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Dietary Habits in Ancient India: An Assessment Through Dental Attrition

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ABSTRACT This study is an attempt to assess the dietary habits of the ancient Indians with the aid of dental attrition. Evidences suggest that there exist a high correlation between the rate of dental attrition and the physical consistency of diet. Attrition rate of the earlier population belonging to different cultures from 2300-300 B.C., *viz.*, the Neolithic, Harappan, Chalcolithic, Megalithic and the Early Historic may be tested by comparing the attrition rates of the Modern Indians with known dietary habits. For such a comparison individual age plays a vital role, which is rather hard to estimate accurately in the ancient skeletal remains. Differences in intermolar attrition gradients within individuals provide an age independent method for comparing attrition rates. Employing this method, when the ancient specimens are compared with the modern population from Eastern India, no significant differences in attrition gradients could be detected. This perhaps, implies that diets of similar consistency were utilised by both the ancient and modern Indians. Low incidence of oral diseases, again, indicates no gross change in food habits of the ancient Indians and their foodstuff were mostly free from high carbohydrate diet, sand and silicus particles. Furthermore, the nature of tartar deposition suggests softer food habit of the ancient Indians. The ancient Indians belong basically to a mixed economic group, used to softer food and had the knowledge of cooking.

Human tooth attrition was often described in the past as a pathological condition, but its frequent occurrence among the earlier and modern skeletal population groups suggest that the erosion of tooth surface is a normal result of tooth function (Goose, 1963; Murphy, 1959; Molnar, 1971). So, the study of worn teeth will provide some informations about the dietary habits, chewing patterns, jaw relationships and tooth eruption sequence, etc., of the ancient and modern population groups.

Attrition is a continuous process of erosion of the enamel and dentine, by which the occlusal surface of the tooth is lost during mastication by rubbing of one tooth surface against another and finally exposed the dentinal area. Progressive tooth wear under a four-fold system of classification, *i.e.*, slight, moderate, medium and marked, appears to be arbitrary, and it lacks proper criteria for classifying the continuous process of the dentine exposure. As such, in the present study different patterns of dentine exposure in each permanent lower molar obtained from 218 adult individuals, who lived in this country during the period from 2300 B.C. to 300 B.C. have been examined and recorded by emplyoing the system of Murphy (1959), with the addition of one new pattern type.

The aim of the present study is to record the incidence of the different patterns of dentine exposure with increasing tooth attrition, in order to assess the dietary habits of the early Indians through dental erosion.

MATERIALS AND METHOD

The present study is entirely based on the collection of skeletal materials from different archaeological sites of the Indian Subcontinent, *viz.*, Harappa, Mohenjodaro, Kalibangan, Lothal,

Table 1: Basic materials for the present study

S. No.	Sites	Individuals: Maxilla & Mandible	Individuals: Mandible only	Individuals: Total	Culture/Date	Total tooth observed
1.	Harappa	28	4	32	Harappan	221
2.	Mohenjo-daro	5	4	9	(2300 B.C. - 1750 B.C.)	
3.	Kalibangan	3		3		
4.	Lothal	10	2	12		
5.	Ruper	5	3	8		
6.	Burzahom	8		8	Neolithic-Chalcolithic	101
7.	Nagarjunakonda (Neolithic)	6	2	8	(2000 B.C. - 1000 B.C.)	
8.	Pandu Rajar Dhibi	5		5		
9.	Brahmagiri	2	1	3	Megalithic	194
10.	Nagarjunakonda (Megalithic	11		11	(900 or 800 B.C. - 300 B.C.)	
11.	Maski	72	25	97		
12.	Kumhar Tekri (Ujjan)	19	3	22	Early Historic (300 B.C.)	102
	Total	174	44	218		618

Table 2: Distribution of dentine exposure in mandibular molars of different groups under three - fold classification*

