Morphometric Analysis of the Sockets for the Upper Temporary Molar Teeth in Human Foetuses

Análisis Morfométrico de los Alvéolos de Molares Temporales Superiores en Fetos Humanos

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SUMMARY: Foetal therapy has made foetal anatomy a promising field. Maxilla had been the core research attraction of many scientists. Alveolar arches, specially the maxillary one had been consistently the focus of attention for research workers due to its importance in dentistry. Twenty nine human foetuses were grouped into I (<24 weeks of IUL), II (25-30 weeks of IUL) and III (>30 weeks of IUL). Maxillae were dissected out and sockets were carefully cleaned. Sockets for the temporary molars, which also hold permanent premolars were measured with the help of Vernier callipers. Three parameters, i.e. maximum mesiodistal diameter, maximum transverse diameter and maximum depth were considered. Readings were analysed statistically by using Student's 't' test. Growth was maximum in group II for the mesiodistal diameter of the socket for 1st temporary molar but significant bilateral variation or sexual dimorphism was not found. A very high rate of growth (+63%) was noticed in group II foetuses. Contrary to mesiodistal values, transverse diameter showed significant higher values on left side in group II foetuses. Similarly in late foetuses of group III, values were significantly more in males than those in females. It might be reflecting the higher measurements in general in male adult skeleton compared to females. The increase in the depth was significantly higher in the last two groups but the rate was again more in group II (57%) than in group III (29%). Although no bilateral variations were noticed, the value was found to be higher in male than female in last foetal group. The values increased with great rate in both group II and III foetuses for the mesiodistal diameter of the socket for 2nd temporary molar. An unexpected increase in the mesiodistal readings of female socket was observed in group II. The values of transverse diameter showed a consistent increase i.e. a significant increase in group II and III foetuses, a pattern observed in mesiodistal diameters also. Values of transverse diameters were on a higher side as compared to the mesiodistal measurements. Group II foetuses showed some sexual dimorphism with a higher value in male with a p value of <0.01. The depths of the sockets for 2nd temporary molar teeth showed highly significant increase in group II (p<0.001). The higher values in male were again observed in larger foetuses of group III. Some of the striking features of our study were, 1. Spurt of growth leading to very high values in group II foetuses, 2. A mesiodistal compression in both the sockets i.e. for 1st and 2nd temporary molars, 3. No bilateral variations, highlighting the natural symmetry of face, 4. Higher values in males in late foetal group.

KEY WORDS: Morphometry; Foetus; Socket; Tooth; Deciduous.

INTRODUCTION

Foetal therapy (Schulman, 1986; Soper *et al.*, 1984) has made foetal anatomy a promising field. Foetal skull and its individual bones were the subjects of interest by several authors in the past (Nemzek *et al.*, 1996; Luke, 1976; Radlanski *et al.*, 1999; Freiband, 1937). Maxilla had been the core research attraction of many scientists (Delaire, 1997; Yanagi, 1989; Woo, 2005). Alveolar arches, specially the maxillary ones had consistently been the focus of attention

for research workers due to its importance in dentistry. Major portion of literature deals with developing teeth during embryogenesis highlighting the histogenesis with little emphasis on its morphogenesis (Nagat & James, 1994; Owens, 1982; van der Linden, 1976; Berkovitz *et al.*, 1977). Maxillary development, even in postnatal life is of great clinical importance due to its potential chance of being surgically corrected to prevent malocclusion (Delaire).

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Literature confirms the interest of researchers in the foetal anatomy pertaining to dentition. Radlanski provided understanding about the growth and developmental changes during dentition in prenatal human heads ranging from 18 to 275mm CRL. Luke examined craniofacial and dental development in 32 human foetuses ranging from 22-42 weeks of intrauterine life. None of the studies ever mentioned the developmental details of sockets for teeth. Present work is an attempt to collect informations about the morphological details of sockets for temporary molars which also hold permanent premolars. The information will add to the knowledge of dentition in foetal skull.

