

**THE FREQUENCY AND DISTRIBUTION PATTERN OF
MINOR SALIVARY GLAND TUMORS IN A GOVERNMENT
DENTAL TEACHING HOSPITAL, CHENNAI, INDIA.**

Dissertation submitted to
THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY
towards the partial fulfillment for the degree of
MASTER OF DENTAL SURGERY



BRANCH – IV
ORAL PATHOLOGY & MICROBIOLOGY

MARCH 2009

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled “**The Frequency and Distribution Pattern of Minor Salivary Gland Tumors in a Government Dental Teaching Hospital, Chennai, India.**” is a bonafide and original research work done under the guidance of **Dr. I. Ponniah, MDS.**, Associate Professor, Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital, Chennai - 600 003. I also declare that this work was done after careful and thorough analysis not amounting to any sort of plagiarisms or ethical deviations based on the retrospective records (1971 – 2008) of the Department of Oral Pathology and Microbiology.

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled “**The Frequency and Distribution Pattern of Minor Salivary Gland Tumors in a Government Dental Teaching Hospital, Chennai, India.**” is a bonafide research work done by **Dr. N.V. Vani** towards the partial fulfillment of the requirement for the degree of **MASTER OF DENTAL SURGERY** in the speciality of **ORAL PATHOLOGY AND MICROBIOLOGY (Branch IV)**, under my constant supervision and critical evaluation.

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ENDORSEMENT BY THE PRINCIPAL / HEAD OF THE INSTITUTION

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DECLARATION

I **Dr. N. V. Vani**, do hereby declare that the dissertation titled “**The Frequency and Distribution Pattern of Minor Salivary Gland Tumors in a Government Dental Teaching Hospital, Chennai, India.**” was done based on the archival samples and records (Department of Oral Pathology & Microbiology, Tamil Nadu Government Dental College & Hospital, Chennai 600 003) in partial fulfillment of the requirements for the degree of **Master of Dental Surgery** in the speciality of **Oral Pathology & Microbiology (Branch IV)** during the course period **2006-2009** under the conceptualization and guidance of my dissertation guide, **Dr. I. Ponniah, MDS.**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

Signature of the PG student

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ABSTRACT

Objectives:

The purpose of this study was to determine the relative frequency and distribution of minor salivary gland tumors and to provide data with respect to age, sex and anatomic location. To compare these data with epidemiologic findings from different geographic locations.

Study Design:

The retrospective records of the Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital, Chennai, south India, served as a source of material for this study. All cases of salivary gland tumors reported over a period of 37 years were retrieved and reviewed.

Results:

Minor salivary gland tumors accounted for 185 cases (1.52% of all oral lesions) with a steady increase in the incidence rate. The malignant tumors (75.1%) were predominant over the benign tumors (24.9%). The tumors were distributed over a wide age range, with a mean age of 46.11 ± 13.92 years and a peak incidence in the fifth and sixth decades of life. Male predominance was observed with a male to female ratio of 1.12:1. Palate (48.6%) was the most commonly involved site. Pleomorphic adenoma (21.6%) was the most common benign tumor and the most common malignant tumor was mucoepidermoid carcinoma (34.1%) followed by adenoid cystic carcinoma (15.7%) and polymorphous low-grade adenocarcinoma (9.7%).

Conclusion:

The present study reports a higher incidence (1.52%) of minor salivary gland tumors compared to other studies, with a predominance of malignant tumors. Our study observed both regional and geographic variation in the frequency and distribution of MSGT.

Keywords:

Minor salivary gland tumors; India; Incidence; Chennai; Cancer registry; Benign salivary gland tumors; Malignant salivary gland tumors.

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INTRODUCTION

Salivary gland tumors constitute a heterogeneous group of lesions with varying histomorphologic features. They are uncommon constituting about 3% of all neoplasms.¹ Approximately 80% of salivary gland tumors are found in the parotid gland, 10 to 15% in the submandibular gland and 5 to 10% in minor salivary glands.² The annual incidence of salivary gland tumors varies around the world from approximately 0.4 to 13.5 cases per 100,000 people.³

Salivary glands are divided into major and minor salivary glands according to their size. Three pairs of major salivary glands – parotid, submandibular and sublingual glands are located extra orally and their secretions reach the oral cavity through their ductal systems. About 600 to 1000 minor salivary glands are located throughout the oral cavity except in gingiva and anterior part of the hard palate. Labial, lingual, palatal, buccal, glosso palatine and retromolar glands are located in the sub mucosal layer as discrete aggregates with short ducts opening directly onto the mucosal surface.⁴ About 450 minor salivary glands are found in the hard palate, 220 in soft palate and 8 in uvula.⁵

According to the data provided by Armed Forces Institute of Pathology, minor salivary gland tumors account for about one fourth of all salivary gland tumors.³ The relative frequency and distribution of these tumors shows variation in several studies from different parts of the world.

The global incidence of salivary gland tumors can be ascertained based on the documented literature.^{1-3, 7-15, 17-49} On the other hand, the overall incidence of salivary gland tumors among Indian population can be ascertained from cancer registries^{7, 8} across the country and few published hospital based studies.^{2, 9-15} Cancer registry of India dates back to 1963 and is one of the oldest tumor registries of Asia⁶. Two types

of cancer registry are available in India - population based cancer registry (PBCR) and hospital based cancer registry (HBCR). Population based cancer registry collects data actively from all the healthcare facilities including pathology reports, medical records, radiology and radiotherapy departments and through death certificates in a defined geographical area providing data on cancer cases confined to that area, whereas hospital based cancer registry collects data passively on all cancer patients attending a particular hospital as per standardized proforma and such data from all the healthcare centers in a defined geographical area results in pooling of data for population based cancer registry.⁷ Generally, the rate of incidence of cancer cases is assessed based on the data provided by these registries, though the geographical area and population covered by these registries are small as compared to the large area and population of India.

Under the national cancer registry programme (NCRP), the Indian council of medical research commenced a network of cancer registries across the country in December 1981. The reports of NCRP become the standard work of reference both within the country and abroad as well.⁷ A consolidated report of the population based cancer registries for the year 2001- 2004 was published by the NCRP, ICMR in December 2006 with regard to the incidence and distribution of cancer cases. This report covers the data of six population based cancer registries which includes Bangalore, Bhopal, Chennai, Delhi, Mumbai and Barshi for the year 2001-2003 and Ahmedabad PBCR for the year 2004.⁷ Coding of diseases in these registries is done according to the international classification of diseases (WHO, ICD-10) to facilitate comparison of data from registries across the world. Salivary gland tumors were coded as ICD-10 C07-8 and only malignant tumors of salivary glands were registered in these cancer registries.⁷

Although the geographical area and population covered by these cancer registries is limited, they give an approximate frequency of salivary gland tumors. The population based cancer registry at Bangalore, covers an area of 365.7 sq kms and an estimated urban population of 6.2 millions as on 2003. The incidence of salivary gland tumors registered during 2001-2003 was 45 in males and 22 in females accounting for 0.74% and 0.3% respectively.⁷ Similarly, the rural cancer registry at Barshi covers a total population of about 0.4 million in 346 villages spread over an area of 3713 sq km. The incidence of salivary gland tumors stated for the year 2001-2003 was about 5 cases in males accounting for 1.58% with none in females, showing exclusive predilection for males than compared to other registries.⁷

The Bhopal cancer registry covers a total area of 286 sq km with a population of about 4.6 million and the incidence of salivary gland tumors registered during 2001-2003 was 6 in males and 3 in females, accounting for 0.38% and 0.21% respectively.⁷ On the other hand, population based cancer registry of Delhi covers an urban area of 891.09 sq km with an estimated population of about 13.6 millions. The incidence of salivary gland tumors was about 124 males and 86 females accounting for 0.77% and 0.56% respectively, during the same period.⁷

The Bombay cancer registry covers a population of about 11.9 million occupying an area of 603 sq km. The incidence of salivary gland tumors stated for 2001-2003 was about 81 in males and 58 in females which accounted for 0.59% and 0.42% respectively.⁷ Likewise, the incidence of salivary gland tumors reported in 2004 was 2 in males and 2 in females with 0.48% and 0.76% respectively, according to the rural cancer registry of Ahmedabad district covering an area of 7677 sq km with a population of 1.56 million people.⁷

The Madras metropolitan tumour registry (MMTR) of Chennai caters to an

area of 170 sq km with a population of about 4.3 million as on March 2001. The completeness of registration of cancer cases in MMTR is estimated to be 96%. The incidence of salivary gland tumors registered during 2001-2003 was 0.55% in males and 0.37% in females.⁷ In a more recent report published by MMTR, the incidence of salivary gland tumors has increased to 0.63% in males and 0.45% in females during the year 2003-2005.⁸

Other than the incidence of salivary gland tumors provided by the cancer registries, there has been only few recorded analysis of salivary gland tumors on Indian population. Four hospital based retrospective studies were conducted and published from southern part of India.^{9, 10, 11, 12} Likewise, four more hospital based retrospective studies were also conducted and published from northern^{2, 13} and southwestern part of India.^{14, 15} These studies have either combined both major and minor salivary gland tumors or was based only on the malignant salivary gland tumors.^{2, 9-13, 15} The salivary gland data from the cancer registries are concerned only with the cancer positive cases and not inclusive of all salivary gland tumors.^{7, 8} Therefore it would be prudent to obtain data on the relative frequency of minor salivary tumors from the oral pathology biopsy register of institutions that caters to the dental needs of large population.

Although there are approximately 10 dental teaching hospitals in Chennai, the Tamil Nadu Government Dental College and Hospital under the Ministry of Health and Family welfare, Government of Tamil Nadu is the only and the oldest tertiary referral center for dental health. It caters to the dental needs of the population of Chennai which is located on the southeast coast of India with an estimated population of 7.5 million as on 2007¹⁶ as well as from other parts of Tamil Nadu and border areas of Andhra Pradesh. It may be noted that this was formerly known as Dental Wing of

Madras Medical College and Government General Hospital. The Dental Wing became a separate college to be re-christened as Madras Dental College and then as Tamil Nadu Government Dental College and Hospital.

Studies conducted on a large number of cases from a single source using current classification and accepted diagnostic criteria will help to determine the appropriate relative frequency of minor salivary gland tumors. Therefore, it was decided to retrieve all cases that were coded as salivary gland tumors from the histopathology register of the Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital, Chennai – 600003, South India. The institution based study not only provides details of patients information and diagnosis but also provides opportunity to re-assess the histopathological diagnosis compared to population based cancer registries, which provides information obtained from various sources with a greater chance of repetition of cases and a possibility of over diagnosis or under diagnosis.

The purpose of this study is to determine the relative frequency and distribution of both the benign and malignant tumors of minor salivary gland origin and to provide data with reference to age, sex, site and histologic subtypes of these lesions from 1971 to 2008 and to compare these data with epidemiologic findings from different geographic locations.

AIMS AND OBJECTIVES

1. To determine the relative frequency and distribution of benign and malignant tumors of minor salivary gland origin.
2. To provide data with reference to age, sex, anatomic location and histologic subtypes of these lesions reported in the Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital, Chennai, South India from 1971 to 2008.
3. To compare these data with epidemiologic findings from different geographic locations.

REVIEW OF LITERATURE

OVERALL INCIDENCE

Fine et al in 1960¹⁷ conducted a clinical and morphological study on 79 cases of minor salivary gland tumors for a period of 43 years (1916 to 1959). The benign tumors were about 42 (53.2%) cases with 25 (31.6%) cases of pleomorphic adenoma, 10 (12.6%) cases of adenomas and 7 (9%) cases of myoepithelial adenoma. There were 37 (46.8%) malignant neoplasms with 20 (25.2%) cases of mucoepidermoid carcinomas, 13 (16.4%) cases of adenoid cystic carcinoma, 1(1.3%) case of adenocarcinoma, mucous carcinoma, acinus cell carcinoma and unclassified lesion each. The benign tumors were predominant over malignant tumors in their study.

