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REVIEW ARTICLE

Classification of odontogenic tumours. A historical review

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Using the term odontome for any tumour arising from the dental formative tissues, Broca suggested a classification of odontogenic tumours (OTs) in 1869. From 1888 to 1914, Bland-Sutton and Gabell, James and Payne modified tumour terminology, while maintaining Broca's odontome concept. Thoma and Goldman's classification (1946) divided the OTs into tumours of ectodermal, mesodermal and mixed origin and abolished the general term odontome. The Pindborg and Clausen classification (1958) based on the idea that the reciprocal epithelial-mesenchymal tissue interactions were also operating in the pathogenesis of OTs. In 1966, WHO established a Collaborating Centre for the Histological Classification of Odontogenic Tumours and Allied Lesions (including jaw cysts) headed by Dr Jens Pindborg. In 1971, the first authoritative WHO guide to the classification of OTs and cysts appeared followed in 1992 by a second edition. In 2002, Philipsen and Reichart produced a revision of the 1992-edition and in 2003, the editors of the WHO Blue Book series: 'WHO Classification of Tumours' decided to produce a volume on the Head and Neck Tumours including a chapter on Odontogenic Tumours and Bone Related Lesions. In July of 2005 this volume was published by IARC, Lyon.
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Introduction

Odontogenic tumours (OTs) are lesions of great interest and importance to oral pathologists and maxillofacial surgeons alike, who for several decades have studied and catalogued these lesions and developed modalities for adequate treatment. However, it is only within the recent 30 years, in fact since the first edition of the WHO classification ('Histological Typing of Odontogenic Tumours, Jaw Cysts and Allied Lesions') was published in 1971 (1), that OTs have attracted major and steadily increasing interest. With the first edition, the terminology and the diagnostic framework became available, and this *modern and logically constructed* classification greatly intensified research into the subject, and markedly stimulated the urge to publish new findings.

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Definition of 'tumour'

There are different ways of defining the content of the term 'odontogenic tumour'. The authors have chosen – in the present context – to use the term 'tumour' in its broadest sense and not restricted to lesions that are definitively neoplastic. Even using this 'broad' definition, OTs are not frequently occurring lesions accounting for < 2–3% of all oral and maxillofacial specimens sent for diagnosis to oral pathology services (2). If viewed as a percentage of *all* tumours in the human body, this figure is reduced to a conservative estimate of approximately 0.002–0.003% (3).

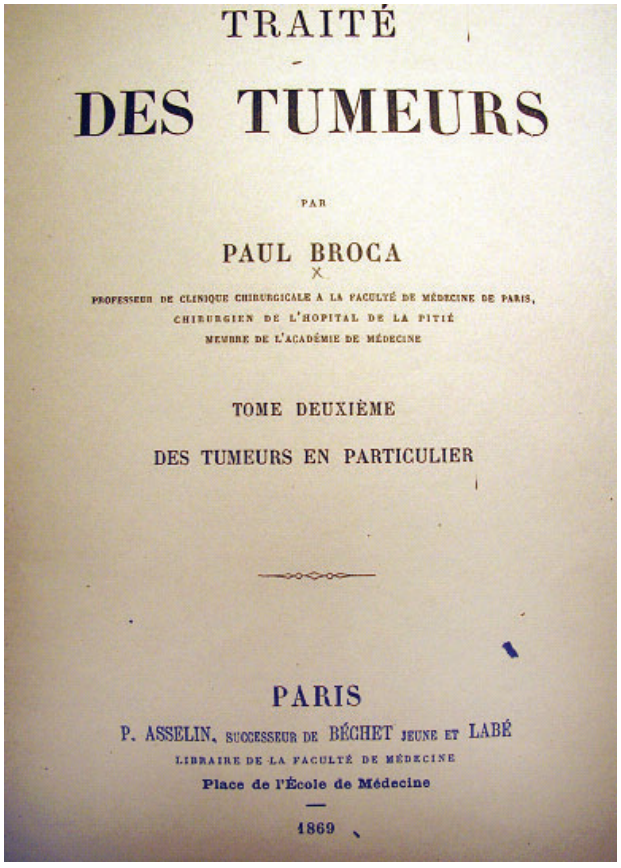
Early reports on OTs

The earliest dental journal report of an OT was that of a 7 cm large bony-hard lesion of a maxillary bicuspid that in todays terminology (4) would be diagnosed as a cementoblastoma. This particular case was published in the inaugural volume of the American Journal of Dental Science (AJDS) in 1839 (5), the appearance of this journal indicating one of many activities in the early years of the Golden Age of Dentistry (1835–1860) (6). This journal was the official publication of the first American Dental Association and the only dental journal accepted by the American Medical Association as a legitimate medical journal. According to Bouquot and Lense (6), approximately half of all scientific articles in the first volume of AJDS were related to pathological conditions of the mouth and jaws. A complex odontoma was reported in AJDS in 1848 (7) and was most unusual in that it erupted with the underlying tooth. The first unequivocal cases of compound odontomas were published in the mid 1850s (8, 9). It was, however, the