MATERIAL AND METHOD

Twenty nine human foetuses were collected from Departmental museum of Anatomy, J.N. Medical College, A.M.U., Aligarh. Foetuses were used for research purposes only after receiving official permission from Ethical committee of J.N. Medical College, A.M.U., Aligarh. Maxillae were dissected out and carefully cleaned by removing soft tissue taking utmost precaution to avoid damage to sockets for teeth. Smallest foetus in which socket could be clearly ascertained was 22 weeks old. To determine the pattern of growth, foetuses were grouped into I (<24 weeks of IUL), II (25-30 weeks of IUL) and III (>30 weeks of IUL). Sockets for the temporary molars, which also hold permanent premolars, were the only ones whose boundaries could be clearly defined and measured with the help of Vernier callipers (Fig.1). Three measurements of the two sockets, i.e. maximum mesiodistal diameter, maximum transverse diameter and maximum depth, were considered for sockets of 1st and 2nd temporary molars in the present study. Readings of the adjacent groups were compared and analysed statistically by using Student's 't' test. The measurements of the two sides were also compared to find out the existence of bilateral variations. Fortunately, we had features of both sexes and thus sexual dimorphism was also taken into account.

Fig. 1 Alveolar arches of right and left maxillae showing the sockets for first (1) and second (2) temporary molars.

RESULTS AND DISCUSSION

Some of the regions of foetal maxillae eg. maxillary sinus, infraorbital groove, infraorbital canal and infraorbital foramen had already been thoroughly investigated (Ghaus & Faruqi, 2006; Ghaus & Faruqi, 2007; Ghaus & Faruqi, 2009). A crypt is the bony cavity enclosing a developing tooth and is formed by the dental sac (Nagat & James). Dental sac (follicle) is the mesenchymal condensation that initially surrounds the enamel organ and the enclosed dental papilla. The dental follicle is important because it contributes to each of the supporting tissues of the tooth root, the periodontal ligament, cementum and alveolar bone.

Anatomists define bony sockets as spaces which hold permanent or/and temporary teeth completely or partially through periodontal ligament. Taking this fact into consideration, we removed everything but retained sockets which were bony in nature.

Measurements of the sockets for 1st temporary molar.

The mean values of the mesiodistal diameters in the Ist, IInd and IIIRD groups were 2.78, 4.53 and 4.90 mm respectively. Growth was maximum in group IInd (per cent change, +63) and this change was highly significant statistically (Table I). This measurement did not show any bilateral variation (Table II) or significant sexual dimorphism (Table III).

The mean readings of transverse diameters in three groups were 3.9, 6.36 and 6.16 mm respectively. A very high rate of growth (+63%) was noticed in group II foetuses (Table IV) similar to mesiodistal diameters. Interestingly, transverse diameters were found to be on higher sides showing a mesiodistal compression of sockets (Table V). Contrary to mesiodistal values, transverse diameter showed significant higher values on left side in group II foetuses (Table VI). Similarly in late foetuses of group III, values were significantly more in males than those in females (Table VII). It might be reflecting the higher measurements in general in male adult skeleton compared to females.

The depths of the sockets in three groups were 2.30, 3.61 and 4.66 mm respectively (Table VIII). The increase in the depth was significantly higher in last two groups but the rate was again more in group II (57%) than in group III (29%). Although no bilateral variations were noticed (Table IX), the value was found to be higher in male than female in last foetal group (Table X).

Measurements of the sockets for 2nd temporary molar.

The mesiodistal measurements in three groups observed were 3.81, 5.38 and 6.87 mm respectively (Table XI). The values

Table I. Mesiodistal diameter (mm) of the socket for 1st temporary molar in human foetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	2.78 $\pm$ 0.34		
II (25-30)	12	4.53 $\pm$ 0.42	+63	<0.001
III (>30 wks)	6	4.90 $\pm$ 0.60	+8	<0.05

Table II. Mesiodistal diameter (mm) of the socket for 1st temporary molar of the two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	2.69 $\pm$ 0.37	6	2.85 $\pm$ 0.29	6	< 0.2
II	6	4.43 $\pm$ 0.43	6	4.62 $\pm$ 0.36	4	< 0.8
III	3	4.59 $\pm$ 0.69	3	5.22 $\pm$ 0.21	14	< 0.1

Table III. Mesiodistal diameter (mm) of the socket for 1st temporary molar of the two sexes in human foetuses.

Groups	Male foetuses		Female foetuses		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	8	4.50 $\pm$ 0.44	4	4.58 $\pm$ 0.34	2	< 0.8
II	4	5.10 $\pm$ 0.54	2	4.51 $\pm$ 0.50	13	< 0.05

Table IV. Transverse diameter (mm) of the socket for 1st temporary molar in human foetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	3.90 $\pm$ 0.85		
II (25-30)	12	6.36 $\pm$ 0.78	+63	< 0.001
III (>30 wks)	6	6.16 $\pm$ 1.03	- 3	< 0.5

Table V. Mesiodistal versus transverse diameter (mm) of the socket for 1st temporary molar in human foetuses.