Wallace et al in 1963¹⁸ studied 14 salivary gland tumors that occurred over a period of 9 years in Canadian Eskimos. Only 3 (21.4%) of them were benign mixed tumors and 11 (78.6%) were malignant which constituted 28% of all cancer cases. Among the malignant tumors, 1(7.1%) was adenoid cystic carcinoma and malignant papillary cystadenoma lymphomatosum each and 9 (64.3%) were undifferentiated carcinomas.

Davies et al in 1964¹⁹ analyzed a series of 129 salivary gland tumors in Uganda Africans. Almost 25 cases (19.4%) were reported in palate and 8 in other minor salivary glands (6.2%). There were 19 (14.7%) cases of pleomorphic adenoma, 1 (0.78%) case of malignant mixed tumor, 2 (1.5%) cases of mucoepidermoid carcinoma and anaplastic carcinoma each, 4 (3.1%) cases of adenoid cystic carcinoma and 5 (3.9%) cases of adenocarcinoma.

Potdar et al in 1969¹⁴ analyzed the clinical behavior and management of 110 cases of minor salivary gland tumors in Bombay, India over a period of 25 years

(1941-1965). About 110 cases of minor salivary gland tumors were recorded which constituted about 31% of all salivary gland tumors. Benign tumors were 49% and consisted entirely of pleomorphic adenoma, while malignant tumors accounted for 51%. Adenoid cystic carcinoma was the most common malignant tumor with 41 cases (37.4%) followed by 7 cases (6.4%) of mucoepidermoid carcinoma, 4 cases (3.6%) each of malignant mixed tumor and adenocarcinoma.

Dhawan et al in 1970²⁰ conducted a study on central salivary gland tumors at All India institute of medical sciences, New Delhi, India over a period of 6 years (1962-1968). Nine cases were reported with 5 cases in maxilla and 4 in mandible. Adenoid cystic carcinoma was the most common tumor with 4 cases followed by 3 cases of mucoepidermoid carcinoma and 2 cases of adenocarcinoma.

Eneroth et al in 1971²¹ reviewed and reclassified 2,867 salivary gland tumors in the parotid gland, submandibular gland and the palate region for a period of 50 years (1919 to 1969). A total of 2,513 cases were classified as salivary gland tumors. Of these, 185 cases were found in palate with 98 cases of pleomorphic adenoma (53%) and 87 cases of malignant tumors (47%) which included 44 adenoid cystic carcinoma (24%), 30 mucoepidermoid carcinoma (16%), 3 (1.6%) carcinoma ex pleomorphic adenoma, 2 (1.08%) acinic cell carcinoma, 7 (3.8%) mucus-producing adenopapillary carcinoma and 1 (0.54%) solid undifferentiated carcinoma.

Spiro et al in 1973²² analyzed 492 cases of minor salivary gland tumors clinicopathologically for a period of 25 years (1939 to 1963). Benign tumors were about 58 cases (11.8%) with 57 cases of pleomorphic adenoma (11.6%) and a single case (0.2%) of oncocytoma. Malignant tumors were most common and accounted for 88.2% (434 cases). Among them, adenoid cystic carcinoma was the most common tumor with 174 cases (35.4%), followed by 106 cases of solid duct carcinoma

(21.5%), 76 cases of mucoepidermoid carcinoma (15.5%), 16 cases of mucus adenocarcinoma (3.3%), 14 cases of oat cell carcinoma (2.9%), 13 cases of malignant mixed tumor (2.6%), 12 cases of colonic-type carcinoma (2.4%), 7 cases of papillary-cystic carcinoma (1.4%), 5 cases of clear cell adenocarcinoma (1.0%), 2 cases of papillary adenocarcinoma (0.4%), 1 case of spindle cell carcinoma (0.2%) and 6 unclassified tumors (1.2%).

Thomas et al in 1980²³ studied 190 cases of salivary gland tumors in Malawi over a period of nine years (1969 to 1977). In this study, minor salivary gland tumors constituted about 49 cases (25.7%) with 32 (65.3%) cases of pleomorphic adenoma, 2 (4.1%) cases of carcinoma in pleomorphic adenoma, 6 (12.2%) cases of undifferentiated carcinoma and adenoid cystic carcinoma each, 2 (4.08%) cases of mucoepidermoid carcinoma and 1(2.04%) case of hemangioma. The crude annual incidence of salivary gland tumors in this population was 0.43 per 100,000.

Isacson et al in 1983²⁴ reported 201 cases of minor salivary gland tumors with 145 (72.5%) benign and 56 (27.5%) malignant tumors over a period of 21 years (1958 to 1979). Pleomorphic adenoma was the most common benign tumor with 69.6% followed by 2.4% of monomorphic adenoma. Among the malignant tumors, adenoid cystic carcinoma (10.4%) was most common followed by adenocarcinomas (7.4%), mucoepidermoid carcinoma (6.4%), carcinoma in pleomorphic adenoma (2.4%) and epidermoid carcinoma (0.9%)..

Chaudhary et al in 1984²⁵ conducted a clinico-pathologic and histogenetic study of 189 intraoral minor salivary gland tumors over a period of 18 years (1964 to 1982). 101 cases (53.4%) were diagnosed as benign tumors and 88 cases (46.6%) as malignant tumors. Pleomorphic adenoma was the most common benign tumor with 92 cases (48.7%) followed by 4 cases (2.1%) of monomorphic adeneoma and a single

case (0.5%) of oncocytoma. Of 88 malignant tumors, mucoepidermoid carcinoma was the most common tumor with 64 cases (33.9%) as compared to 19 (10%) cases of adenoid cystic carcinoma. 4 cases (2.1%) were diagnosed as carcinoma ex pleomorphic adenoma and 1 case (0.5%) as secondary acinic cell carcinoma.

Eveson et al in 1985²⁶ conducted a demographic study on 2410 cases of primary epithelial salivary gland tumors. A total of 336 minor salivary gland tumors were recorded which accounted for 14% of salivary gland tumors. The benign tumors comprised 53.6%, with pleomorphic adenoma being 42.6% and 11% of monomorphic adenoma. The malignant salivary gland tumors comprised 46.4%, with adenoid cystic carcinoma (13.1%) being the most common followed by adenocarcinoma (11.9%), mucoepidermoid carcinoma (8.9%), carcinoma in situ (7.1%), undifferentiated carcinoma (2.1%), acinic cell carcinoma (1.8%) and squamous cell carcinoma (1.2%).

Regezi et al in 1985²⁷ conducted a histologic and immunohistochemical study over a period of 19 years (1964 to 1983). A total of 238 (0.33%) cases of minor salivary gland tumors were retrieved from 72,282 oral lesions. The incidence of minor salivary gland tumors in their study was 0.3%. Of the 150 (63.03%) benign tumors, 119 (50%) were pleomorphic adenoma, 30 (12.60%) monomorphic adenomas which included 23(9.66%) cases of canalicular adenoma, 2 (0.84%) cases of oncocytoma and sialadenoma papilliferum each and 4 (1.68%) cases of inverted ductal papillomas. Out of 88 (36.97%) malignant tumors, 55 (23.11%) were mucoepidermoid carcinomas, 30 (12.60%) adenoid cystic carcinoma, one (0.42%) epithelial-myoepithelial carcinoma and 2 (0.84%) cases of adenocarcinoma NOS.

Chau et al in 1986²⁸ conducted a retrospective study on 98 cases of intraoral minor salivary gland neoplasms over a period of 16 years (1968 to 1984). They observed 61 cases of benign tumors (62%), out of which 53 (54.08%) were

pleomorphic adenomas and 8 (8.16%) monomorphic adenomas. Of the 37 malignant tumors (38%), 19 (19.4%) were mucoepidermoid carcinomas, 12 (12.24%) adenoid cystic carcinomas, 4 (4.08%) adenocarcinomas and a single case (1.02%) of carcinoma ex pleomorphic adenoma and epidermoid carcinoma each.

Waldron et al in 1988²⁹ conducted a demographic and histologic study on 426 minor salivary gland tumors. Benign tumors accounted for 57.5% and malignant tumors were 42.5% in their series. Pleomorphic adenoma was the most common neoplasm with 174 cases (40.8%) followed by 46 cases (10.7%) of monomorphic adenomas which included 26 cases (6.1%) of canalicular adenoma and 13 cases (4.6%) of basal cell adenoma, 20 cases (4.6%) of cystadenomas and 5 cases (1.1%) of sialadenoma papilliferum. Mucoepidermoid carcinoma was the most common malignant tumor with 65 cases (15.2%) which was followed by 47 cases (11%) of polymorphous low-grade adenocarcinoma, 40 cases (9.3%) of adenoid cystic carcinoma, 15 cases (3.5%) of acinic cell carcinoma, 6 cases (1.6%) of carcinoma ex pleomorphic adenoma, 2 cases (0.6%) of clear cell carcinoma and 6 cases (1.6%) of adenocarcinoma.

Takahashi et al in 1990³⁰ conducted a demographic and histologic study of 200 cases of intraoral minor salivary gland tumors. Benign tumors accounted for 127 cases (63.5%) with 124 cases (62%) of pleomorphic adenomas and 3 cases (1.5%) of monomorphic adenomas which included 2 (1%) cases of basal cell adenoma and 1(0.5%) case of oncocytoma. The malignant tumors were about 73 cases (36.5%) represented by 33 (16.5%) adenoid cystic carcinoma, 16 (8.0%) mucoepidermoid carcinoma, 10 (5%) carcinoma ex pleomorphic adenoma, 6 (3%) acinic cell carcinoma, 5 (2.5%) adenocarcinomas and a single cases of (0.5%) polymorphous low-grade adenocarcinoma, undifferentiated carcinoma and clear cell carcinoma each.

Van Heerden et al in 1991³¹ studied retrospectively 70 cases of intraoral minor salivary gland neoplasms in an African population for a period of 8 years. Out of which, 34 cases (48%) were classified as benign and 36 cases (52%) as malignant tumors. All the benign tumors were pleomorphic adenoma, while polymorphous low-grade adenocarcinoma was the most common malignant tumor with 11 cases which accounted for 15.7% of MSGT. Adenoid cystic carcinoma was the second most common malignant tumor with 9 cases (12.8%) followed by mucoepidermoid carcinoma with 6 cases (8.6%), carcinoma ex pleomorphic adenoma with 5 cases (7.1%), adenocarcinoma NOS with 3 cases (4.2%) and a single case (1.4%) of epithelial-myoepithelial carcinoma and undifferentiated carcinoma each.

Rippin et al in 1992³² studied 194 cases of intra-oral salivary gland tumors in United Kingdom for a period of 13 years (1975 to 1988). Benign tumors were 106 cases (55%) whereas 88 cases (45%) were malignant. Pleomorphic adenoma was the most common benign tumor with 77 cases (40%). This was followed by 21 cases (11%) of monomorphic adenoma, 4 cases (2%) of oncocytoma and papillary cystadenoma each. Adenoid cystic carcinoma was the most common malignant tumor with 37 cases (19%) followed by 33 cases (17%) of mucoepidermoid carcinoma, 16 cases (8%) of adenocarcinoma and 2 cases (1%) of undifferentiated carcinoma.

Van der wal et al in 1992³³ reclassified 101 minor salivary gland tumors histologically over a period of 18 years (1970 to 1988). Benign tumors were 42 cases (42%) and the remaining 59 cases (58%) were malignant. Pleomorphic adenoma was the most common benign tumor with 33 cases (33%) followed by 4 cases (4%) of myoepithelioma, 3 cases (3%) of canalicular adenoma and 1 case (1%) of basal cell adenoma and intraductal papilloma each. Among the malignant tumors, adenoid cystic carcinoma was the most common tumor with 27 cases (26%) followed by 13

cases (13%) of mucoepidermoid carcinoma, 8 cases (8%) of polymorphous low-grade adenocarcinoma, 4 cases (4%) of acinic cell carcinoma, 3 cases (3%) of adenocarcinoma NOS, 2 cases (2%) of carcinoma ex pleomorphic adenoma and 1 case (1%) of papillary cystadenocarcinoma and salivary duct cyst each.

