RADIOGRAPHIC FETAL OSTEOMETRY: APPROACH ON AGE ESTIMATION

C. Carneiro[1,2,3,4], E. Cunha[5,6], P. Borralho[1,3,4], A. Pascal[7], F. Curate[8]

[1]Faculdade de Medicina da Universidade de Lisboa; [2]Delegação Sul do Instituto Nacional de Medicina Legal; [3]Hospital Garcia de Orta; [4]Escola Superior de Tecnologia da Saúde de Lisboa; [5]Faculdade de Ciências e Tecnologia da Universidade de Coimbra; [6]Instituto Nacional de Medicina Legal; [7]Université de la Méditerranée; [8] Centro de Investigação em Antropologia e Saúde - Universidade de Coimbra

INTRODUCTION

The estimation of gestational age and/or viability on fetal remains can be an important forensic issue (Cunha et al, 2009; Piercecchi-Marti et al, 2002). The two main criteria used for this purpose are dental mineralization and skeletal data, such as long bone diaphyseal length (Cunha et al, 2009). When using the second method, forensic specialists usually use reference tables (Fazekas and Kosa, 1978). Since these tables are mostly based on ultrasonographic measurements (Hadlock, 1982, 1994; Doubilet, 1993; Jeanty, 1983) which are known to differ from real bones measurements (Adalian et al, 2001) or, on the other hand, are based on ancient literature (Fazekas and Kosa, 1978; Olivier and Pinneau, 1960), we decided to update radiographic data for the Portuguese population, using a validated method (Adalian et al, 2001). We also wanted to know which of the 3 studied bones (femur, tibia and humerus) was more accurate and verify whether there are significant differences between male and female fetuses.

MATERIALS & METHODS

Anonymous fetopathological autopsy records were collected from spontaneous and therapeutic abortions. We selected 80 fetuses (46 males and 34 females) of known gestational age (GA) according to the following criteria:

- GA between 13 and 40 weeks;
- absence of external malformation;
- absence of pathological alterations which could compromise normal skeletal growth (e.g. Intra Uterine Growth Restriction);
- lack of maternal pathology;
- time elapsed between intrauterine death and fetal expulsion inferior to a week;
- twin pregnancy were included only when there were no signs of discordant growth.

We performed diaphyseal bone length measurements (femur, tibia and humerus) using post-mortem radiography (XR). Measurements were taken with a 0.5 mm graduated metal ruler. Whenever it was necessary, the obtained value was converted to scale (included in the XR). Preferably, the measures were taken from the left side, and from the anterioposterior (AP) position (figures 1 and 2).

Statistical analysis was performed with SPSS 17.0.