Groups	Molars	No. of Teeth	N	Discrete (a - d)	Intermediate (e - g)	Coalesced (h & i)	Source
Harappa	M_1	77	2.6	62.3	24.7	10.4	Present
	M_2	78	37.2	55.1	6.4	1.3	study
	M_3	66	74.2	19.7	6.1	-	
Neolithic-Chalcolithic	M_1	35	-	51.4	22.9	25.7	Present
	M_2	35	20.0	48.6	14.3	17.1	study
	M_3	31	45.2	25.8	22.6	6.4	
Megalithic	M_1	63	9.5	77.8	9.5	3.2	Present
	M_2	84	38.0	42.9	17.9	1.2	study
	M_3	47	53.2	38.3	4.2	4.2	
Early Historic	M_1	39	-	43.6	23.1	33.3	Present
	M_2	35	20.0	48.6	20.0	11.4	study
	M_3	28	50.0	39.3	-	10.7	
Modern Indian	M_1	315	0.9	60.0	24.1	14.9	Pal, 1970
	M_2	302	33.1	51.0	14.6	1.3	
	M_3	222	66.7	28.4	2.7	2.2	

*Discrete (a-d) where the exposed areas remain separate; Intermediate (e-g) where both the discrete and coalesced areas occur simultaneously; Coalesced (h & i) where all the four cusps coalesced into one.

Rupar, Burzahom, Nagarjunakonda, Pandu Rajar Dhibi, Brahmagiri, Maski and Kumhar Tekri (Ujjain). The entire materials are at present housed in the Osteology Laboratory of the Anthropological Survey of India. All these remains are in a relatively fragile condition, and some of them are fragmentary, deformed and distorted. The determination of sex and age of such

materials is very difficult and often impossible. So, in the present study only the adult individuals are considered and they are further subdivided into cultural groups, *viz.*, Harappan, Neolithic-Chalcolithic, Megalithic and Early Historic (Table 1).

The assignment of different archaeological sites to different cultures was done by scholars mainly on the basis of cultural characteristics of the associated finds with skeletal remains. It should, however, be mentioned that with the exception of Burzahom (Kashmir) the Neolithic culture of India shows much overlapping with the Chalcolithic. There are many regional variations, of the Neolithic industries, mostly associated with the contemporary Chalcolithic culture. Krishnaswami (1960), Allchin and Allchin (1968) called this complex as "Neolithic-Chalcolithic". In the present study, the author has found it convenient to use the "Neolothic-Chalcolithic" as a culture category for classifying the materials.

It is observed that dentine has become exposed at the centre of an attritional facet in each dental cusp. The dentinal area is characteristically sector-shaped at the time of earliest appearence of the dentine. But the shape is changed due to the enlargement of the attritional area and gradually coalesced until the whole occlusal area was affected. In case of mandibular molar the presence of fifth cusp (Hypoconulid) is often noticed and the dentine exposure on this cusp is in close accord with that on the distobuccal cusp (Entoconid) and that these two areas often show early fusion. So the presence or absence of fifth cusp is ignored in classifying the pattern types.

The pattern types may be classified briefly as follows according to the degree of dentine exposure (Fig. 1):

N - Teeth with no dentine exposure but enamel facet is present
a - dentine exposed on any one cusp
b - dentine exposed on any two cusps
c - dentine exposed on any three cusps
d - dentine exposed on all the four cusps but the dentinal areas remaining separate
e - any two dentinal areas coalesced into one through lateral angles, leaving one discrete area or none. The coalescence may occur diagonally
f - same as pattern 'e' but instead of one discrete area there should be two discrete areas in addition to one coalesced area, or, there should be two coalesced areas.
g - any three dentinal areas coalesced into one, leaving one discrete area or none
h - all the four dentinal areas coalesced into one with some enamel present on the occlusal surface
i - enamel present on the rim only.

