	4x3x2.2cm	22mm	10mm	1	bone involved	Invasive type	-
38	305515	60	F	R	dentulous	BM/GBS/RMT	ulceroproliferative	Ca Right Lower alveolus	T4a	N1	M0	Yes	hemimandibulectomy	2.4cm	2cm	1cm	1.5cm	0.5cm	EROSION	IVA	well differentiated squamous cell carcinoma	Cohesive	PT4aN0M0	2.5x1x2.5cm	25mm	20mm	0	bone involved	Invasive type	-