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Dental Formulas of Humans and Other Mammals: Classification according to their Evolution

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Abstract: ***Introduction: A dental formula is a graphic representation that indicates the number of teeth that a certain species has. We suppose that mammals, and among them man, can have a different evolution in the number and distribution of teeth andthis will be reflected in the dental formula. The objective of this work is to evaluate if this hypothesis is correct or not and to make a classification of the dental formulas according to their evolution. Methods: A bibliographic review was made to know the permanent dental formulas in the most common mammals and with this the material was obtained. These were grouped into 4 tables taking into account the absence or not of incisors and canines and the type of feeding. Results: They are in tables 1-4. Conclusions: A- Dental agenesis may have a genetic cause, but they are within an evolutionary tendency of the dentition, which are a consequence of the change in eating habits. B- In the dental formulas of mammals there are three different evolutions: I- Mammals without incisors.Herbivores. II- Mammals without canines. Rodents. III- Mammals with incisors and canines: IIIa- Carnivores. IIIb- Omnivores and others.The human is in this group.***

Keywords: dental, formulas, mammals, classification, evolution

1. Introduction

A dental formula is a graphic representation that indicates the number of teeth that a certain species has. It is a fraction where the numerator represents the teeth of the upper jaw and the denominator the teeth of the lower jaw. As the teeth on the right and left side are usually equal in number, in that fraction only those on one side are represented. In this way the total number of teeth will be the result of adding the amount of the numerator and the denominator, and multiplying by two [1,2]. Dental formulas are only used in mammals, because in these, differentiation can be made in the shape, position and function of the teeth. They are classified into I: incisors, C: canines, PM: premolars and M: molars [3]. There is no dental formula in fish, amphibians, or reptiles, where equal teeth are replaced as they wear out [4].

The evolutionary process of the teeth of mammals, their natural selection and their food specialization has given them different functions. This has led to variations in the shape, size and number of teeth. The non-current mammal with the largest number of teeth has dental formula 3.1.5.3/3.1.5.3, with a total of 48 teeth. Among current mammals, the largest number of teeth has a dental formula 3.1.4.3/3.1.4.3, with a total of 44 teeth. The denture is usually symmetrical, but this is not always the case. On other occasions the dental formula is similar in nearby species, but in other cases it can vary a lot [1].

The proportion of premolars and molars in titis (2132/2132) is inverse to that of humans (2123/2123), but no explanation has been given to this evolutionary process. In others such as the ringed lemur, galago, loris and capuchin monkey have an equal proportion of premolars and molars (2133/2133) [1].
We suppose that mammals, and among them man, can have a different evolution in the number and distribution of teeth and this will be reflected in the dental formula. The objective of this work is to evaluate if this hypothesis is correct or not and to make a classification of the dental formulas according to their evolution.

2. Material and methods

A bibliographic review was made to know the permanent dental formulas in the most common mammals and with this the material was obtained [1,3,5-9]. These were grouped into 4 tables taking into account the absence or not of incisors and canines, and the type of feeding.

3. Results

They are in tables 1-4.

4. Discussion

It is a paradox that in fish there is no dental formula, because animals like the shark can have up to 3000 teeth at a time, arranged in five rows. Its teeth are modified scales with the typical structure of a tooth, with external layer of enamel, middle layer of dentine and inner cavity or pulp. When a tooth is damaged or lost, a new tooth appears, although it can also be replaced every 10-60 days [4].

The teeth of mammals have specialized for different functions, so that there are animals that have lost teeth during their evolution, because they were not necessary [1]. The herbivorous mammals of Table 1 do not have incisors and / or canines, and in the case of rodents (Table 2) they lack the canines. The rest of mammals could be grouped in a single table, but there is a large group of them that are carnivores, so we put them in table 3a and the others in table 3b.

In the evolution of primates, there is a tendency to reduce the length of the jaw and prognathism, the size of the mandibular canine, the number of cusps of the first molar and the presence of the third molar [10].

In humans, an evolutionary tendency to lose third molars has been described, and agenesis of maxillary lateral incisors and second mandibular premolars frequently occurs [11-16]. For that reason they have a different evolutionary trend from the mammals in Tables 1 and 2.

Within table 3b there are mammals like llama, guanaco, alpaca and vicuña that are herbivores and yet we can not put them in table 1, because they have incisors and canines, indicating an evolutionary trend different from the rest of herbivores.

It is considered that family dental agenesis has a genetic cause [11,17-19] and it has been described as a dominant autonomic inheritance with incomplete penetration and variable expression [12]. However, the phylogenetic theory explains dental agenesis as evolutionary changes of the species, as a consequence of a masticatory hypofunction due to a change in eating habits, with a progressive reduction of the teeth [12]. In our opinion both theories can be combined, to give an explanation to dental agenesis.