Loyola et al in 1995³⁴ conducted a retrospective analysis on 164 cases of minor salivary gland tumors over a period of 23 years (1970 to 1993). Benign tumors accounted for 62% whereas malignant tumors were about 38%. Pleomorphic adenoma was the most common benign tumor which accounted for 53%, followed by 4% of cystadenoma, 2% of myoepithelioma and 1% of inverted ductal papilloma, basal cell adenoma and intraductal papilloma each. Among the malignant tumors, mucoepidermoid carcinoma was the most common tumor with 17% followed by 13% adenoid cystic carcinoma, 4% acinic cell carcinoma, 2% polymorphous low-grade carcinoma and 1% of epithelial myoepithelial carcinoma and adenocarcinoma each.

Rivera-Bastidas et al in 1996¹ performed a retrospective analysis on 62 cases of intraoral minor salivary gland tumors in Venezuelan population over a period of 24 years (1968 to 1992). Out of 9,000 cases, minor salivary gland tumors were about 62 cases (0.7%), with 34 cases (55%) being benign and 28 cases (45%) malignant. The incidence of MSGT in their study was 0.7%. Of the benign tumors, 24 (38.71%) were pleomorphic adenoma, 4 (6.45%) cystadenoma, 3 (4.84%) sialadenoma papilliferum, 2 (3.22%) basal cell adenoma and 1 case (1.61%) of inverted ductal papilloma. Among 28 malignant tumors, 18 (29.03%) were mucoepidermoid carcinoma, 6 (9.68%) adenoid cystic carcinoma and 2 cases (3.22%) of adenocarcinoma and undifferentiated carcinoma each.

Lopes et al in 1999³⁵ retrospectively studied 196 cases of intraoral minor salivary gland tumors from a pool of 40,000 head and neck lesions for a period of 39

years (1954 to 1993). The incidence of MSGT in their study was 0.4%. Out of 196 cases, 68 cases were benign and 128 malignant showing a predominance of malignant (65.3%) over benign (34.7%) tumors. Pleomorphic adenoma was the predominant benign tumor with 65 (33.16%) cases, followed by 3 (1.53%) cases of basal cell adenoma. The most common malignant tumor was mucoepidermoid carcinoma with 76 cases (38.78%), followed by 34 cases (17.35%) of adenoid cystic carcinoma, 9 cases (4.6%) of adenocarcinoma NOS, 3 cases (1.53%) of polymorphous low-grade adenocarcinoma, 2 (1.02%) cases of salivary duct carcinoma and papillary cystadenocarcinoma each and 1 (0.51%) case of acinic cell carcinoma and basal cell adenocarcinoma each.

Sousa et al in 2001¹⁵ analyzed 62 cases of salivary gland tumors at a tertiary referral center in Goa, India over a period of 10 years (1987-1997). Minor salivary gland tumors were 3 cases (4.8%) with 2 cases of pleomorphic adenoma and 1 case of adenoid cystic carcinoma.

Ahmad et al in 2002¹³ conducted a clinico-pathological study on 100 primary salivary gland tumors in Kashmir, India over a period of 2 years (1998 to 2000). Minor salivary gland tumors constituted about 12% with 66.6% benign and 33.4% malignant tumors. Pleomorphic adenoma was the most common benign tumor with 58.3% followed by 8.3% of myoepithelioma. Among the malignant tumors, adenoid cystic carcinoma was most common and accounted for 25% of minor salivary gland tumors followed by 8.4% of adenocarcinoma.

Jansisyanont et al in 2002³⁶ reported their experience on 80 cases of intraoral minor salivary gland tumors reported over a period of 10 years (1991 to 2001). Malignant tumors were predominant with 61 cases (76.3%) compared to 19 cases of benign tumors (23.7%). Pleomorphic adenoma was the most common benign tumor

with 17 cases (21.3%), followed by a single (1.25%) case of basal cell adenoma and canalicular adenoma each. Likewise, mucoepidermoid carcinoma was most common with 33 cases (41.3%), followed by 7 cases (8.8%) of adenoid cystic carcinoma, 3 cases (3.8%) of adenocarcinoma and acinic cell carcinoma each, 9 cases (11.3%) of polymorphous low-grade adenocarcinoma and 6 cases (7.5%) of undifferentiated carcinoma.

Vargas et al in 2002³⁷ retrospectively studied salivary gland tumors in Brazilian population for a period of 7 years (1993 to 1999). A total of 124 patients with 99 benign (80%) and 25 malignant (20%) tumors were diagnosed. Only 6 tumors (5%) were reported in minor salivary glands. Pleomorphic adenoma was the most common benign neoplasm with 2 cases being reported in minor salivary glands. A total of 4 malignant tumors were diagnosed in minor salivary glands with 3 cases of mucoepidermoid carcinoma and one case of adenoid cystic carcinoma.

Pandey et al in 2003⁹ analyzed 42 cases of malignant minor salivary gland tumors for a period of 17 years (1982 to 1999). Mucoepidermoid carcinoma was the most common tumor with 19 cases (45.2%), followed by 9 cases (21.4%) of adenoid cystic carcinoma, 7 cases (16.6%) of adenocarcinoma, 5 cases (11.9%) of mucin producing adenocarcinoma and 2 cases (4.8%) of undifferentiated carcinoma.

Sajeevan et al in 2003¹⁰ analyzed 30 cases of salivary gland lesions over a period of 9 years (1993 to 2001). Minor salivary gland tumors accounted for 16.6% occurring predominantly in palate. 50% were diagnosed as pleomorphic adenoma and 50% as mucoepidermoid carcinoma.

Dorairajan et al in 2004¹¹ conducted a retrospective study on salivary gland tumors at Madras Medical College and Research Institute, Government General Hospital, Chennai for a period of 10 years (1991-2001). A total of 436 salivary gland

tumors were diagnosed, with a male to female ratio of 3.3:1. Minor salivary gland tumors were about 27 cases (6%) with 8 cases being benign and the remaining 19 cases were malignant tumors. Adenoid cystic carcinoma was the most common malignant tumor with 9 cases (33.3%) followed by 7 cases (26%) of adenocarcinoma and 3 cases (11.1%) of mucoepidermoid carcinoma.

Hyam et al in 2004³⁸ studied retrospectively 30 cases of malignant minor salivary gland tumors over a period of 22 years (1980 to 2002). Adenoid cystic carcinoma was most common with 12 cases (40%) followed by 9 cases of mucoepidermoid carcinoma (30%), 6 cases (20%) of polymorphous low grade adenocarcinoma, 2 cases (7%) of adenocarcinoma and a single case (3%) of malignant salivary gland tumor of uncertain malignancy.

Kasangaki et al in 2004³⁹ studied retrospectively 142 cases of salivary gland tumors in Uganda population over a period of 12 years (1988 to 2000). These constituted about 7.5% of all oral neoplasms. Almost, 54.23% of cases were diagnosed as benign and 45.77% as malignant. Pleomorphic adenoma was the most common benign tumor and accounted for 77.9% followed by 18.18% of salivary gland adenoma and 3.9% of oncocytoma. Among the malignant salivary gland tumors, adenocarcinoma was most prevalent with 36.92%, followed by 27.69% of adenoid cystic carcinoma, 9.23% of mucoepidermoid carcinoma, 6.15% of mucous secreting carcinoma, 4.62% of acinic cell carcinoma and 3.08% of carcinoma ex pleomorphic adenoma.

Nagarkar NM et al in 2004² conducted a retrospective study on 36 salivary gland tumors in Government Medical College and Hospital, Chandigarh over a period of 4 years (1997 to 2001). Minor salivary gland tumors constituted about 25%, with 66.6% benign and 33.4% malignant tumors. Pleomorphic adenoma was the most

common tumor which accounted for 66.6% of all tumors, followed by 22.2% of adenoid cystic carcinoma and 11.1% of mucoepidermoid carcinoma.

Vuhahula in 2004⁴⁰ conducted a clinicopathological study on salivary gland tumors in Uganda over a period of 10 years (1979 to 1988). A total of 268 cases of salivary gland tumors were diagnosed, out of which 145 (54%) were benign and 123 malignant (46%) with a malignant to benign ratio of 1:1.18. Minor salivary gland tumors accounted for 88 cases (32.8%), with 41 benign (46.9%) and 47 malignant tumors (53.4%). Of the 41 benign minor salivary gland tumors, 28 were pleomorphic adenoma (68.3%), 8 myoepithelioma (19.5%), 1 basal cell adenoma (2.4%), 1 oncocytoma (2.4%) and 3 cystadenoma (7.4%). Among the 47 malignant minor salivary gland tumors, adenoid cystic carcinoma was most common with 18 cases (38.3%), followed by 9 cases (19.2%) of mucoepidermoid carcinoma, 5 cases (10.6%) of acinic cell carcinoma, 2 cases (4.3%) of epithelial-myoepithelial carcinoma, 7 cases (14.9%) of polymorphous low-grade adenocarcinoma, 3 cases (6.4%) of adenocarcinoma, 2 cases (4.3%) of carcinoma in pleomorphic adenoma and 1 cases (2.1%) of malignant myoepithelioma.

Lima et al in 2005⁴¹ conducted an epidemiological survey on salivary gland tumors over a period of 19 years (1980 to 1999). A total of 245 cases were reported which accounted for 0.15% of the all cases. Minor salivary gland tumors were about 46 cases (18.78%), with 24 (52.17%) benign tumors and 22 (47.83%) malignant tumors. Pleomorphic adenoma was the most common benign tumor with 23 (50%) cases, followed by a single (2.17%) case of canalicular adenoma. Among the malignant minor salivary gland tumors, adenoid cystic carcinoma was most common with about 8 cases (17.4%), followed by 6 (13.04%) cases of mucoepidermoid carcinoma, 3(6.52%) cases of acinic cell carcinoma, 4 (8.7%) cases of

adenocarcinoma and 1 (2.17%) case of carcinoma in pleomorphic adenoma.

Toida et al in 2005⁴² retrospectively studied 82 cases of intraoral minor salivary gland tumors over a period of 24 years (1979 to 2003). Out of these, 55 cases (67.1%) were benign tumors and 27 cases (32.9%) were malignant. The benign tumors consisted of 54 (65.85%) cases of pleomorphic adenoma and a single case (1.22%) of papillary cystadenoma. Among the malignant tumors, adenoid cystic carcinoma was most common with 10 cases (12.2%), followed by 8 cases (9.76%) of mucoepidermoid carcinoma, 3 cases (3.66%) of acinic cell carcinoma, 2 cases (2.44%) of adenocarcinoma and carcinoma in pleomorphic adenoma each, 1 case (1.22%) of basal cell adenocarcinoma and papillary cystadenocarcinoma each.

Yih et al in 2005⁴³ reviewed 213 cases of intraoral minor salivary gland neoplasms over a period of 37 years (1964 to 2001) and observed 119 benign tumors (56%) and 94 malignant tumors (44%). Pleomorphic adenoma was the most common benign tumor with 93 cases (43.66%), followed by 25 (11.74%) cases of canalicular adenoma and a single (0.47%) case of oncocytoma. The most common malignant neoplasm was mucoepidermoid carcinoma which represented 45 (21.13%) cases out of 94 malignant lesions. Adenoid cystic carcinoma was the second most common neoplasm with 22 (10.33%) cases followed by 18 cases (8.45%) of polymorphous low-grade adenocarcinoma, 4 cases (1.88%) of adenocarcinoma NOS, 2 cases (0.94%) of carcinoma ex pleomorphic adenoma, 1 case (0.47%) of acinic cell carcinoma, papillary cystadenocarcinoma and cystadenocarcinoma each.

Jaber et al in 2006⁴⁴ reviewed 75 cases of intraoral minor salivary gland tumors in Libyan population over a period of 23 years (1977 to 2000). The frequency of benign tumors was 38.6% (29 cases) and 61.3% for malignant tumors (46 cases). Pleomorphic adenoma was the most common benign tumor with 23 cases (30.6%)

followed by 3 (4%) cases of cystadenoma, 2 cases (2.6%) of basal cell adenoma, and 1 case (1.33%) of canalicular adenoma. The most common malignant tumor was mucoepidermoid carcinoma with 19 cases (25.3%), followed by 13 cases (17.3%) of adenoid cystic carcinoma, 8 (10.67%) cases of adenocarcinoma, 3 (4%) cases of polymorphous low-grade adenocarcinoma, 2 (2.6%) cases of carcinoma ex pleomorphic adenoma and one (1.33%) case of epidermoid carcinoma.