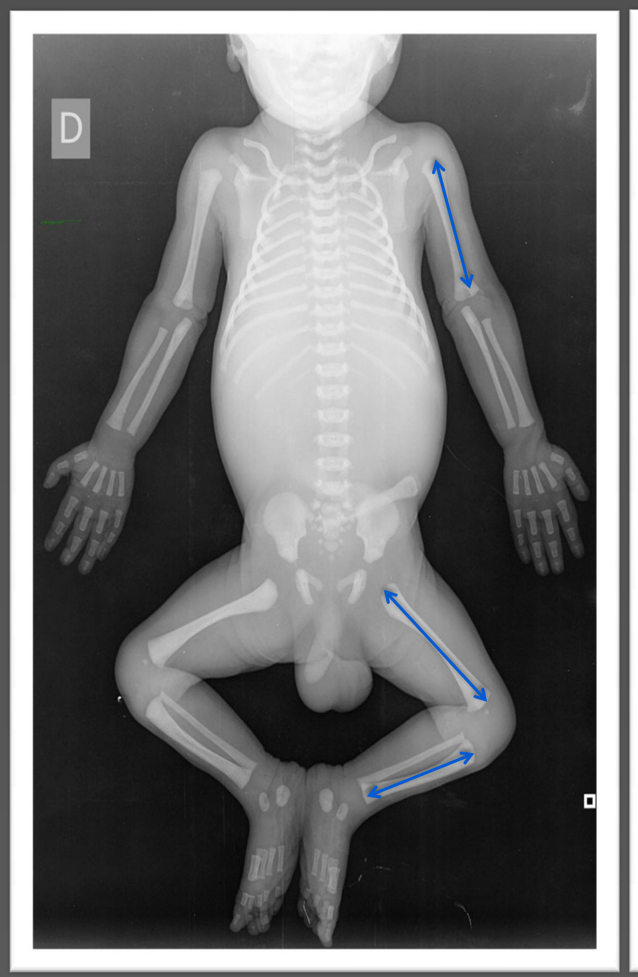

Fig.1: Typical XR – AP position

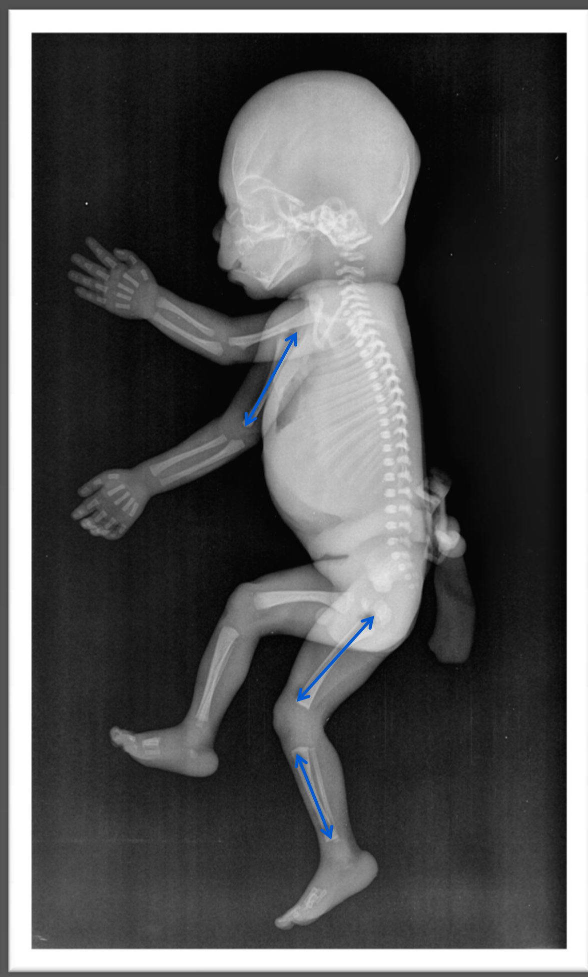

Fig..2 : Typical XR – lateral position

RESULTS & DISCUSSION

The reliability of the method was evaluated by using the Technical Error of Measurements (TEM). The intra-evaluator error (repeatebility) obtained acceptable values for beginner anthropometrists (femur = 0,405%; tibia = 0, 747%;humerus = 1,091%) as well as the inter-evaluator error (reprodutibility; femur = 0,61%; tibia = 0, 86%;humerus = 1,07%) (Perini, 2005).

Results confirmed a strong correlation between the three bones studied and GA, being the correlation between femur lenghth and GA the strongest ($r=0.967$; $p<0,01$, see figure 3), followed by the tibia ($r=0.966$; $p<0,01$) and the humerus ($r=0.964$; $p<0,01$).

When cheking for male and female asymmetries, although we suspected that there are differences, these were not statistically significant.

The obtained regression equation appears to be very useful for making predictions (it has a very good fit) since the value of r^2 is close to 1 (table 1).

We were able to obtain tables with the values of each bone for 10 age groups (in weeks), as follows (tables 2, 3 and 4).

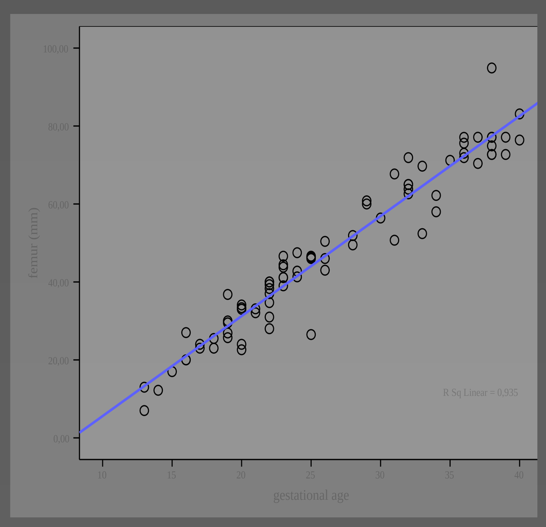

Figure 3: Strong correlation between femur length and GA

Table 1: Regression equations

BONE	REGRESSION EQUATION	ERROR
FEMUR	GA=(20.050+bone length)/2.565	0.08
TIBIA	GA=(16.356+bone length)/2.178	0.07
HUMERUS	GA=(12.031+bone length)/2.089	0.07