RESULTS AND DISCUSSION

Percentage distribution of dentine exposure patterns under three-fold classification system, *i.e.*, discrete (a-d), intermediate (e-g) and coalesced (h & i) in mandibular molars of different ancient population groups including the modern Indians from Eastern India which is predominantly rice eating area, reveals that the occurrence of diserete type is more frequent, while the intermediate and coalesced pattern types are more common on the first molars, somewhat less in the second and least in the third. This is trend holds good for both the ancient and modern Indian population groups (Table 2). So this attrition sequence can be considered as an indirect indication of eruption sequence of the permanent molars (Murphy, 1959; Pal, 1971).

It may be noted here that the modal ages for the eruption of permanent molars are 6 years, 12 years and 18 to 21 years for the first, second and third molar respectively (Scott and Symons, 1961; Brothwell, 1963; Miles, 1963). As the first molar erupts at 6 years and soon starts functioning in the mouth cavity on reaching the occlusal plane, its attrition will be more marked than the second molar due to the later's late eruption. Similarly, the degree of attrition will be more on the second than on the third molar. So the lesser attrition of the second and third molars may be due to their late eruption.

For correlation of pattern types with age the dentine exposure patterns in mandibular molars from known age mandibles *i.e.*, 20 to above 50

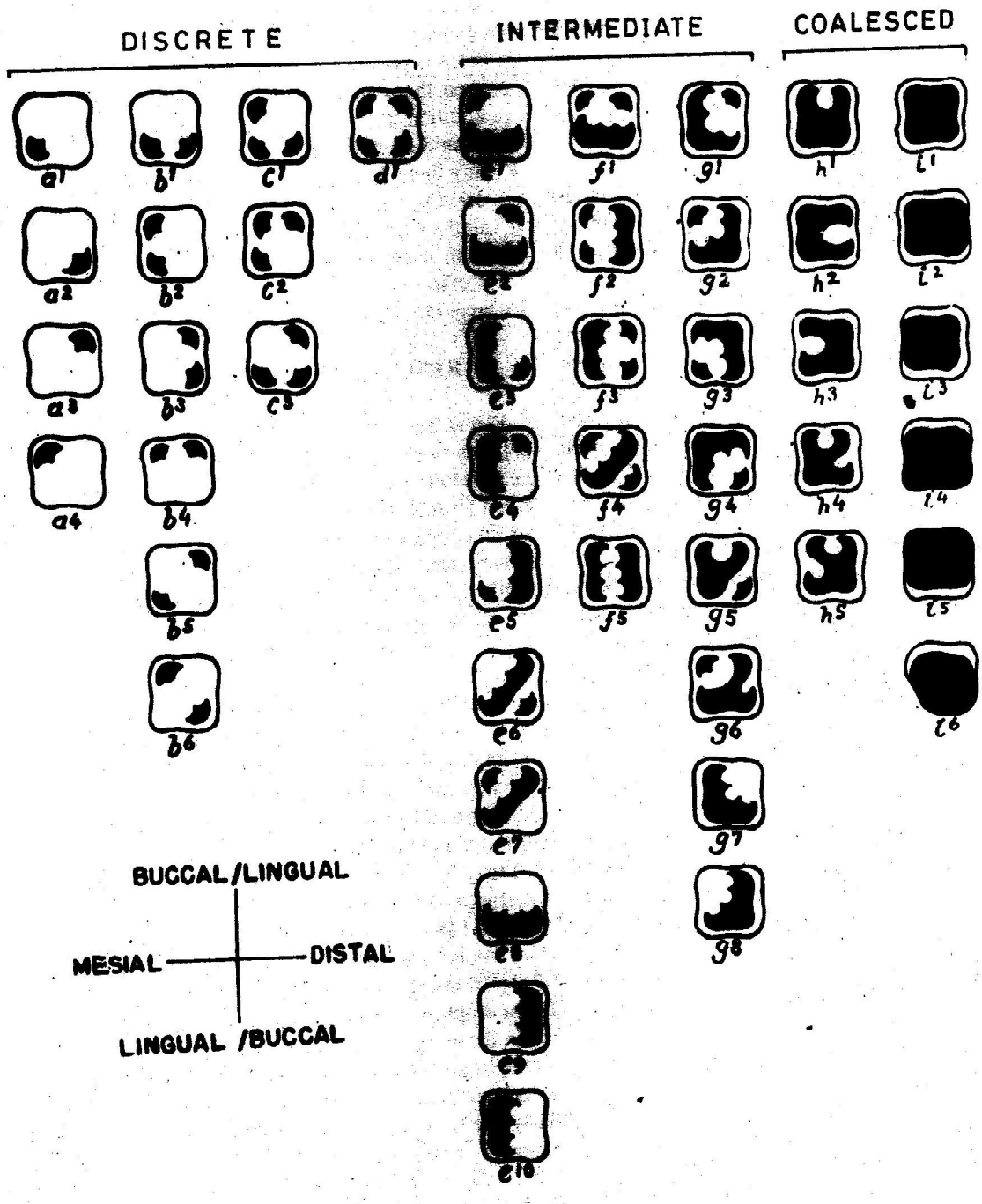

Fig.1. Patterns of dentine exposure

Table 3: Spearman's rank correlation coefficients caluculated for attrition in mandibular molars