Buchner et al in 2007⁴⁵ conducted a retrospective study on 380 cases of intraoral minor salivary glands from a pool of 92,860 cases during a period of 20 years (1986 to 2005). The minor salivary gland tumors constituted about 0.4% with 224 benign tumors (59%) and 156 malignant tumors (41%). Of the 224 benign tumors, pleomorphic adenoma was the most common with 149 cases (39.2%), followed by 24 cases (6.3%) of cystadenoma, 23 cases (6.1%) of canalicular adenoma, 12 cases (3.16%) of sialadenoma papilliferum, 6 cases (1.6%) of basal cell adenoma, 5 cases (1.3%) of myoepithelioma, 3 cases (0.8%) of intraductal papilloma and 2 cases (0.5%) of inverted ductal papilloma. Among the 156 malignant tumors, 83 (21.8%) were mucoepidermoid carcinoma, 27 (7.1%) polymorphous low-grade adenocarcinoma, 24 (6.3%) adenoid cystic carcinoma, 6 (1.6%) acinic cell carcinoma, 8 (2.1%) adenocarcinoma NOS, 4 (1%) clear cell carcinoma NOS, 2 (0.5%) carcinoma ex pleomorphic adenoma and 1 cases (0.25%) of basal cell adenocarcinoma and myoepithelial carcinoma each.

Pires et al in 2007⁴⁶ conducted a clinicopathological study on 546 cases of intraoral minor salivary gland tumors over a period of 14 years (1991 to 2005). These tumors accounted for 0.4% of all cases with 305 benign tumors (55.9%) and 241 malignant tumors (44.1%). Pleomorphic adenoma was the most common benign tumor with 181 cases (33.2%), followed by 50 cases (9.2%) of canalicular adenoma,

42 cases (7.7%) of papillary cystadenoma, 16 cases (2.9%) of ductal cystadenoma, 9 cases (1.6%) of sialadenoma papilliferum, 4 cases (0.7%) of oncocytoma, 2 cases (0.4%) of intraductal papilloma and 1 case (0.2%) of myoepithelioma. Among the malignant tumors, mucoepidermoid carcinoma was most common with 125 cases (22.9%) followed by 35 cases (6.4%) of adenoid cystic carcinoma, 28 cases (5.1%) of polymorphous low-grade adenocarcinoma, 21 cases (3.8%) of acinic cell adenocarcinoma and adenocarcinoma each, 3 cases (0.5%) of adenosquamous carcinoma, 2 cases (0.4%) of carcinoma ex-pleomorphic adenoma and epithelial-myoeithelial carcinoma each and 1 case (0.2%) of papillary cystadenocarcinoma, mucinous adenocarcinoma, myoepithelial carcinoma and clear cell carcinoma each.

Wang et al in 2007⁴⁷ conducted a retrospective study on intraoral minor salivary gland tumors in Chinese population over a period of 14 years (1990 to 2004). A total of 737 minor salivary gland tumors consisted of 340 (46.1%) benign and 397 (53.9%) malignant tumors were reported. Pleomorphic adenoma was the most common benign neoplasm with 278 cases (37.72%), followed by 49 cases (6.64%) of myoepithelioma, 4 cases (0.54%) of basal cell adenoma, 1 case (0.14%) of warthin's tumor, 6 cases (0.81%) of cystadenoma and 2 cases (0.27%) of ductal papillomas. Adenoid cystic carcinoma was the most frequent type of malignant tumors with 143 cases (19.40%), followed by 91 cases (12.35%) of mucoepidermoid carcinoma, 41 cases (5.56%) of adenocarcinoma NOS, 34 cases (4.61%) of polymorphous low-grade adenocarcinoma, 24 cases (3.26%) of myoepithelial carcinoma, 22 cases (2.99%) of carcinoma ex pleomorphic adenoma, 13 cases (1.76%) of undifferentiated carcinoma, 10 cases (1.36%) of adenosquamous carcinoma, 8 cases (1.09%) of cystadenocarcinoma, 7 cases (0.95%) of acinic cell carcinoma, 3 cases (0.41%) of epithelio-myoeithelial carcinoma and 1 case (0.14%) of salivary duct carcinoma.

Copelli et al in 2008⁴⁸ reviewed 43 cases of malignant minor salivary gland tumors over a period of 9 years (1995 to 2004). Adenoid cystic carcinoma was the most common tumor which accounted for 60.6% followed by 27.9% mucoepidermoid carcinoma, 4.6% adenocarcinoma NOS, 2.3% polymorphous low-grade adenocarcinoma and 4.6% cases of acinic cell carcinoma.

Jones et al in 2008⁴⁹ conducted a demographic study on 741 salivary gland tumors from a pool of 58,880 biopsy specimens over a period of 31 years (1974 to 2005). Among this, the minor salivary gland tumors accounted for 455 cases (61.8%), out of which 283 cases (62.2%) were benign and 172 cases (37.8%) were malignant. Pleomorphic adenoma was the most common benign salivary gland tumor with 184 cases (40.4%) of minor salivary gland tumors, followed by 35 cases (7.7%) of basal cell adenoma, 34 cases (7.5%) of canalicular adenoma, 11 cases (2.4%) of papillary cystadenoma, 7 cases (1.5%) of myoepithelioma, 5 cases (1.1%) of intraductal papilloma, 4 cases (0.9%) of sialadenoma papilliferum, 2 cases (0.4%) of inverted duct papilloma and 1 case (0.2) of oncocytoma. Among the malignant tumors, mucoepidermoid carcinoma was the most common tumor with 59 cases (13.0%) followed by 52 cases (11.4%) of adenoid cystic carcinoma, 28 cases (6.2%) of polymorphous low-grade adenocarcinoma, 11 cases (2.4%) of carcinoma ex pleomorphic adenoma, 6 cases (1.3%) each of acinic cell carcinoma and adenocarcinoma NOS, 3 cases (0.7%) of basal cell adenocarcinoma, 2 cases (0.4%) each of papillary cystadenocarcinoma and salivary duct carcinoma and 1 case (0.1%) each of clear cell carcinoma, mucinous adenocarcinoma and myoepithelial carcinoma.

Subhashraj et al in 2008¹² analyzed 684 cases of salivary gland tumors over a period of 16 years (1991 to 2006). About 150 cases of minor salivary gland tumors were reported which accounted for 22% of all salivary gland tumors with 91 cases

(60.67%) of benign tumors and 59 (39.33%) cases of malignant tumors. Pleomorphic adenoma was most common with 87 cases (58%), followed by 2 cases (1.33%) of basal cell adenoma, 1 case (0.67%) of oncocytoma and unclassifiable benign tumor each. Among 59 cases of malignant tumors, adenoid cystic carcinoma was the most common malignant tumor with 25 cases (16.67%), followed by 10 cases (6.67%) of mucoepidermoid carcinoma, 9 cases (6%) of adenocarcinomas, 3 cases (2%) of carcinoma ex-pleomorphic adenoma and squamous cell carcinoma each, 2 cases (1.33%) of myoepithelial carcinoma and epithelial-myoepithelial carcinoma each, 1 case (0.67%) of acinic cell carcinoma, cystadenocarcinoma, carcinosarcoma, lymphoepithelial carcinoma, basal cell adenocarcinoma and mucinous adenocarcinoma each.

AGE, GENDER AND ANATOMIC LOCATION

Fine et al in 1960¹⁷ conducted clinical and morphological study on 79 cases of minor salivary gland tumors. They observed that the average age in their patients ranged from 42 to 46.3 years. The average age for benign tumors was 46.3 years and 54.4 years for malignant tumors. There was a female predominance with a male to female ratio of 1:1.2. Palate was the most common location with 41 cases (51.9%) followed by 12 (15.19%) in lips, 13 (16.46%) in cheeks, 1 (1.27%) in tonsil, 4 (5.06%) in tongue and 8 (10.13%) in the floor of the mouth.

Davies et al in 1964¹⁹ observed that the age ranged from 15 to 64 years, with a peak incidence in 25 to 34 years and female predominance with a male to female ratio of 1:1.75, in their retrospective study on 14 salivary gland tumors.

Potdar et al in 1969¹⁴ reviewed 110 cases of minor salivary gland tumors and

observed that the age ranged from 10 to 76 years, with a mean age of 40.8 years for males and 46.4 years for females. Their study showed a male predominance with a male to female ratio of 1.8:1. Palate was most commonly involved with 59 cases (53.6%) followed by 10 cases (9%) in maxillary sinus, 9 cases (8.2%) each in cheek and tongue, 5 cases (4.5%) in alveolus, 3 cases (2.7%) in lips, 1 case (0.9%) in floor of the mouth and the remaining 14 cases (12.7%) in other intraoral sites.

Spiro et al in 1973²² analyzed 492 cases of minor salivary gland tumors clinicopathologically and found that the age ranged from 7 to 86 years with an average age of 53 years. The median age was 48 years for benign tumors which was lower than 56 years observed for malignant tumors. They reported an almost equal frequency, with a male to female ratio of 1:1.02. Palate was the most common site with 181 cases (36.8%), followed by 67 cases in maxillary antrum (13.6%), 54 in tongue (11.0%), 49 in cheek or lips (10.0%), 47 in nasal cavity (9.6%), 29 in gingiva (5.9%), 17 in floor of the mouth (3.5%), 15 in larynx (3.0%), 11 in tonsil (2.2%), 10 in nasopharynx (2.0%), 8 in ethmoid (1.6%) and 4 in oropharynx (0.8%).

Thomas et al in 1980²³ studied 190 cases of salivary gland tumors in Malawi over a period of nine years and found that the average age for patients with benign tumors were 39.4 years and 40.8 years for malignant tumors. They observed an almost equal frequency with a male to female ratio of 1:1.18. Palatal tumors were slightly more common in females. Palate was most commonly involved with 36 cases (18.9%) and 13 cases in other minor salivary glands (6.8%).

Eveson et al in 1985²⁶ conducted a demographic study on 336 minor salivary gland tumors and reported that the mean age for benign salivary gland tumors was 49.2 ± 18.3 and 55.9 ± 16.3 for malignant tumors. The mean age for males was 52.0 ± 17.2 and 52.1 ± 18.6 for females. The peak incidence was in the seventh decade

for males and sixth decade for females. They observed that palate was most commonly involved with 54% of cases followed by 21% in lips and 11% in buccal mucosa and the remaining (14%) in other intraoral sites.

Regezi et al in 1985²⁷ analyzed 238 minor salivary gland tumors both histologically and immuno histochemically. Their study revealed that palate was most commonly involved with 109 cases (45.8%) followed by 61 cases (25.63%) in upper lip, 37 (15.55%) in buccal mucosa and gingiva, 8 (3.36%) in lower lip, 6 (2.52%) in retromolar region, 5 (2%) in floor of the mouth and one (0.42%) case in tongue

Chau et al in 1986²⁸ conducted a retrospective study on 98 cases of intraoral minor salivary gland neoplasms and observed that the age range in their patients was 13 to 79 years with a mean age of 44 ± 18.9 years, for males being 43 ± 17.5 and females 44 ± 20.2 . For benign neoplasms, the age ranged from 13 to 79 years with a mean age of 42 ± 18.9 years and the mean age for both males and females was 42 years. For malignant neoplasms, the age ranged from 15 to 79 years with a mean age of 45 ± 18.8 years and the mean age for both males and females was 45 years. The age distribution was bimodal with the first peak in the third decade and second peak in the seventh decade. They reported an equal frequency with a male to female ratio of 1:1. Palate (61%) was most commonly affected which was followed by cheek (14%), upper lip (10%), retromolar region (7%), lower lip (2%), tongue (1%) and intra-bony (mandible 2%, maxilla 1%).