renowned French dentist, the founder of modern dentistry, Pierre Fauchard, who in 1746 (10) provided the first accurate description of an odontoma, undoubtedly being the earliest odontogenic lesion on record. As a curiosity, Richard Owen in 1846 (11) described an odontoma discovered in a 500 000-year-old British fossilized horse. Owen may be remembered as author of dental histology textbooks where his name is firmly associated with the so-called incremental or contour lines (Owen lines) easily demonstrated microscopically in ground sections of dentine.

Broca, 1869

During the mid-19th century, the number of reports on OTs increased quite considerably, published not only in American dental and medical journals but to a large extent reports also emerged in European scientific journals, like those in France, UK, Germany, Italy and Scandinavia. With the increasing number and varieties of reported cases of OTs, time seemed ripe for the initial attempts to start classifying them. In 1869, the French physician and professor of pathology and clinical surgery, Pierre Paul Broca produced a monograph (12), in which he suggested several tumour classifications among which was one on OTs (Figs 1–2). He used the term odontome, for any tumour arising


TRAITÉ

DES TUMEURS

PAR

PAUL BROCA

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TOME DEUXIÈME

DES TUMEURS EN PARTICULIER

PARIS

P. ASSELIN, SUCCESSEUR DE BÉCHET JEUNE ET LABÉ
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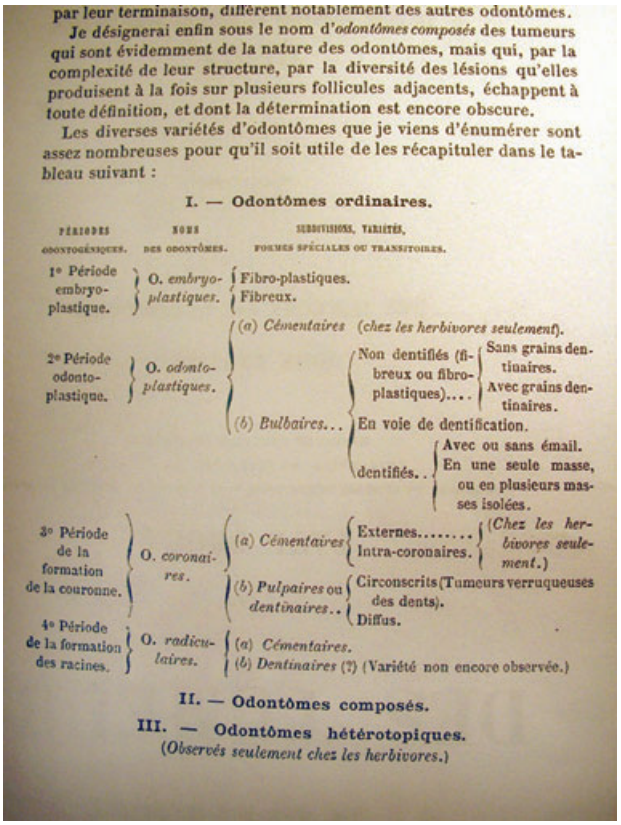
1869

Figure 1 Front page of Paul Broca's 'Traité de Tumeurs', 2nd volume, 1869.


par leur terminaison, diffèrent notablement des autres odontômes.

Je désignerai enfin sous le nom d'*odontômes composés* des tumeurs qui sont évidemment de la nature des odontômes, mais qui, par la complexité de leur structure, par la diversité des lésions qu'elles produisent à la fois sur plusieurs follicules adjacents, échappent à toute définition, et dont la détermination est encore obscure.

Les diverses variétés d'odontômes que je viens d'énumérer sont assez nombreuses pour qu'il soit utile de les récapituler dans le tableau suivant :

I. — Odontômes ordinaires.

PÉRIODES ODONTOGÉNIQUES.	NOMS DES ODONTÔMES.	SUBDIVISIONS, VARIÉTÉS, FORMES SPÉCIALES OU TRANSITOIRES.		
1° Période embryo-plastique.	O. *embryo-plastiques.*	Fibro-plastiques.		
		Fibreux.		
2° Période odonto-plastique.	O. *odonto-plastiques.*	(*a*) *Cémentaires* (*chez les herbivores seulement*).		
		(*b*) *Bulbaires*...	Non dentifiés (fibreux ou fibro-plastiques)....	Sans grains dentinaires.
				Avec grains dentinaires.
			En voie de dentification.	
			dentifiés...	Avec ou sans émail. En une seule masse, ou en plusieurs masses isolées.
3° Période de la formation de la couronne.	O. *coronaires.*	(*a*) *Cémentaires*	Externes.....	(*Chez les herbivores seulement.*)
			Intra-coronaires.	
		(*b*) *Pulpaires ou dentinaires*..	Circonscrits (Tumeurs verruqueuses des dents).	
			Diffus.	
4° Période de la formation des racines.	O. *radiculaires.*	(*a*) *Cémentaires.*		
		(*b*) *Dentinaires* (?) (Variété non encore observée.)		