In 1939 the English paleontologist Butler proposed to subdivide the dentition of the mammals in development fields, existing one for molars and premolars, another for incisors and another for the canines. In each of these fields there is a key tooth that from the point of view of development is more stable than the others. In this way, the third molar and the upper lateral incisor would be the most affected [18]. The results obtained are consistent with this theory and confirm a different evolution of dental formulas of mammals, depending on whether or not there are certain teeth.

5. Conclusions

1) Dental agenesis may have a genetic cause, but they are within an evolutionary tendency of the dentition, which are a consequence of the change in eating habits.
2) In the dental formulas of mammals there are three different evolutions:

I- Mammals without incisors.Herbivores.
II- Mammals without canines. Rodents.
III- Mammals with incisors and canines:
IIIa- Carnivores.
IIIb- Omnivores and others.The human is in this group.

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Table 1: Dental formulas of herbivorous mammals, where there are missing incisors and sometimes also canines

Mammal common name	Hemimaxilla	Hemijaw	Total Teeth
	I.C.PM.M.	I.C.PM.M.	
Elephant	1.0.3.3	0.0.3.3	26
Sheep	0.0.3.3	4.0.3.3	32
Cow			
Moose	0.0.3.3	3.1.3.3	32
Pronghorn			
Bison			
Whitetaildeer			
Mountain goat			
Muskox			
Bighorn			
Armadillo	0.0.7.1	0.0.7.1	32
Elk	0.1.3.3	3.1.3.3	34
Caribou			

Table 2: Dental formulas of rodent mammals, where canines are missing

Mammal common name	Hemimaxilla	Hemijaw	Total Teeth
	I.C.PM.M.	I.C.PM.M.	
House mouse	1.0.0.3	1.0.0.3	16
Muskrat			
Rice rat			
Jumping mouse	1.0.1.3	1.0.0.3	18
Beaver	1.0.1.3	1.0.1.3	20
Kangaroorat			
Porcupine			
Geomys			
Nutria			
Apache foxsquirre			
Mountain Beaver	1.0.2.3	1.0.1.3	22
Golden-mantledsquirrel			
Chipmunks			
Red squirrel			
Prairie dog			
Marmota			
Pikas	2.0.3.2	1.0.2.3	26
Rabbit	2.0.3.3	1.0.2.3	28
Hare			

Table 3 (a): Dental formulas of mammals where there are incisors and canines. Carnivores

Mammal common name	Hemimaxilla	Hemijaw	Total Teeth
	I.C.PM.M.	I.C.PM.M.	
Lynx	3.1.2.1	3.1.2.1	28
Jaguar	3.1.3.1	3.1.2.1	30
Cat			
Lion			
Ocelote			
Arcticfox	3.1.4.2	3.1.4.3	42
Grey fox			
Coyote			
Brown bear			
Polar bear			
Grizzlybear			
Black bear			
Wolf			
Dog			

Table 3(b): Dental formulas of mammals where there are incisors and canines. Others

Mammalcommonname	Hemimaxilla	Hemijaw	Total Teeth
	I.C.PM.M.	I.C.PM.M.	
Pallidbat	1.1.1.3	2.1.2.3	28
Hognose bat	2.1.2.3	0.1.3.3	30
Langnose bat	2.1.2.2	2.1.3.2	30
Sifaka	2.1.2.3	2.0.2.3	30
CommonMarmoset	2.1.3.2	2.1.3.2	32
Aye-Aye	2.1.2.3	2.1.2.3	32
Shrew	3.1.3.3	1.1.1.3	32
Sea otter	3.1.3.1	2.1.3.2	32
Llama	1.1.1-2.3	3.1.1-2.3	28-32
Guanaco			
Alpaca			
Vicuña			
Human	2.1.2.3	2.1.2.3	32
Tarsier monkey			
Stripedskunk	3.1.3.1	3.1.3.2	34
Weasels			
Badger			
Mink			
Ring-tailedlemur	2.1.3.3	2.1.3.3	36
Galago			
Loris			
capuchinmonkey			
Peccary	2.1.3.3	3.1.3.3	38
Marten	3.1.4.1	3.1.4.2	38
Racoon	3.1.4.2	3.1.4.2	40
Coati			
Horse	3.0-1.3-4.3	3.0-1.3.3	36-42
Pig	3.1.4.3	3.1.4.3	44
Wild pig			
Opossum	5.1.3.4	4.1.3.4	50

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