Waldron et al in 1988²⁹ conducted a demographic and histologic study on 426 minor salivary gland tumors and observed that the age range was from 8 to 100 years. The mean age for patients with benign tumors was 49.8 ± 19.12 years whereas the mean age for malignant tumors was 55.2 ± 17.59 . The mean age for patients with malignant tumors was 5.4 years greater than for patients with benign tumors. The

mean age for male patients was 50.6 ± 17.20 and 53.1 ± 19.48 for female patients. They showed an overall female predominance with a male to female ratio of 1:1.59. Palate (42.5%) was the most frequent site of involvement followed by upper lip (18.5%), buccal mucosa (15%), retromolar region (5.4%), floor of the mouth (4.8%), maxillary vestibule (4.3%), lower lip (3.4%) and 6.1% in other intraoral sites.

Takahashi et al in 1990³⁰ retrospectively studied 200 cases of intraoral minor salivary gland tumors and reported that the patient's age ranged from 10 to 85 years. The mean age for patients with benign tumors was 44.8 ± 17.3 years and 54.8 ± 13.3 years for malignant tumors. The peak incidence for benign tumors was in the fourth and fifth decades and for malignant tumors in the seventh decade. The mean age for female patients was 47.2 ± 16.2 years and for male patients 50.6 ± 17.3 years. The peak incidence for males was in the sixth and seventh decade and for females in the fourth, fifth and sixth decades. They reported marked female predominance with male to female ratio of 1.8:1. Palate was most commonly involved with 132 (66%) cases in palate, followed by 23 (11.5%) in lip, 17 (8.5%) in buccal mucosa, 12(6%) in gingiva, 8 (4%) in floor of mouth, 7 (3.5%) in tongue and 1 (0.5%) case in mandible

Van Heerden et al in 1991³¹ studied retrospectively 70 cases of intraoral minor salivary gland neoplasms in an African population and observed the age range to be 10 to 85 years. The age range for benign tumors was 10 to 64 years, with a mean age of 36.5 ± 14.7 years. The age range for malignant tumors was 22 to 85, with a mean age of 49.8 ± 16.3 . They showed female predominance with a male to female ratio of 1:1.6. Palate (82.8%) was most frequently involved which was followed by upper lip (7.1%), buccal mucosa (5.7%) and floor of the mouth, retromolar region and mandibular gingiva with 1.4% each.

Rippin et al in 1992³² studied 194 cases of intra-oral salivary gland tumors in

United Kingdom and reported a mean age of 50.4 years. The mean age for males was 50.7 years and 50.1 years for females. They observed female predilection with a male to female ratio of 1:1.13. Their study showed that 48% of all tumors occurred in palate which was followed by 16% in upper lip, 15% in cheek, 12% in floor of the mouth and remaining in other intraoral sites.

Van der wal et al in 1992³³ reclassified 101 intraoral minor salivary gland tumors histologically and reported that the age ranged from 17 to 86 years, with a mean age of 53.6 years for males and 16 to 82 years, with a mean age of 50 years for females. Their study revealed an equal frequency in both genders with a male to female ratio 1:1. Palate was the most common location with 61 cases (60%) followed by 13 cases (13%) in lips, 8 cases (8%) in cheeks, 7 cases (7%) in floor of the mouth and upper alveolar ridge each, 3 cases (3%) in retromolar area and 1 case (1%) in mandible and tongue each.

Loyola et al in 1995³⁴ observed that the patient's age ranged from 8 to 81 years with a mean age of 41.5 ± 17.5 years. The mean age for males was 42.2 ± 17.2 and for females 41.7 ± 17.1 years. The age range for benign tumors was 8 to 81 with a mean of 39.9 ± 18.7 years, whereas the age range for malignant tumors was 17 to 72 years with a mean of 43.5 ± 15.4 years suggesting that the malignant tumors occur in older patients compared to benign tumors. They observed female predominance with a male to female ratio of 1:1.3. Palate was the most commonly involved site for both benign and malignant tumors (67% of benign and 73% of malignant tumors) followed by buccal mucosa (17%) and lip (10%) for benign tumors. The other common site for malignant tumors was retromolar area (13%) and buccal mucosa (8%).

Rivera-Bastidas et al in 1996¹ studied retrospectively 62 cases of intraoral minor salivary gland tumors and observed that the age range of the patients was 10

to 72 years with a peak incidence in 21-30 years. For benign tumors, the patient age ranged from 10 to 72 years with a mean of 38 years. The mean age for females was 39 years and 37 years for males. The peak incidence of benign tumors occurs in 21-30 years for males and 31-40 years for females. For malignant lesions, the age range was from 10 to 71 years with a mean age of 42 ± 17.96 years. The mean age for females was 45 years and 37 years for males. This suggests that the peak incidence of malignant tumors occurs in 41-50 year old group for females. They showed female predominance with a male to female ratio of 1:1.8. The male to female ratio for benign tumors was 1:2.4 indicating a higher proportion of benign tumors among females, whereas the male to female ratio for malignant tumors was 1.4:1 indicating male predominance. Palate (54.8%) was most commonly involved followed by lips (12.9%), cheeks (9.7%), floor of the mouth (8.1%), retromolar region (6.5%), mandible (1.6%), maxilla (1.6%) and site not specified in 4.8%.

Lopes et al in 1999³⁵ retrospectively studied 196 cases of intraoral minor salivary gland tumors and observed that the mean age for benign tumors was 43.5 years and 49.1 years for malignant tumors. They reported an equal frequency in both males and females with a male to female ratio of 1:1. The ratio for benign tumors was 1:1.3, showing a predominance of benign tumors in females and 1.16:1 for malignant tumors with predominance of malignant tumors in males. Palate was commonly involved with 138 cases (70.4%) followed by 19 cases (9.7%) in tongue, 13 (6.63%) in buccal mucosa, 12 (6.12) in retromolar region, 10 (5.1%) in lip, 9 (4.6%) in alveolar mucosa and 5 (2.5%) cases in floor of the mouth.

Ahmad et al in 2002¹³ conducted a clinico-pathological study on 100 primary salivary gland tumors in Kashmir, India over a period of 2 years and reported palatal predominance accounting for 58.3% followed 16.6% in nasal region and 8.3% each in

lip, cheek and parapharyngeal space.

Jansisyanont et al in 2002³⁶ reported their experience on 80 cases of intraoral minor salivary gland tumors reported over a period of 10 years and observed that the median age for minor salivary gland tumors was 54 years for males and 55 years for females. The patients age ranged from 9 to 84 years for malignant tumors and 33 to 90 years for benign tumors. The median age for benign tumors was 64.5 years for males and 58 years for females. The median age for malignant tumors was 52 years for males and 54 for females. The median age for malignant tumors was 6 years younger than that for benign tumors. They showed marked female predominance with a female to male ratio of 1.6:1. The female to male ratio was 1.9:1 for malignant tumors and 1:1.1 for benign tumors. Palate was the most common site for minor salivary gland tumors reporting 43 cases (53.8%), followed by 13 cases in buccal mucosa (16.3%), 6 in upper lip (7.5%), 5 in retromolar fossa (6.2%), 5 in maxilla (6.2%), 4 in mandible (5%) and 4 cases in lower lip (4%).

Vargas et al in 2002³⁷ retrospectively studied salivary gland tumors in brazilian population for a period of 7 years and reported a mean age of 47.7 years for benign tumors and 48.8 years for malignant tumors.

Pandey et al in 2003⁹ analyzed 42 cases of malignant minor salivary gland tumors for a period of 17 years and observed that the patient's age ranged from 14 to 76 years with a mean age of 46.9 years. Their study showed a slight male predominance with a male to female ratio of 1.4:1. Palate was the most common site accounting for 11 cases (26.1%), followed by 7 cases (16.6%) in pharynx, 5 cases (11.9%) in tongue, 4 cases (9.5%) in buccal mucosa, 3 cases (7.1%) in retromolar trigone, 2 cases (4.7%) each in floor of the mouth and tonsil, 1 case (2.3%) in lip and the site was not known in 6 cases (14.2%).

Sajeevan et al in 2003¹⁰ analyzed 30 cases of salivary gland lesions over a period of 9 years and observed that the age ranged from 20 to 29 years to above 60 years. 50% of these tumors occurred in 30 to 39 years. They showed a marked female predominance with a male to female ratio of 2:1.

Hyam et al in 2004³⁸ studied 30 cases of malignant minor salivary gland tumors over a period of 22 years and observed that the mean age was 62 years with a range of 22 to 86 years. They showed an equal frequency of malignant minor salivary gland tumors in both males and females with a ratio of 1:1. Palate was most commonly involved with 18 cases (60%) followed by buccal mucosa and oropharynx.

Kasangaki et al in 2004³⁹ analyzed 142 cases of salivary gland tumors in Uganda population over a period of 12 years and observed that the mean age for salivary gland tumors in the Uganda population was 33.83 ± 18.83 with an age range of 1 to 80 years. The mean age of benign neoplasm was 26.74 ± 16.0 , while that of malignant neoplasm was 42.49 ± 9.15 . The peak incidence was in the third decade. The male to female ratio was 1:1.18 showing equal frequency in both genders. Site was unspecified in 67 cases (47.2%). Of the remaining cases, palate was most commonly involved with 34 cases (23.9%), followed by 20 cases (14.1%) in parotid gland, 12 cases (8.5%) in floor of the mouth, 3 cases (2.1%) in lip, 2 cases (1.4%) in gingiva, 2 cases (1.4%) in retro molar region and 2 cases (1.4%) in maxilla.

Nagarkar et al in 2004² conducted a retrospective study on 36 salivary gland tumors over a period of 4 years and observed that palate was most commonly involved with 66.6% followed by 33.4% in buccal mucosa.

Vuhahula in 2004⁴⁰ conducted a clinicopathological study on salivary gland tumors in Uganda over a period of 10 years and showed that the age range was 0.5 to 80 years, with a mean age of 38.1 years. The mean age of patients with benign tumors

was 33.5 years and those of malignant tumors were 43.1 years. There was female predominance with a male to female ratio of 1:1.3.

Lima et al in 2005⁴¹ conducted an epidemiological survey on salivary gland tumors over a period of 19 years and observed that the mean age for benign tumors was 40.1 years and 54.8 years for malignant tumors. The peak incidence for benign tumors was in third decade and for malignant lesions, the peak incidence is in the seventh decade. They reported female predominance with a male to female ratio of 1:1.6. The ratio for benign tumors was 1:1.67 and 1:1.64 for malignant

Toida et al in 2005⁴² retrospectively studied 82 cases of intraoral minor salivary gland tumors over a period of 24 years and reported that the age ranged from 10 to 90 years with a mean age of 51.4±18.1 years. The age range for benign tumors was 10 to 90 years with a mean of 49.4±18.4 years and the age range for malignant tumors was 14 to 83 years with a mean of 55.4±17.3 years. The peak incidence was between the fifth and the seventh decades. There was female predominance with a male to female ratio of 1:1.9. Benign tumors showed a marked predilection for females whereas the malignant tumors showed a slight predilection for males. Palate was the most common site with 64 cases (78.1%), followed by 10 cases (15.62%) in buccal mucosa, 6 cases (9.38%) in upper lip and 1 cases (1.56%) each in floor of the mouth and retromolar region.

Jaber et al in 2006⁴⁴ reviewed 75 cases of intraoral minor salivary gland tumors in Libyan population over a period of 23 years. They observed that the mean age at diagnosis of salivary gland tumors was 44.2 years with a range of 15 to 86 years. The median age of patients with benign tumors was 44.1 years with a range of 15 to 86 years and 44.3 years for malignant tumor with a range of 19 to 70 years. The peak occurrence was in the fifth decade for males and sixth decade for females. The

male to female ratio was 1:1.4. Palate was most commonly involved with 26 cases (34.6%) being reported, followed by 11 cases in cheek (14.6%), 8 in tongue (10.6%), 9 in upper lip (12.0%), 2 in lower lip (2.6%), 7 in retromolar area (9.3%), 8 in floor of the mouth (10.6%), 2 in mandible (2.6%) and 2 cases in maxilla (2.6%).

Buchner et al in 2007⁴⁵ conducted a retrospective study on 380 cases of intraoral minor salivary glands during a period of 20 years and reported that palate was commonly involved with 206 cases (54.21%), followed by 64 cases (16.84) in upper lip, 54 cases (14.21%) in buccal mucosa, 20 cases (5.26%) in retromolar region, 18 cases (4.74%) in lower lip, 13 cases (3.42%) in floor of mouth and 5 cases (1.31%) in tongue.