II. — Odontômes composés.

III. — Odontômes hétérotopiques.
(*Observés seulement chez les herbivores.*)

Figure 2 Broca's classification of odontogenic tumours (or 'odontomes') as it appears on p. 300 of the 2nd volume.

from the dental formative tissues and he suggested to classify the lesions according to the stage of development of the tooth when abnormal growth commenced. However, Broca's classification did obviously not gain much ground or attention outside France. His extensive research-work was in fact not at all focussed on oral pathology. To look for his major contributions to science one has to search within the fields of anatomy, general pathology, neurology, ethnology, physiology and anthropology, and in addition, he is considered the founder of modern brain surgery. Late in life, this remarkable researcher and polyhistor turned to politics and became life member of the French Senate.

Malassez, 1885

In 1885 (13), another Frenchman, wellknown to oral histologists and indeed to oral pathologists, Louis Charles Malassez came forward with minor modifications to Broca's classification, again leaving no obvious impact internationally, in contrast to the *epithelial rests of Malassez*.

Bland-Sutton, 1888

Of more lasting value was Bland-Sutton's contribution to OT classification from 1888 (14). He, in fact, laid down the foundation to what could be called modern

OT-taxonomy by basing his classification upon the nature of the particular cells of the tooth germ from which the tumour arose. Bland-Sutton included odontogenic cysts and fibrous osteogenic tumours in his classification, but the term odontome or rather odontoma remained as the common designation for any tumour of odontogenic origin.

Gabell, James and Payne, 1914

Early in the year of 1914 (15), Gabell, James and Payne were asked by the British Dental Association to produce a report on odontomes. These authors elaborated on and further modified Bland-Sutton's classification. Again, the term odontome was used for all OTs. Their classification recognized three main groups of odontomes: (i) the *epithelial odontomes* included the neoplasm known at the time as a multilocular cyst as well as non-neoplastic cysts. (ii) the *composite odontomes* comprised those lesions in which the abnormal tissues derived from both epithelium and mesenchyme and formed either irregular calcified masses or recognizable tooth-like structures. And lastly (iii) *connective tissue odontomes*, a group including fibrous and other connective tissue tumours that were thought to arise from dental mesenchyme only.

Change in tumour terminology

In the years to follow, detailed studies of the odontomes led to a gradual replacement of this terminology by one more compatible with general pathological use, with the different lesions designated so far as possible in accordance with the parent cell type. Thus, the multilocular cyst became the *adamantinoma* or adamantoblastoma, terms in common use for quite some years, until Ivy and Churchill in 1930 introduced the now current *ameloblastoma*. The connective tissue odontomes became fibromas or cementomas according to their structure. The composite lesions, consisting of both epithelial and mesenchymal elements, however, retained their original designation as *odontomes* or odontomas.

Thoma and Goldmann, 1946

American Academy of Oral Pathology, 1952

In the classification by Thoma and Goldman published in 1946 (16), the odontogenic cysts introduced by Bland-Sutton in 1888 were again *excluded* whereas the enamel pearls – being developmental malformations rather than neoplasms – were in fact considered tumours under the name of *enamelomas*. The Thoma and Goldman classification was widely accepted and used in several, particularly American oral pathology text books and formed the nucleus of the classification adopted with minor changes in the American Academy of Oral Pathology in 1952. At this time the term odontoma has been narrowed down to designate only those lesions that consist of both epithelial and mesenchymal elements.

Pindborg and Clausen, 1958

Gorlin et al., 1961

A new concept became popular and much debated in the 1950s when discussing the pathogenensis of OTs, and the main theme was: is it likely that the so-called inductive effect or phenomenon accepted to occur and making an important impact on normal odontogenesis, also operates in OT pathogenesis? Pindborg and Clausen (1958) (17) suggested that this reciprocal epithelial–mesenchymal interaction could very well explain at least some of the cellular changes encountered in tumour pathogenesis. On this basis, the authors came forward with a much debated – but generally positively received – classification. The tumours were divided into two main groups: *epithelial* and *mesodermal*. Depending on the ability of the epithelium to induce changes in the surrounding mesenchymal tissue, the epithelial tumours were further subdivided in to two groups: (A) comprising pure epithelial tumours with *no* inductive changes in the connective tissue, like ameloblastoma and calcifying epithelial odontogenic tumour [CEOT, described in detail and named in 1958 by Pindborg (18) and since often referred to as the Pindborg tumour]. The second group (B) was composed of epithelial tumours that *do* show inductive changes in the mesenchyme. These tumours comprised a soft tissue type [ameloblastic fibroma (or sarcoma)] and those characterized by the occurrence of hard dental tissue, dentinomas and odontomas. Lastly, the mesodermal tumours covered odontogenic fibroma (and fibrosarcoma), odontogenic myxoma and cementifying fibroma. The Pindborg and Clausen classification, slightly modified by Gorlin et al. in 1961 (19), was at the time viewed as a major step forward, and played an important role in the WHO publication 'Histological Typing of Odontogenic Tumours' (1).