Table 2: Femur length growth

AGE GROUP (WEEKS)	N	MEAN	STANDARD DEVIATION	95% C. I. for Mean
13-15	4	12.3000	4,11015	5,7598-18,8402
16-18	7	23.2143	2,61179	20,7988-25,6298
19-21	12	31.1000	4,43765	27,2805-32,9195
22-24	17	39.7600	5,06846	37,1540-42,3660
25-27	7	43.5429	7,81875	36,3117-50,7740
28-30	5	55.7200	4,94641	49,5782-61,8618
31-33	9	63.2000	7,23084	57,6419-68,7581
34-36	7	69.8571	7,07716	63,3119-76,4024
37-39	10	76.6760	6,85447	71,7726-81,5794
40-42	2	79.7500	4,73762	37,1842-122,3158

Table 3: Tibia length growth

AGE GROUP (WEEKS)	N	MEAN	STANDARD DEVIATION	95% C. I. for Mean
13-15	4	10,1250	2,09662	6,7888-13,4612
16-18	7	20,2142	2,32481	18,0642-22,3644
19-21	12	26,2500	4,07398	23,6615-28,8385
22-24	16	34,7412	4,25662	32,4731-37,0094
25-27	7	38,8714	7,70210	31,7482-45,9947
28-30	5	48,3400	5,10029	42,0071-54,6729
31-33	9	53,2667	6,59090	48,2005-58,3329
34-36	7	61,4286	6,80018	55,1395-67,7177
37-39	10	65,0400	3,54627	62,5032-67,5768
40-42	2	68,2500	6,29325	11,7074-124,7926

Table 4: Humerus length growth

AGE GROUP (WEEKS)	N	MEAN	STANDARD DEVIATION	95% C. I. for Mean
13-15	4	11,0500	2,37557	7,2699-14,8301
16-18	7	23,1429	2,17398	21,1323-25,1535
19-21	12	29,2417	4,07106	26,6550-31,8283
22-24	17	37,0412	3,91584	35,0278-39,0545
25-27	7	41,2143	7,91169	33,8972-48,5314
28-30	5	48,0400	4,52692	42,4191-53,6609
31-33	9	56,8556	5,78254	52,4107-61,3004
34-36	7	61,5429	5,78356	56,1940-66,8918
37-39	10	65,9300	2,71131	63,9904-67,8696
40-42	2	67,4500	1,06066	57,9203-76,9797

CONCLUSIONS

We were able to achieve values for 10 age groups. Furthermore a useful regression equation was obtained for each bone studied. We hope to enlarge this sample in a near future.

REFERENCES

Adalian, P., Piercecchi-Marti, M.-D., Bourliere-Najean, B., Panuel, M., Fredouille, C., Dutour, O., Leonetti, G. Postmortem Assessment of Fetal Diaphyseal Femoral Length: Validation of a Radiographic Methodology. J Forensic Sci 2001; 46 (2): 215– 219; Cunha, E., Baccino, E., Martrille, L., Ramsthaler, F, Prieto, J., Schuliar, Y., Lynnerup, N., Cattaneo, C. The problem of aging human remains and living individuals: A review. Forensic Science International 2009; 193: 1-13; Fazekas, I. G., Kósa, F. Forensic Fetal Osteology. Budapeste: Akadémiai Kiadó; 1978Piercecchi-Marti, M.-D., Adalian, P., Bourliere-Najean, B., Gouvernet, J., Maczel, M., Dutour, O., Leonetti, G. Validation of a radiographic method to establish new fetal growth standards: radio-anatomical correlation. J. Forensic Sci. 2002; 47:328–331Perini, T. A.; Oliveira, G. L.; Ornellas, J. S., Oliveira, F. P. Technical Error of measurement in anthropometry. Rev Bras Med Esporte 2005; 11(1): 86-90;Callen, P. W. Ultrasonography in Obstetrics and Gynecology, 4th edition. Philadelphia: Saunders; 2000