Pires et al in 2007⁴⁶ conducted a clinicopathological study on 546 cases of intraoral minor salivary gland tumors over a period of 14 years and found that the mean age of patients affected with minor salivary gland tumors was about 60 years, with 58 years for benign tumors and 62 years for malignant tumors. There was female predominance with a male to female ratio of 1:1.61. Palate was the most common site accounting for 181 cases (33.4%). This was followed by upper lip with 106 cases (19.6%), buccal mucosa with 98 cases (18.1%), vestibule with 39 cases (7.2%), lower lip with 38 cases (7%), alveolar ridge with 36 cases (6.6%), floor of the mouth with 21 cases (3.9%) and 23 cases (4.2%) in other intraoral sites.

Wang et al in 2007⁴⁷ conducted a retrospective study on intraoral minor salivary gland tumors in Chinese population over a period of 14 years and reported that the average age of patients for benign tumors was 40.7 years with an age range of 3 to 82 years. The peak incidence was between third and fifth decade. In case of malignant tumors, the mean age was 49.4 years with a range of 14 to 85 years. The peak incidence was between fifth and seventh decade. They observed an equal

frequency, with a male to female ratio of 1:1.07. The male to female ratio was 1:1.1 for benign tumors and 1.2:1 for malignant tumors. Palate (67.4%) was most commonly involved, followed by buccal mucosa (10.4%) and lips (7.1%). Benign tumors showed predilection for palate (77.4%) followed by lips and buccal mucosa (9.1%) each and other regions (4.4%). Malignant tumors also showed predilection for palate (58.9%), followed by buccal mucosa (11.6%), floor of mouth (9.1%), tongue (7.8%) and lips (5.3%). Their study revealed that the tumors of tongue, floor of the mouth, alveolar mucosa and retromolar area were predominantly malignant.

Copelli et al in 2008⁴⁸ reviewed 43 cases of malignant minor salivary gland tumors over a period of 9 years and observed that the age range for malignant minor salivary gland tumors was from 15 to 83 years with a mean age of 53.9 years. They observed an equal distribution in both sexes. Palate (53.5%) was the most common site followed by 9.3% each in floor of the mouth and retromolar area, 6.9% each in alveolar mucosa and tongue, 4.7% each in lip, cheek and mandible.

Jones et al in 2008⁴⁹ conducted a demographic study on 741 salivary gland tumors over a period of 31 years and observed that the age ranged from 14 to 95 years with a mean age of 57.7 years for benign tumors. Likewise, the age range for malignant tumors was 16 to 91 with a mean age of 56.6 years. They reported an overall female predominance, with a male to female ratio of 1:1.4 for benign tumors and 1:1.6 for malignant tumors. Palate was the most common site accounting for 227 cases (49.8%), followed by 93 cases (20.4%) in upper lip, 55 cases (12.0%) in buccal mucosa, 21 cases (4.6%) in maxillary gingiva, 14 cases (3.0%) in lower lip, 8 cases (1.8%) each in floor of mouth and retro molar area, 7 cases (1.5%) each in tongue, naso pharynx and fauces, 5 cases (1.1%) in mandibular gingiva, 3 cases (0.9%) in tuberosity, 1 case (0.2%) intra osseously in mandible and the site was unknown in 2

cases (0.4%).

Subhashraj et al in 2008¹² analyzed 684 cases of salivary gland tumors over a period of 16 years and found that the average age range for benign tumors was 41 to 50 years with a mean age of 43 years. The average age range for malignant tumors was 51 to 60 years with a mean age of 56 years. The peak incidence was fifth decade for female patients and sixth decade for male patients. They showed an overall male predominance, with a male: female ratio of 1.04:1. The ratio was almost similar for both benign and malignant tumors. Palate was the commonest site reporting almost 102 cases (68%), followed by buccal mucosa with 22 cases (15%), floor of the mouth with 14 cases (9%) and 12 cases in lips (8%).

MATERIALS AND METHODS

Clinical data were collected from the files of histopathology reporting register of the Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital (under the Ministry of Health and Family welfare, Government of Tamil Nadu), Chennai, South India for a period of 37 years [1971-2008]. A total of 12150 cases of oral and maxillofacial lesions were diagnosed during this period. Out of which 221 salivary gland tumors were retrieved (8 cases from a review of odontogenic tumors). Clinical information with respect to patient's age, sex, anatomic location and histopathologic diagnosis were obtained from the register. Hematoxylin and Eosin stained slides were available for most of the cases and were reviewed by two independent oral pathologists. Consensus was reached for so many cases. When necessary, four micron thickness sections were cut from tissue blocks and stained with Hematoxylin and Eosin stain. Special stains including periodic acid Schiff and mucicarmine stain were used in selected cases to aid in the diagnosis. Major salivary gland tumors accounted for 4 cases and were excluded from the study. On review, about 10 cases that failed to meet the diagnostic criteria of salivary gland tumors were also excluded. Further, almost 19 cases were excluded from the study due to non-availability of slides and tissue blocks, three salivary gland tumors identified from the review of odontogenic tumors were also excluded for lack of consensus and due to the need for IHC studies to confirm the diagnosis. Tumors that recur post-operatively were considered as a single case. Salivary gland tumors were classified according to the criteria of the WHO working group on histologic classification of salivary gland tumors published in 2005⁵⁰ (Table 1).

Procedure for Hematoxylin and Eosin staining⁵¹

- Sections are deparaffinized with xylene.

- Hydration with descending grades of alcohol.
- The sections are drained and transferred to Hematoxylin, where they are left for 10 minutes.
- The slides are then drained and washed in running water until the sections are blue.
- The sections are dipped in acid alcohol where they are agitated for a few seconds and again washed in running water until blue again.
- The sections are counterstained with eosin for 30 seconds.
- The sections are washed in running water for 3-4 minutes, to differentiate the eosin.
- After draining, the sections are dehydrated in ascending grades of alcohol.
- The sections are cleared with xylol, where they are given two changes for 30 seconds each.
- The sections being clear, the slides are dried and mounted with Distrene 80 Dibutyl phthalate Xylol (DPX) under a coverslip.

RESULTS:

1. Nuclei: Blue.
2. Cytoplasm: Varying shades of pink.

PAS technique⁵¹

- Bring sections to water.
- Oxidize for 5-10 minutes in 1 per cent aqueous periodic acid.
- Wash in running water for 5 minutes and rinse in distilled water.
- Treat with Schiff reagent for 10-30 minutes.
- Transfer directly to first sulphite rinse for 1 minute.
- Transfer directly to the second sulphite rinse for 2 minutes.

- Transfer directly to the third sulphite rinse for 2 minutes.
- Wash for 10 minutes in running water.
- Counterstain with Hematoxylin and tartrazine in cellosolve.
- Dehydrate, clean and mount in D.P.X or Canada balsam.

RESULTS:

1. P.A.S positive substances: Bright red.
2. Nuclei: Blue
3. Other tissue constituents: Yellow

Mucicarmine technique⁵¹

Solution:

- Carmine : 1 g
- Aluminium hydroxide : 1 g
- 50 per cent alcohol : 100 ml

These constituents are mixed by shaking and to them is added

- Aluminium chloride : 0.5 g

Boil in water-bath for 2 ½ - 3 minutes. Cool, make up to original volume with 50 per cent alcohol, and filter. The stock solution is stable for several months.

METHOD:

- Bring sections to water.
- Stain nuclei with haematoxylin.
- Differentiate in acid-alcohol and blue in tap-water.
- Stain for 30 minutes in the staining solution given above.
- Rinse in distilled water, dehydrate, clear, and mount in Canada balsam or D.P.X.

RESULTS:

Mucin : Red

Nuclei : Blue

The stained and mounted slides for all cases were examined under the light microscope to confirm the previous histopathologic parameters.

Statistical analysis:

The mean and standard deviation was calculated, values were verified using chi square test and their significance was assessed by calculating the P value. The data were analyzed by the statistical package for the social sciences version 15.0 (SPSS).

Observations & Results

General frequency

During a period of 37 years (1971 – 2008), a total of 12,150 oral biopsies were received in the Department of Oral Pathology and Microbiology, Tamil Nadu Government Dental College and Hospital, Chennai, India. Of these, the minor salivary gland tumors were 185 cases which accounted for 1.52% of all oral lesions.

Among these, 46 cases (24.9%) were benign tumors and 139 cases (75.1%) were malignant tumors. The malignant tumors were almost three times more common than the benign tumors in our study.

Table 2 – General frequency of minor salivary gland tumors.

Chart 1 – Frequency of minor salivary gland tumors.

Incidence of Minor salivary gland tumors over decades (1971 – 2008):

The incidence of intraoral minor salivary gland tumors were assessed in four decades from 1971 to 2008. Our study showed a steady increase in the frequency of minor salivary gland tumors over the decades. An almost similar incidence rate was observed from 1971 to 1980 and 1981 to 1990, following which there was an increase in the incidence rate from 1991 onwards. Our study also revealed a drastic increase in the incidence rate from 2001 to 2008 showing a trend towards increase in the incidence rate of minor salivary gland tumors in the recent years.

Table 3 – Frequency of minor salivary gland tumors over 4 decades (1971-2008).

Chart 2 – Number of minor salivary gland tumors distributed over 4 decades (1971-2008).

Chart 3 – Incidence of minor salivary gland tumors over 4 decades (1971-2008)

Age distribution

The age range of patients with minor salivary gland tumors in the present study was 12 to 82 years, with a mean age of 46.11 ± 13.92 years. The peak age of occurrence was in 5th and 6th decades.

The age range for benign tumors was from 13 to 70 years, with a mean age of 33.5 ± 13.0 years and a peak age of occurrence in 4th and 5th decades. Likewise, the age range for malignant tumors was from 12 to 82 years, with a mean age of 41.3 ± 13.0 years. The peak age of occurrence for malignant tumors was in the 5th and 6th decade.

The age range for male patients was from 13 to 80 years, with a mean age of 46.55 ± 13.80 years and the age range for female patients was from 12 to 82 years, with a mean age of 46.11 ± 14.07 years. The peak incidence of occurrence for both males and females was in the 5th and 6th decades of life. The malignant tumors also showed a slight predilection for older patients than the benign tumors. A statistically significant relationship was found between the age of the patients with benign and malignant tumors ($P = 0.004$).

Table 4 – Age distribution of minor salivary gland tumors in decades.

Chart 4 – Age distribution (in decades) of minor salivary gland tumors.

Table 5 – Correlation of age (in decades) with gender.

Gender Distribution

There was a slight male predilection with 98 cases (53%) when compared to 87 female patients (47%). The male to female ratio was about 1.12:1. The benign tumors showed a slight predilection for females, whereas the malignant tumors showed a marked predilection for males.

Table 6 – Gender distribution of minor salivary gland tumors

Chart 5 – Gender distribution of minor salivary gland tumors.

Gender distribution over decades (1971-2008):

The gender distribution of minor salivary gland tumors was assessed over 4 decades (1971-2008). Females showed a slight predominance over males in all the three decades (1970 – 2000) with a transition towards male predominance in the recent years (2000 – 2008).

Table 7 – Gender distribution of minor salivary gland tumors over 4 decades (1971-2008).

Site Distribution

Palate was the most common site for minor salivary gland tumors with almost 90 cases (48.6%) being reported in this location. This was followed by alveolus with 27 cases (14.6%), floor of the mouth with 22 cases (11.9%), buccal mucosa with 14 cases (7.6%), intraosseous (mandible) with 10 cases (5.4%), upper lip with 7 cases (3.8%), retromolar area with 6 cases (3.2%), maxillary antrum with 2 cases (1.1%), tongue and vestibule with 1 case (0.5%) each. The site was not specified in 5 cases (2.7%).

A statistically significant relationship was found between anatomic location and benign and malignant tumors ($P = 0.001$).

Table 8 – Site distribution of minor salivary gland tumors.

Chart 6 – Site distribution of minor salivary gland tumors.