The WHO initiative, 1958

Moving further along the winding road of OT classifications, an important initiative was taken by the WHO in 1958. The WHO Executive Board passed a resolution requesting the Director-General to explore the possibility that WHO might organize an International Reference Centre and a number of Collaborating Laboratories in various parts of the world and arrange for the collection of human tissues and their histological classification. The main purpose of these centres would be to develop histological definitions of tumour types and to facilitate the wide adoption of a uniform nomenclature with the obvious aim of improving communication among cancer workers.

WHO Collaborating Centre, 1966–1969

WHO Histological Typing of Odontogenic Tumours, Jaw Cysts, and Allied Lesions, first edition, 1971

The WHO Collaborating Centre for the histological classification of OTs and allied lesions was established in 1966 at the Department of Oral Pathology, The Royal Dental College in Copenhagen, Denmark, headed by professor Jens Pindborg. At a meeting in Geneva,

Switzerland in the same year, attended by professors Ivor Kramer, University of London and Jens Pindborg, a tentative classification was drafted and it was decided that jaw cysts should be included. All the histological preparations from the cases studied were reviewed during the following years by an international panel of expert oral and general pathologists. Finally, in 1969, the classification was adopted. Two years later, in 1971, the first authoritative and useful guide to the classification of OTs, cysts and allied lesions was published by WHO, authored by Pindborg and Kramer (1). In the preface it was stressed that the book was not intended to serve as a textbook, why literature references were not supplied.

WHO Histological Typing of Odontogenic Tumours, 1992, second edition

Twenty-one years later, in 1992 a second edition entitled: 'Histological Typing of Odontogenic Tumours' appeared (20). In addition to epithelial cysts it comprised neoplasms and other lesions related to bone. The authors of the first edition, professors Kramer and Pindborg were joined by a third author, professor Mervyn Shear in this new edition. The basic framework of the first edition remained essentially unchanged. However, some recently recognized tumours were added, such as the squamous OT and clear cell OT, to mention a few new-comers.

Revision of the 1992-edition of the WHO classification (Philipsen and Reichart, 2002)

In early 2002, the authors of the present article met to discuss if time had come to suggest a revision and updating of the second edition of the WHO classification and the meeting resulted in a publication later that year (21). The advances made in our understanding of the origins and interactions of the odontogenic tissues in tumour development during the intervening decade were quite substantial, not the least thanks to the rapid progress within immunohistochemistry and molecular biology methodologies. Several reports of hitherto unknown tumour entities and variants further added to the suggestion of a revision.

WHO Classification of Tumours, 2000–2005

In the year 2000, the International Agency for Research on Cancer (IARC) in Lyon, France started a new book series, 'WHO Classification of Tumours'. The new 'WHO Blue Books' encompass both histopathological and genetic criteria for tumour classification. The series editors are Paul Kleihues, Lyon and Leslie Sobin, Washington. The first volume dealt with Tumours of the Nervous System (2000), followed by the Digestive System (2000), Haematopoietic and Lymphoid Tissues (2001), Soft Tissues and Bone (2002), Breast and Female Genital Organs (2003), Urinary System and Male Genital Organ (2004), Lung, Pleura, Thymus and Heart (2004), Endocrine Organs (2004), Head and Neck Tumours [July 2005, (4)] and Skin Tumours (December 2005).

Pathology and Genetics, Head and Neck Tumours, 2005

To participate in the volume on the Head and Neck Tumours with particular reference to chapter 6: Odontogenic Tumours and Bone Related Lesions, the editors invited a number of oral and general pathologists: P.A. Reichart (responsible editor), H.P. Philipsen, P.J. Slootweg, J.J. Sciubba, I. van der Waal, F. Praetorius and G. Jundt, to act as a working group for editing the manuscripts from the contributors and attending the final Editorial and Consensus Conference in Lyon in mid-July 2003, where revision of the tumour terminology was debated at great length and finally agreed upon.

Future OT classifications

Although, a new, totally revised and enlarged WHO classification is now at the disposal of pathologists worldwide, there is nothing to indicate that the last word has been said regarding terminology and classification of OTs. It is hoped that the new Blue Book will act as a source of inspiration and increase the curiosity for continuous research into OTs and allied lesions.

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