Groups	Mesiodistal		Transverse		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	11	2.78 $\pm$ 0.34	11	3.90 $\pm$ 0.85	40	< 0.001
II	12	4.53 $\pm$ 0.42	12	6.36 $\pm$ 0.78	41	< 0.001
III	6	4.90 $\pm$ 0.60	6	6.16 $\pm$ 1.03	26	< 0.01

Table VI. Transverse diameter (mm) of the socket for 1st temporary molar of two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	3.61 $\pm$ 0.54	6	4.14 $\pm$ 0.98	15	< 0.1
II	6	6.03 $\pm$ 0.74	6	6.70 $\pm$ 0.68	11	< 0.001
III	3	6.22 $\pm$ 1.33	3	6.10 $\pm$ 0.58	2	< 0.8

Table VII. Transverse diameter (mm) of the socket for 1st temporary molar in human foetuses of the two sexes.

Groups	Male foetuses		Female foetuses		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
II	8	6.30 $\pm$ 0.81	4	6.49 $\pm$ 0.71	3	< 0.2
III	4	6.78 $\pm$ 0.60	2	4.90 $\pm$ 0.43	38	< 0.001

Table VIII. Depth (mm) of the socket for 1st temporary molar in human foetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	2.30 $\pm$ 1.07		
II (25-30)	12	3.61 $\pm$ 0.81	+ 57	< 0.001
III (>30 wks)	6	4.66 $\pm$ 0.27	+ 29	<0. 001

Table IX. Depth (mm) of the socket for 1st temporary molar on the two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	2.44 $\pm$ 1.30	6	2.18 $\pm$ 0.81	12	< 0.5
II	6	3.54 $\pm$ 0.74	6	3.68 $\pm$ 0.87	4	< 0.2
III	3	4.78 $\pm$ 0.05	3	4.53 $\pm$ 0.33	6	< 0.2

Table X. Depth (mm) of the socket for 1st temporary molar of the two sexes in human foetuses.

Groups	Male foetuses		Female foetuses		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
II	8	3.38 $\pm$ 0.84	4	4.08 $\pm$ 0.481	21	< 0.002
III	4	4.71 $\pm$ 0.28	2	4.55 $\pm$ 0.20	4	< 0. 001

Table XI. Mesiodistal diameter (mm) of the socket for 2nd temporary molar in human fetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	3.81 $\pm$ 0.88		
II (25-30)	12	5.38 $\pm$ 1.04	+ 41	< 0.001
III (>30 wks)	6	6.87 $\pm$ 0.53	+ 28	< 0.001

Table XII. Mesiodistal diameter (mm) of the socket for 2nd temporary molar of the two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	4.07 $\pm$ 0.68	6	3.59 $\pm$ 0.97	13	< 0.1
II	6	5.86 $\pm$ 0.63	6	4.90 $\pm$ 1.15	20	< 0.02
III	3	6.92 $\pm$ 0.62	3	6.82 $\pm$ 0.40	1	< 0.5

Table XIII. Mesiodistal diameter (mm) of the socket for 2nd temporary molar of the two sexes in human foetuses.

Groups	Male foetuses		Female foetuses		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
II	8	4.96 $\pm$ 0.96	4	6.23 $\pm$ 0.59	26	< 0.001
III	4	7.05 $\pm$ 0.53	2	6.50 $\pm$ 0.25	8	< 0. 05

Table XIV. Transverse diameter (mm) of the socket for 2nd temporary molar in human foetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	4.34 $\pm$ 1.05		
II (25-30)	12	6.48 $\pm$ 0.74	+ 49	< 0.001
III (>30 wks)	6	8.15 $\pm$ 0.68	+ 26	< 0. 001

Table XV. Mesiodistal versus Transverse diameter (mm) of the socket for 2nd temporary molar in human foetuses.

Groups	Mesiodistal		Transverse		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	11	3.81 $\pm$ 0.88	11	4.34 $\pm$ 1.05	14	< 0. 01
II	12	5.38 $\pm$ 1.04	12	6.48 $\pm$ 0.74	20	< 0.001
III	6	6.87 $\pm$ 0.53	6	8.15 $\pm$ 0.68	19	< 0.01

Table XVI. Transverse diameter (mm) of the socket for 2nd temporary molar of two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	4.23 $\pm$ 0.70	6	4.43 $\pm$ 1.27	5	< 0. 5
II	6	6.70 $\pm$ 0.48	6	6.25 $\pm$ 0.87	7	< 0. 1
III	3	8.25 $\pm$ 0.96	3	8.15 $\pm$ 0.00	1	< 0.8

Table XVII. Transverse diameter (mm) of the socket for 2nd temporary molar in human foetuses of the two sexes.