Individual Tumors

Among 185 minor salivary gland tumors, benign tumors were 46 cases (24.86%) while 139 cases (75.14%) were malignant tumors. Pleomorphic adenoma represented the majority of benign tumor with 40 cases which accounted for 87% of benign and 21.6% of MSGT. The other benign tumors reported in this study included

basal cell adenoma with 2 cases which accounted for 4.3% of benign and 1.1% of MSGT. A single case of cystadenoma, myoepithelioma, oncocytoma and sialadenoma papilliferum were observed which accounted for 2.2% of benign and 0.5% of MSGT each.

Among the malignant tumors, mucoepidermoid carcinoma represented the most common malignant tumor with 63 cases. This represented 45.3% of malignant and 34.1% of MSGT. The adenoid cystic carcinoma was the second most common malignant tumor with 29 cases and accounted for 20.9% of malignant and 15.7% of MSGT. Our study observed polymorphous low-grade adenocarcinoma as the third most common malignant tumor with almost 18 cases (12.9% of malignant and 9.7% of MSGT) being reported. This was followed by 15 cases (10.8% of malignant and 8.1% of overall tumors) of adenocarcinoma NOS, 8 cases (5.8% of malignant and 4.3% of overall tumors) of basal cell adenocarcinoma, 2 cases (1.4% of malignant and 1.1% of overall tumors) of clear cell carcinoma and a single case (0.7% of malignant and 0.5% of overall tumors) of sebaceous carcinoma, carcinoma ex pleomorphic adenoma, mucinous adenocarcinoma and salivary duct carcinoma each.

Table 9 – Frequency of individual minor salivary gland tumors.

Chart 7 – Distribution of individual minor salivary gland tumors.

Benign tumors

Pleomorphic adenoma:

Pleomorphic adenoma was the most common benign tumor and represented 87% of benign and 21.6% of minor salivary gland tumors. The age range observed in our study was from 13 to 70 years, with a mean age of 46.24 ± 14.05 . The peak incidence was in the fourth and fifth decades of life. The age range for males was 13

to 60 years with a mean age of 46.62 ± 13.86 years, whereas the age range for females was 19 to 70 years with a mean age of 46.40 ± 14.09 years. There was a slight female predominance, with a male to female ratio of 1:1.2. Palate was the most common site with 27 cases (67.5%), followed by 5 cases in upper lip (12.5%) and 1 case (2.5%) each in alveolus, buccal mucosa, floor of the mouth, retromolar area and vestibule. The site was not specified in 3 cases (7.5%).

Other benign tumors:

The other benign tumors observed in our study were basal cell adenoma, cystadenoma, oncocytoma, myoepithelioma and sialadenoma papilliferum.

Two cases of basal cell adenoma was reported which accounted for 4.3% of benign and 1.1% of all tumors. One case was diagnosed in a 58 year old male in palate and the other case was observed in a 50 year old female in alveolus.

A single case of cystadenoma was reported in a 37 year old male patient in palate. Similarly, a single case of myoepithelioma was observed in a 65 year old female in the floor of the mouth. Oncocytoma was found in a 70 year old male patient in the palate and a rare case of sialadenoma papilliferum with epithelial dysplasia and carcinoma in situ was observed in a 40 year old male in floor of the mouth.

Malignant tumors

Mucoepidermoid carcinoma:

Mucoepidermoid carcinoma was the most common malignant tumor with 63 cases and accounted for 45.3% of malignant and 34.1% of MSGT. The age range of the patients was from 12 to 82 years, with a mean age of 46.31 ± 14.08 years. The age range for males was 16 to 78 years, with a mean of 47.16 ± 14.02 whereas the age range for females was 12 to 82 years, with a mean age of 46.20 ± 14.16 years. The

peak incidence was observed in fifth and sixth decades. This tumor showed a predilection for males, with a male to female ratio of 1.25:1. Palate was the most common site with 32 cases (50.79%) followed by 11 cases (17.46%) in alveolus, 6 cases (9.52%) each in floor of the mouth and mandible, 5 cases (7.93%) in buccal mucosa, 2 cases (3.17%) in retromolar area and 1 case (1.58%) in tongue.

Adenoid cystic carcinoma:

Adenoid cystic carcinoma was the second most common malignant tumor in our study with 29 cases and represented 20.9% of malignant and 15.7% of MSGT. The age range of the patients was 21 to 62 years, with a mean age of 46.74 ± 13.77 . The age range for males was 23 to 61 years, with a mean age of 46.92 ± 13.94 years whereas the age range for females was 21 to 62 years, with a mean of 46.79 ± 13.80 . The peak incidence was in the fifth and sixth decades. There was a slight male predominance with a male to female ratio of 1.2:1. The most common location was palate with 11 cases (37.93%) followed by 6 cases in floor of the mouth (20.68%), 4 cases (13.79%) in alveolus, 3 cases (10.34%) in buccal mucosa, 2 cases (6.89%) in maxillary antrum and 1 case (3.4%) each in retromolar area and mandible. The site was not specified in 1 case (3.4%).

Polymorphous low-grade adenocarcinoma:

Polymorphous low-grade adenocarcinoma was the third most common malignant tumor in our study with 18 cases which represented 12.9% of malignant and 9.7% of MSGT. The age range was 25 to 80 years, with a mean age of 47.03 ± 14.11 years. The age range for male patients was 45 to 80 years, with a mean age of 54.60 ± 13.80 whereas the age range for female patients was from 25 to 65 years, with a mean of 47.36 ± 14.25 years. The peak incidence occurred in the fifth decade. There was a marked female predilection with a male to female ratio of 1:2.

Palate was the most common location accounted for 8 cases (44.44%) which was followed by 3 cases (16.66%) each in buccal mucosa and mandible, 2 cases (11.11%) in upper lip and 1 case (5.55%) each in alveolus and floor of the mouth.

Adenocarcinoma NOS:

Fifteen cases were diagnosed as adenocarcinoma not otherwise specified which accounted for 10.8% of malignant and 8.1% of MSGT. The age range of the patients was 25 to 75 years, with a mean age of 46.55 ± 13.77 years. The age range for male patients was 25 to 66 years, with a mean age of 45.93 ± 13.67 years whereas the age range for female patients was from 30 to 75 years, with a mean age of 46.70 ± 13.85 years. The peak incidence was in the sixth decade. There was male preponderance with a male to female ratio of 2:1. Palate and alveolus was the most common site with 5 cases (33.33%) each followed by 4 cases in floor of the mouth (26.66%). The site was not specified in 1 case (6.66%).

Basal cell adenocarcinoma:

Basal cell adenocarcinoma accounted for 5.8% of malignant and 4.3% of MSGT with 8 cases. The age range of the patients was 30 to 75 years, with a mean age of 47.20 ± 14.16 years. The mean age for males was from 53 to 75 years, with a mean age of 63.4 ± 14.08 whereas the age range for female patients was from 30 to 60 years, with a mean age of 47.20 ± 14.16 years. Palate was the most common site with 4 cases (50%) followed by 2 cases (25%) in floor of the mouth and 1 case (12.5%) each in alveolus and buccal mucosa.

Other malignant tumors:

Two cases were diagnosed as clear cell carcinoma. One case occurred in a 40 year old male patient in alveolus and the other was reported in the retromolar area of a 65 year old male patient.

The other malignant tumors included a single case of sebaceous carcinoma in a 58 year old male patient in buccal mucosa; carcinoma ex pleomorphic adenoma in a 45 year old female in alveolus; mucinous adenocarcinoma in a 45 year old female in retromolar area and salivary duct carcinoma in a 26 year old male in alveolus were reported.

Table 10 – Age distribution (in decades) of individual minor salivary gland tumors.

Table 11 – Sex distribution of individual minor salivary gland tumors.

Table 12 – Site distribution of individual minor salivary gland tumors.

Chart 8 – Gender distribution of individual minor salivary gland tumors.

Discussion

Comparison of actual variation of the relative frequency of MSGT is difficult to establish. This is because of the difference in the assessment of the relative frequency of MSGT where some have adopted to establish it by calculating the overall prevalence of MSGT with respect to other head and neck malignancies or tumors, while others have established the relative frequency of MSGT among the total biopsies encountered during the study period. The latter method is further complicated by the fact that some institutional analysis were reported from the oral surgery unit, which did not state whether their review included re-analysis of the original histological diagnosis. These differences will lead to variations in the assessment of the actual rate of the relative frequency of individual MSGT.

When reports from the tertiary referral units are compared with those from the institution, the relative percentage of malignant tumors is bound to be high in the tertiary referral centre, because of the more number of invasive cancer cases encountered in such reference centers.²² On the other hand, the institutional based assessment of relative frequency will not only have lesser number of salivary gland tumors^{1, 28, 31, 33, 36, 42, 44} when compared with the total number of biopsies but also lesser percentage of malignant tumors when compared to the overall salivary gland tumors.^{1, 12, 17, 24-30, 32, 34, 42-46, 49} Another problem is the extrapolation of the data of an institutional study to the population density in a given geographic or regional location, where the population figures are not static over a long period compared to the study period that may range from one or more decades involved in an institutional study.

The results of the present study reports 185 (out of a total of 12150 biopsy samples) minor salivary gland tumors over a period of 37 years. The relative frequency of minor salivary gland tumors was 1.52%. Benign and malignant tumors

constituted 24.9% and 75.1% respectively (see. Table 2).

Review of the literature revealed that the relative frequency of MSGT in the institutional studies ranged from 0.3% to 0.7%.^{1, 27, 35, 45, 46} Spiro et al,²² have reported a rate of 1.5% but this also included other malignant tumors. Minor salivary gland tumors in our study represented 1.52% of all oral biopsies. This incidence rate is higher compared to the range stated.

The prevalence of malignant minor salivary gland tumors were found to be in the range of 53.9% to 88.2%^{22, 33, 35, 36, 44, 47} from studies that showed a higher incidence of malignant tumors than benign tumors in their analysis of MSGT. The higher incidence of malignant tumors found in this study is consistent with these results. But our figure of 75.1% is comparatively higher when compared to other reported studies that showed predominance of benign over the malignant tumors, a range of 28% to 46.8% of malignant tumors.^{1, 12, 17, 24-30, 32, 34, 42, 43, 45, 46, 49} These low and high figures were found both within the institutional based studies and across the geographic location. Toida et al⁴² and Wang et al⁴⁷ have found that 33% to 53.9% of the MSGT were malignant tumors in their study. Though our geographic location is closer to Japan and China (Toida et al & Wang et al), the high incidence of malignant tumors found in this study (75.1%) corresponds to the values obtained by Jansisyanont et al (76.3%), in United States of America.³⁶ This indicates not only regional variation but also differences in the ethnicity within a geographic location as evident from the figures in Table 13. Furthermore, as evident from studies conducted within the Indian population, also reflects variations in the incidence of benign and malignant tumors – Table 14.

The relative prevalence of malignant salivary gland tumors (both minor and major) was 0.46% to 0.54% according to the annual report of MMTR for the year

2001-2003 and 2003-2005, respectively.^{7, 8} This indicates that the incidence of salivary gland cancers shows an increase during the respective periods in the same population group in which the present analysis was conducted. Our study revealed, from 1971 to 2008, a steady increase in the incidence rate of overall MSGT with an upward trend in the incidence of minor salivary gland tumors, especially in the last decade (see. Table 3). This observation is interesting in view of the notable decrease in the incidence of oral cancers as reported by the MMTR,⁸ while the percentage of malignant tumors (MSGT) were found to be higher in the present institutional based study.