Group	*No.*	*r for* $M_1 \cdot M_2$	*No.*	*r for* $M_2 \cdot M_3$	*No.*	*r for* $M_1 \cdot M_3$
Modern Indians	207	.999	184	.999	184	.999
Harappan	67	.999	60	.999	60	.997
Neolithic-Chalcolithic	34	.997	28	.995	28	.990
Megalithic	42	.998	35	.998	35	.995
Early historic	32	.994	30	.997	30	.998

Table 4: t - values (Abbreviation used for Molar Pairs : A=M_1 M_2; B=M_2M_3 C=M_1 M_3)

Molar Pairs		*Modern Indian* A B C	*Harappan* A B C	*Neolithic Chalcolithic* A B C	*Megalithic* A B C	*Early Historic* A B C
Modern Indian	A	-				
	B	-				
	C	-				
Harappan	A	0.000	-			
	B	0.000	-			
	C	0.200	-			
Neolithic Chalcolithic	A	0.138	0.131	-		
	B	0.198	0.198	-		
	C	0.300	0.233	-		
Megalithic	A	0.095	0.088	0.058	-	
	B	0.088	0.0.82	0.131	-	
	C	0.200	0.100	0.167	-	
Early Historic	A	0.025	0.241	0.122	0.179	-
	B	0.138	0.132	0.082	0.179	-
	C	0.100	0.100	0.267	0.150	-

Table 5: Food habit and its effect on teeth

Food Source	*Nature of Food*	*Effect on Teeth*	
		Initial Effect	*Late Effect*
Hunting & gathering	Tough and Fibrous	Severe attrition	Exposure of pulp cavity
Agriculture	Soft and sticky	Oral debris & Calculus resulting dental abscess & Periodontal disease	Tooth loss
	High Carbohydrate content	Dental caries	Tooth loss

years from Eastern India (Pal, 1970)) when scored by using 4-point scale, that is

1 = no dentine exposure, but enamel facet is present

2 = dentine exposed and the exposed areas remain separate

3 = Where both the discrete and coalesced types occur simultaneously, and

4 = where all the four cusps coalesced into one, reveals that the degree of dentine exposure increases with the increase in age (Fig. 2).

So in dietary investigation the rate of attrition and individual age are the most important factors.