Groups	Male foetuses		Female foetuses		Per cent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
II	8	6.28 $\pm$ 0.79	4	6.86 $\pm$ 0.43	9	< 0.01
III	4	8.23 $\pm$ 0.82	2	8.00 $\pm$ 0.15	3	< 0. 5

Table XVIII. Depth (mm) of the socket for 2nd temporary molar in human foetuses.

Groups	n cases	Mean $\pm$ SD (mm)	Percent change	p value
I (<24 wks)	11	2.45 $\pm$ 1.25		
II (25-30)	12	4.22 $\pm$ 1.00	+ 72	< 0.001
III (>30 wks)	6	4.65 $\pm$ 1.07	+ 10	< 0. 2

Table XIX. Depth (mm) of the socket for 2nd temporary molar on the two sides in human foetuses.

Groups	Right side		Left side		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
I	5	2.60 $\pm$ 1.11	6	2.33 $\pm$ 1.35	12	< 0.2
II	6	4.23 $\pm$ 0.64	6	4.21 $\pm$ 1.26	5	< 0.8
III	3	4.27 $\pm$ 1.02	3	5.03 $\pm$ 0.97	18	< 0.01

Table XX. Depth (mm) of the socket for 2nd temporary molar of the two sexes in human foetuses.

Groups	Male foetuses		Female foetuses		Percent difference	p Value
	n cases	Mean $\pm$ SD (mm)	n cases	Mean $\pm$ SD (mm)		
II	8	4.15 $\pm$ 1.06	4	4.33 $\pm$ 0.85	5	< 0. 2
III	4	5.29 $\pm$ 0.65	2	3.38 $\pm$ 0.37	57	< 0. 001

Table XXI. Comparison of the mesiodistal diameters (mm) of the sockets for 1st and 2nd temporary molars in human foetuses.

Groups	Mesiodistal diameter of 1 st temporary molar		Mesiodistal diameter of 2 nd temporary molar		Percent difference	p Value
	n cases	Mean ± SD (mm)	n cases	Mean ± SD (mm)		
I	11	2.78 ± 0.34	11	3.81 ± 0.88	37	< 0. 001
II	12	4.53 ± 0.42	12	5.38 ± 1.04	19	< 0. 01
III	6	4.90 ± 0.60	6	6.87 ± 0.53	40	< 0.001

Table XXII. Comparison of the transverse diameters (mm) of the sockets for 1st and 2nd temporary molars in human foetuses.

Groups	Transverse diameter of 1 st temporary molar		Transverse diameter of 2 nd temporary molar		Percent difference	p Value
	n cases	Mean ± SD (mm)	n cases	Mean ± SD (mm)		
I	11	3.90 ± 0.85	11	4.34 ± 1.05	11	< 0. 05
II	12	6.36 ± 0.78	12	6.48 ± 0.74	02	< 0.05
III	6	6.16 ± 1.03	6	8.15 ± 0.68	32	< 0.001

Table XXIII. Comparison of the depth (mm) of the sockets for 1st and 2nd temporary molars in human foetuses.

Groups	Depth of 1 st temporary molar		Depth of 2 nd temporary molar		Percent difference	p Value
	n cases	Mean ± SD (mm)	n cases	Mean ± SD (mm)		
I	11	2.30 ± 1.07	11	2.45 ± 1.25	7	< 0. 2
II	12	3.61 ± 0.81	12	4.22 ± 1.00	17	< 0.001
III	6	4.66 ± 0.27	6	4.65 ± 1.07	0.22	< 0.8

increased with great rate in both group II and III foetuses. Although no bilateral variations were noticeable (Table XII), an unexpected increase in the mesiodistal readings of female socket was observed in group II (Table XIII).

The values of transverse diameter in three groups were 4.34, 6.48 and 8.15 mm respectively (Table XIV) and showed a consistent increase i.e. a significant increase in group II and III foetuses, a pattern observed in mesiodistal diameters also. Values of transverse diameters were on a higher side as compared to the mesiodistal measurements and therefore showing a mesiodistal compression like the sockets for 1st temporary molars (Table V). Although no bilateral variations were discernible (Table XVI), group II foetuses showed some sexual dimorphism with a higher value in male (Table XVII) with a p value of <0.01.