This study also identifies the age of patients to range from 12 to 82 years (mean 46.11±13.92 years) with a peak incidence in the fifth and sixth decades of life for both males and females. Like most other reported series,^{1, 17, 22, 26, 28, 30, 34, 35, 42, 44, 46, 47} our study also reveals that the malignant tumors showed a slight predilection for older patients (see. Table 4 & 5). In contrast, only one report showed the occurrence of malignant tumors at a relatively younger age.³⁶ Moreover, there was a statistically significant correlation of age with both benign and malignant tumors, similar to other reported series.^{24, 26, 30, 31}

In the present study, the prevalence of MSGT was found more in males (53%) than in females (47%) with a ratio of 1.12:1 (see. Table 6). This observation is in accordance with Takayashi et al³⁰ and Potdar et al,¹⁴ but in contrast to others.^{1, 17, 22, 28, 29-36, 42, 44, 45, 47} When gender distribution was assessed over decades (1971-2008), female predominance was observed. Nevertheless, there was a sudden shift towards male predilection during the last decade (2001-2008 – see. Table 7). Overall, in agreement with other studies,^{1, 35, 47} malignant tumors tend to occur more frequently in males in this study. The MMTR also reports increase in the incidence of oral cancers

in males during this period compared to previous decades.⁸

As in the present study, review of literature revealed the palate being the most commonly affected site.^{1, 9, 11-14, 17, 22, 24-36, 42-49} In the present study, 48.6% of cases occurred in the palate. This figure although comparable with some studies,^{22, 27, 44, 46} was found to be lower with most other studies.^{1, 16, 26, 28, 30, 34-37, 42, 45, 47} On the other hand, the palate was the single most frequent site for benign tumors than for malignant tumors, similar to most other studies.^{1, 22, 24, 27, 28, 31, 34, 35} According to MMTR data,⁸ the tongue and buccal mucosa are the most frequently involved site for cancers of the oral cavity.

The anatomical distribution of minor salivary gland tumors found in the present study differs from other reported studies. Unlike in most other reported series,^{12, 16, 26, 28, 34, 36, 42, 44, 47} where the buccal mucosa was identified as the second most common site, the present study found the alveolus (14.6%) to be the second most common site. The present study also identifies positive correlation for malignant tumors occurring at specific sites, similar to the observation made by Eveson and Cawson²⁶ and Potdar et al.¹⁴ Tumors in certain intra-oral sites such as tongue, maxillary antrum and mandible were invariably found to be malignant (see. Table 8). This shows a statistically significant correlation between the site and malignant salivary gland tumors.

Another notable finding was the incidence (5.4%) of intraosseous MSGT (mandible) found in this study compared to a range of 0.2% to 2.6%.^{1, 29, 30, 33, 44, 49} The higher incidence found in our study is similar to that reported by Jansisyanont et al.³⁶ Our review (10 cases) initially identified 7 cases of intraosseous salivary gland tumors. Another 3 cases (MEC, ACC and PLGA) was retrieved from the review of odontogenic tumors, which was either reported as malignant or plexiform

ameloblastoma. Overall, there were 6 cases of MEC, 3 of PLGA and a single case of ACC. The frequency of MEC and site of predilection of intraosseous tumors is in agreement with Li et al.⁵²

Pleomorphic adenoma was the most common benign MSGT in our study that accounted for 21.6% of MSGT. This is consistent with the worldwide prevalence rate ranging from 11.6 to 66.6 % of MSGT.^{1, 2, 12, 17-19, 21-37, 42-47, 49} But interestingly, our figure of 21.6% although similar to that reported by Jansisyanont et al,³⁶ is comparatively lower with other studies from India, as well as from other geographic locations.^{1,2, 9-15, 17, 21, 26-35, 42-47, 49}

Like most reported series,^{26, 28, 30, 36, 42, 43, 46, 47} our study also identifies palate (67.5%) as the most commonly involved site for PA followed by upper lip (12.5%). In PA, female predominance was observed in the ratio of 1:1.2, which is in accordance with the previous reports ranging from 1:1.1 to 1:2.5.^{1, 22, 24, 26, 27, 29-31, 42, 43, 45-47, 49}

Our study identified basal cell adenoma as the second most common benign MSGT that accounted for 4.3% of benign and 1.1% of MSGT. Although our data is similar to that reported by Takahashi et al,³⁰ Lopes et al³⁵ and Subhashraj et al,¹² is substantially lower compared to a range of 1.25 – 7.7% reported in other studies.^{1, 35, 36, 44, 45, 49}

The absence of CA in the present study is notable, especially in view of its reported prevalence (1.25% to 11.74%) in minor salivary glands in the American population.^{17, 22, 25, 27, 29, 36, 43, 45, 46} Although others might consider it due to differences in the diagnostic interpretations,⁴⁵ it might be a distinct feature in Asian population as almost all studies from this region have found no CA in their analysis,^{2, 9-15, 30, 42, 47} and in fact one case of ACC was reported as CA before this review. Our review also

showed two ACC that had acceptable focus of BCA and CA, respectively. But in view of the malignant component being ACC, it was diagnosed as such.

Myoepithelioma accounted for 5.7% of all benign MSGT according to the report in the WHO classification.⁵⁰ In the present study, the proportion of myoepithelioma was 2.2% of benign and 0.5% of MSGT which is in accordance with Pires et al.⁴⁶ However, this is substantially lower compared to other studies reporting an incidence rate ranging from 1.3% to 8.8%.^{17, 45, 47, 49} Further, a single case of oncocytoma was found in our study which accounted for 0.5% of MSGT, similar to that observed by Yih et al,⁴³ Jones et al.⁴⁹ and subhashraj et al.¹²

Sialadenoma papilliferum is a rare benign tumor of salivary gland origin and was first described by Abrams and Finck in 1969.⁵³ The present study also observes a case of sialadenoma papilliferum but with epithelial dysplasia and carcinoma in situ in the exophytic component. This lesion was found in the floor of the mouth.⁵⁴

The relative frequency of malignant MSGT varies around the world; studies from American population show that MEC is the most common tumor,^{17, 25, 27, 29, 36, 43, 45, 46} while most studies from European and Asian countries have observed ACC as the most common malignant tumor.^{2, 11-15, 26, 30, 33, 42, 47} Most studies from India have also observed ACC to be the most common malignant tumor.^{2, 11-15, 55} Our study observed mucoepidermoid carcinoma as the most common malignant MSGT followed by adenoid cystic carcinoma and polymorphous low-grade adenocarcinoma. A similar pattern of frequency was also observed by others.^{43, 46}

MEC in the present study comprised of 45.3% of malignant and 34.1% of all MSGT and was found in the palate more often than any other intra oral site. These observations is in accordance with other studies.^{1, 9, 17, 21, 22, 24, 25, 27-29, 34-36, 38, 45, 46, 49} Of the malignant MSGT found in this study , MEC was also the most common

adenocarcinoma to involve the palate.

With regard to involvement in children (1.4%), MEC was the only malignant tumor that affected children below 16 years of age. In general, the incidence of intraosseous (mandible) MEC (9.52%) was found to be higher than others,^{28, 43} although a higher incidence rate (12.1%) was found by Jansisyanont et al.³⁶

Adenoid cystic carcinoma was the second most common malignant MSGT in our study and accounted for 20.9% of malignant and 15.7% of all MSGT. This is consistent with other reported series.^{1, 17, 25, 27, 28, 34, 35, 43, 44, 46, 49} Like most reported studies,^{1, 9, 12, 17, 21, 22, 24-36, 38, 42-49} the most common site of involvement of this tumor is the palate (50.79%), while the maxillary sinus accounted for only 6.89% (2/29 cases) of this tumor as against a higher prevalence of this tumor in this location.^{22, 50, 56} Similarly, central adenoid cystic carcinoma was found to be relatively common,⁵⁷ but only a single case (mandible) was identified in this series.

PLGA appears to show greater affinity for minor salivary glands as is evident from the increasing recognition of this entity,^{29, 31} since its identification by Evans and Batsakis in 1983.⁵⁸ The WHO classification also reports PLGA as the second most common malignant tumor of minor salivary gland origin.⁵⁰ The present study observes PLGA to be the third most common malignant tumor accounting for 12.9% of malignant MSGT. PLGA was found to be the most common malignant tumor in an African series,³¹ while it was the second most common malignant tumor in some America series.^{29, 36, 45} The reported variation in the prevalence of this entity might be related to differences in interpretations. Prior to 1983, this tumor was interpreted as other salivary gland tumors, most commonly as adenoid cystic carcinoma or pleomorphic adenoma. Of the 18 cases of PLGA, in the study by Yih et al,⁴³ 8 were interpreted as pleomorphic adenomas and 1 as adenoid cystic carcinoma before 1983.

Our review (18 cases) also revealed that PLGA was interpreted as other lesions, two as PA and one was diagnosed as plexiform ameloblastoma, before 1983, and thereafter, 6 cases were interpreted as MEC, ACC and adenocarcinoma NOS. This indicates that PLGA is not only difficult for general pathologist to interpret,⁵⁹ as it is not frequent in major salivary glands but also for specialist pathologist. This is perhaps due to overlapping histomorphological features with other salivary gland tumors.⁵⁹ The 3 cases of PLGA that was interpreted as MEC, before this review, was possibly due to the abundance of mucous cells in an otherwise PLGA. As reported in other studies,^{29, 31, 36, 38, 43-47, 49, 59} the present study also found higher predilection for both the site and gender. Over 44% of PLGA was found in the palate, and a 2:1 ratio of female predominance was observed. Furthermore, our study also found 3 cases (1 in male & 2 in females) of intraosseous PLGA, which is an uncommon location for this tumor.⁶⁰

The diverse histological features of salivary gland neoplasms present difficulties in the diagnosis of a small number of lesions. Such tumors are categorized as adenocarcinoma NOS, which are a histologically heterogeneous group of tumors that could not be classified into a well-defined specific category.⁵⁰ This tumor accounts for 8.1% (15 cases) of MSGT in our study, which is higher than the range of 0.8 to 7.4% reported in other studies.^{1, 17, 24, 27, 28, 30, 34-36, 38, 42, 43-49} Most studies from India also report higher values (9 to 26%) of this non-specific entity.^{9,11-14}

On review of the 22 cases of adenocarcinomas NOS reported in the biopsy register, re-classification yielded 3 cases of basal cell adenocarcinoma and one each of mucinous adenocarcinoma, PLGA, MEC and ACC. The palate (33.3%) and alveolus (33.3%) are the most frequently involved sites, this observation is in accordance with Wang et al.⁴⁷ Males are the predominantly affected gender groups in

most studies,^{26, 28, 30, 42, 46, 47} as does the present study.

Basal cell adenocarcinoma occur mostly in the parotid gland and they are considered rare in minor salivary glands.⁵⁰ Review of the literature revealed only 21 reported cases of basal cell adenocarcinoma of minor salivary glands.^{61, 62} Our study identified 8 cases which accounted for 5.8% of malignant and 4.3% of MSGT when compared to a range of 0.2% to 1.2% reported by other large series.^{42, 45, 49}

The rest of the malignant tumors together comprised only 3.1% of the MSGT to draw any meaningful comparison with other reported series. (see Table 9,10,11,12)

SUMMARY AND CONCLUSION

Our study reported 185 minor salivary gland tumors over a period of 37 years, showing a predominance of malignant tumors over benign tumors. The incidence rate was 1.52% with a steady increase over the decades (1971 to 2008). These tumors were distributed over a wide age range, with a peak incidence in fifth and sixth decades. Males were most commonly affected compared to females. Almost one half of these tumors occurred in palate and the remaining tumors were identified in other intraoral sites. The intraosseous tumors observed in our study included 6 MEC, 3 PLGA and 1 ACC. A statistically significant correlation was observed between age and anatomic location with benign and malignant tumors.

Pleomorphic adenoma was the most common benign tumor, while the most common malignant tumor was mucoepidermoid carcinoma followed by adenoid cystic carcinoma and polymorphous low-grade carcinoma. Unlike in most other Asian studies, our study identified mucoepidermoid carcinoma as the most common malignant tumor. A higher incidence of basal cell adenocarcinoma was also observed.

In conclusion, our study shows a higher incidence of minor salivary gland tumors compared to other studies with an incidence rate of 1.52%. Of these, 75% were malignant and the rest were benign tumors. The frequency of malignant tumors is significant in the context of the gradual trend towards decline in the incidence of oral cancers in Chennai. Further, a trend towards male predilection was observed in the recent times akin to the increasing incidence of oral cancers in males in this city. The frequency and distribution of MSGT in the present study shows both regional and geographic variations. Further epidemiological studies from India and other Asian countries should be encouraged for comparison and estimation of racial or geographic variations.

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