Smith (1972) points out that to assess the dietary habits of the earlier population it is necessary to compare the rate of attrition of the earlier population with the attrition rate from the modern groups of known dietary habits. For such comparison the age is the most important factor. But working with skeletal material, especially the ancient skeletal remains, the estimation of age is very difficult and often impossible owing to their fragmentary and destorted condition. So to avoid age factor, as per Smith's suggestion the difference in intermolar gradients within the individual is considered by using 4 point scale and for intergroup comparison Spearman's rank correlation coefficient were calculated for each of the molar tooth pairs, *i.e.*, M_1M_2 ; M_2M_3 and M_1M_3 of different ancient population groups including the modern Indians. The results presented in table 3, reveals no significant difference between the modern and early Indians when it is statistically tested (Table 4), indicating that the diets of similar consistency were utilised by the ancient Indians, though they culturally differed among themselves.

So when we want to know the nature of foods taken by the ancient people, especially of India and Pakistan subcontinent we have to depend entirely on archaeological evidences obtained from excavated materials of different sites which are the main sources of getting such information.

Unfortunately no remnants of agricultural implements have been found in any Harappan settlements. But it is surmised that wooden plough and sickles with chart blades were known to them. The granaries of Harappa and Mohenjo-daro are the best examples to suggest that the Harappans were basically an agricultural people. Some varieties of wheat and barley, charred peas, sessamum, melonseeds, rai are reported from Harappa and Mohenjo-daro respectively

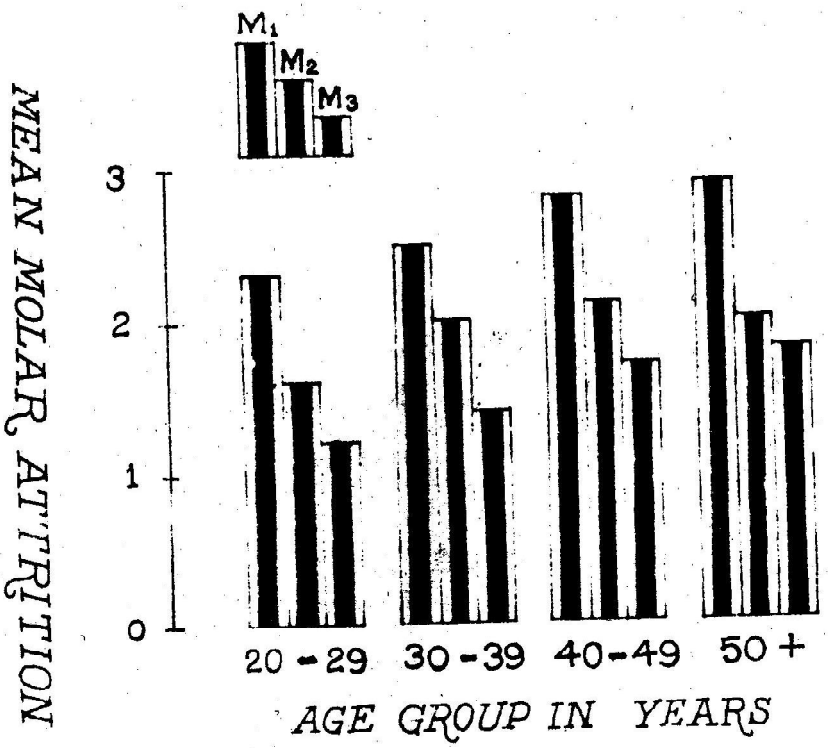

Fig.2. Relation of dental attrition with age

suggest the cultivation of these crops (Vats, 1940). Millet known as Bajra seems to have been confined to Saurashtra (Santapu, 1953). Like the wheat, rice played an important role in Saurashtra (Rao, 1973). The discovery of rice husks and spikelets embedded in clay and pottery at Lothal is of particular interest.