The depths of the sockets for 2nd temporary molar teeth were 2.45, 4.22 and 4.65 mm respectively (Table XVIII). As in most of the measurements of both the sockets, 2nd

group showed highly significant increase ($p < 0.001$). Bilateral variations were unnoticeable (Table XIX) but the higher values in male were again observed in larger foetuses of group III (Table XX).

Comparison between two sockets. Mesiodistal and transverse diameters of socket for 2nd temporary molar were invariably larger than those of sockets for 1st temporary molar when analysed statistically (Table XXI and XXII). Difference in depth was significantly noticed except in group II foetuses (Table XXIII). The information reflects the larger size of 2nd premolar which is often observed in adults (Ash & Nelson, 2003).

Specific references pertaining to our observations were lacking in literature. Some of the striking features of our study were, 1. Spurt of growth leading to very high values in group II foetuses, 2. A mesiodistal compression in both the sockets i.e. for 1st and 2nd temporary molars, 3. No bilateral variations, highlighting the natural symmetry of face, 4. Higher values in males in late foetal group.

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RESUMEN: La terapia fetal ha hecho de la anatomía fetal un campo prometedor. El maxilar ha sido la atracción central de investigación de muchos científicos. Los arcos alveolares, especialmente el maxilar ha sido siempre el foco de atención para los investigadores debido a su importancia en la odontología. Veintinueve fetos humanos se agruparon en grupos I (<24 semanas de vida intrauterina), II (25-30 semanas de vida intrauterina) y III (> 30 semanas de vida intrauterina). Los maxilares fueron disecados y los alvéolos fueron limpiados cuidadosamente. Los alvéolos de los molares temporales, que también tienen premolares permanentes, fueron medidos con la ayuda de un caliper Vernier. Fueron considerados 3 parámetros, es decir, diámetro mesiodistal máximo, diámetro transversal máximo y profundidad máxima. Las lecturas fueron analizadas estadísticamente mediante el uso de la prueba t de Student. El crecimiento fue máximo en el grupo II para el diámetro mesiodistal del alvéolo del primer molar temporal, pero la variación significativa o bilateral de dimorfismo sexual no fue encontrada. Una tasa muy alta de crecimiento (+63%) se observó en los fetos del grupo II. Contrariamente a los valores mesiodistal, los diámetros transversos mostraron valores significativamente más altos en el lado izquierdo en el grupo de fetos II. Del mismo modo en los fetos del grupo III, los valores fueron significativamente más altos en varones que en las de mujeres. Esto podría estar reflejando las mediciones más altas en general en el esqueleto del hombre adulto en comparación con las mujeres. El aumento de la profundidad fue significativamente mayor en los dos últimos grupos, pero la tasa fue mayor en el grupo II (57%) que en el grupo III (29%). Aunque no se observaron variaciones bilaterales, el valor se encontró que fue mayor en niños que en niñas en el grupo fetal. Los valores se incrementaron con rangos excepcionales tanto en el grupo de fetos II y III para el diámetro mesiodistal del segundo molar para la toma de temporal. Un aumento inesperado en las lecturas mesiodistal de mujeres se observó en el grupo II. Los valores de diámetro transversal mostraron un aumento constante es decir, un aumento significativo en el grupo II y III. Valores de diámetro mesiodistal de los diámetros transversales estaban en un lado más alto en comparación con las mediciones mesiodistal. En el Grupo II se observó algunos fetos con dimorfismo sexual con un valor mayor en los hombres de $p < 0,01$. La profundidad de los alvéolos de los segundos molares temporales mostraron un aumento muy significativo en el grupo II ($P < 0,001$). Los valores más elevados en los hombres se vuelven a observar en los fetos del grupo III. Algunos de los rasgos más llamativos de nuestro estudio fueron: 1. Aceleración de crecimiento que conduce a valores muy altos en el grupo de fetos II; 2. Una compresión mesiodistal en ambos, es decir, alvéolos para el 1^{er} y 2^{do} molares temporales; 3. No hay variaciones bilaterales, destacando la simetría natural de la cara; 4. Los valores más altos en los varones se observaron en el grupo fetal tardío.

PALABRAS CLAVE: Morfometría; Feto; Alvéolos; Diente; Deciduos.

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