The Neolithic cultures had appeared in various parts of India and are not as yet well enough known to allow any inferences regarding their economy. The northern Neolithic of Kashmir is becoming better known as the reports on the excavations at Burzahom are published, but it is too early to say to what extent the hunting, stock-raising and agriculture played in their economy (Allchin and Allchin, 1968). But in southern Neolithic there are several indications of rice with several pulses like horse-gram, green gram, black gram, grass pea, and lentil. Cultivation of wheat during Chalcolithic period suggested by its occurrence at Navdatoli and Sonegaon. The evidence of rice at Mahisadal and Pandu Rajar Dhibi, West Bengal, also suggest its cultivation. The frequency of rice husk embedded in clay and pottery both in the Iron Age and subsequent Early Historic periods in the sites of the Ganges suggest that the cultivation of rice was a feature not only confined in the central Ganges region but also towards peninsula during the Iron Age.

The range of domesticated animals, or of wild animals used for food, is quite large. Apart from sheep and goats, there is reported evidence of humped and humpless cattle. Bones of Indian boar were frequently found which might have been either domesticated or hunted. The bones of domestic fowl are noteworthy. There is also a range of wild animals which were undoubtely hunted for food, these include the sambar deer, spotted deer, hog deer and several varieties of tortoise. The copper fish-hooks found at Lothal also suggest that fishes were caught for food.

From the charred grains and animal bones found in the excavations we may conclude that the early Indians ate wheat, rice barley and bajra in addition to fish, fowl, cattle, deer, pig, black buck and birds. The pottery types such as dish-on-stand, beaker, dish and bowl also suggests th eating habit of the earlier people. In addition t pottery, vessels, a few dishes and bowls made o stone, ladles and bowls made of shell were als used. The terracotta dough plates, stone quern and grinding mills suggest that cakes made o flour were eaten by the earlier people.

Some scholars (Brothwell 1963; Davis 1963 Goldstein 1948; Moorrees 1957) tend to associate the dietary habits with the occurrence of oral diseases (Table 5). If this is true than the data of dental morbidities of the ancient Indians obtained from previous study (Pal 1979) shown in table 6, can be utilised in the present study. The table reveals that the ancient Indians had a very low incidence of dental caries suggesting that during the period 2300 B.C. - 300 B.C. there was no gross change in the food habits of the ancient Indians and their foodstuff was mostly free from high carbohydrate foods. Their food was not at all tough and fibrous in nature, and foodstuff was also free from sand and silicious materials as indicated by the extremely low incidence or even complete absence of pulp expo-

Table 6: Percentage frequency of different dental morbidities in early Indians

Morbidity	*Harappan*	*Neolithic-Chalcolithic*	*Megalithic*	*Early Historic*
No. of Teeth	*1501*	*577*	*1013*	*431*
Dental Caries	1.8	0.3	2.5	2.1
Antemortem tooth loss	2.1	0.5	0.3	3.2
Alveolar abscess	0.1	0.7	0.3	0.7
Exposure of pulp cavity	0.5	1.4	0.1	0.0
Resorption of alveolar bone (Medium & Marked)	31.5	10.6	11.2	10.9
Dental Calculus (Medium & Marked)	10.6	11.1	11.9	6.7

sure through attrition. Apart from dental caries and pulp exposure, the ancient Indians had a considerable degree of tartar deposition and alveolar bone loss in their margin of the gums pointing towards softer foodhabits of the ancient Indians. But the greater degree of loss of alveolar bone among the Harappans does not suggest that the Harappan people were more susceptible to periodontal disease. Alveolar bone resorption may be of functional origin or it may be due to aging (Robinson and Boling, 1952) or periodontal disease (Brothwell, 1963). We must bear in mind that the alveolar abscess which is one of the symptoms of periodontal disease was virtually absent (0.1 per cent) in them. The alveolar bone loss among the ancient Indians in general appears to be more functional in nature than pathological, because in the these groups the incidence of abscess was well below 1 per cent.

So from the foregoing facts it will be well justified to assume that the ancient population of India and Pakistan subcontinent, belonged basically to a mixed economic group with the knowledge of cooking and habituated in taking softer food.

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