Can fetal cranial circumference determine the cause and predict cephalopelvic disproportion?

Octavian Munteanu[1], Luiza Radulescu[2], Alexandru T. Ispas[3], Florin C. Cirstoiu[4], Monica M. Cirstoiu[1]

1. Department of Obstetrics and Gynecology, Bucharest Emergency University Hospital
2. Department of Biochemistry, University of Medicine and Pharmacy "Carol Davila", Bucharest
3. Department of Anatomy, University of Medicine and Pharmacy "Carol Davila", Bucharest
4. Department of Orthopedics and Traumatology, Bucharest Emergency University Hospital

Correspondence:
Dr. Octavian Munteanu
e-mail: octav_munteanu@yahoo.com

Abstract

Objective. *This study was undertaken in order to evaluate if fetal cranial circumference can determine the cause and predict cephalopelvic disproportion (CPD).* ***Methods.*** *We retrospectively evaluated the medical records of 661 pregnant women who underwent Cesarean delivery due to CPD, at Bucharest Emergency University Hospital, from January 1st 2011 to January 1st 2012. Following the diagnostic codes three groups were formed - Group A - strictly maternal anomalies determined CPD, Group B - strictly fetal anomalies determined CPD and Group C, in which a single cause (fetal or maternal) could not be determined.* ***Results.*** *Using One-Way ANOVA we have determined that the difference between the mean of the cranial circumference varies statistically among the three groups (p=0.023). Performing a canonical discriminant analysis a discriminant function, which can frame a patient into one of the three groups (A, B or C), based on the fetal cranial circumference, was extracted.* ***Conclusions.*** *Using a discriminant function, fetal cranial circumference can determine the cause (fetal, maternal or mixed anomalies) and predict CPD.*

Keywords: *cephalopelvic disproportion, fetal cranial circumference, discriminant function*

Introduction

Cephalopelvic disproportion (CPD) is a mismatch in size, between the fetal cranium and maternal pelvis, which prevents an adequate engagement of the fetus through the birth canal. CPD is responsible for almost 50% of primary cesarean sections in nulliparous women[1,2].

Due to the fact that worldwide a tendency to overdiagnose CPD, especially in nulliparous patients has been noted[3-5] and because it has been demonstrated that Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes[6], clinical practice guidelines and protocols have been imputed, with significant results[7-10]. Unfortunately, in Romania a clear protocol in evaluating the risk of CPD has not yet been developed.

Many studies have demonstrated the influence of particular, both maternal (height[11-19], age[20], weight[21,22], total weight gain[19,21-24], pre-pregnancy and before-delivery BMI[19,22,23,25]), or parity[17,19,20,23,24] and fetal (estimated birth weight[14,22-24] or pubis-fundal height[19,24]) risk factors of cesarean delivery due CPD. However, to the best of our knowledge, no recent study was undertaken in order to evaluate the causes and risk of CPD using fetal cranial circumference.

Received: *February 09, 2013*
Revised: *March 22, 2013*
Accepted: *May 08, 2013*

Objective

This study was undertaken in order to evaluate if fetal cranial circumference can determine the cause and predict CPD.

Methods

We retrospectively evaluated the medical records of all 3962 pregnant patients who delivered at Bucharest Emergency University Hospital from January 1st 2011 to January 1st 2012. 661 pregnant women who underwent Cesarean delivery due to CPD were enrolled in the study.

Following the diagnostic codes, three groups were formed. In Group A we enrolled 458 patients (69.3%) in which strictly maternal anomalies (generally contracted pelvis, inlet contraction of pelvis, outlet contraction of pelvis, mid-cavity contraction, or other abnormalities of the female genital tract or pelvic organs) determined CPD. In Group B we enlisted 6 patients (0.95%) in which strictly fetal anomalies (macrosomic and voluminous fetuses or dystocia due to fetal abnormalities) determined CPD. Group C is composed of 197 patients (29.8%) in which a single cause (fetal or maternal) could not be determined.

Maternal age, gestational age, birth weight and calculated Apgar score at one minute of the neonate were evaluated, but fetal cranial circumference was mainly focused. The information was obtained from the inpatient charts and computerized database of the Statistical Unit at Bucharest Emergency University Hospital.

All analyses were conducted using the SPSS version 19. The descriptive analysis of the quantitative data was presented as frequency, mean, standard deviation, minim and maxim. One-Way ANOVA was used to test if the difference between the mean of the cranial circumference varies statistically among the three

groups. A p-value <0.05 was considered statistically significant. We also had the intention to develop a discriminant function which could approximate framing a patient into one of the three groups based on the fetal cranial circumference.

Results

Of the 3962 pregnant patients who delivered at Bucharest Emergency University Hospital 1124 (28.37%) delivered vaginally, 10 (0.25%) were forceps-assisted and 2828 (71.38%) underwent Cesarean section; 23.37% of the latter category, meaning 661 patients, were enrolled in the study. The incidence of CPD at Bucharest Emergency University Hospital, from January 1st 2011 to January 1st 2012, was of 16.68% (Table 1).

The descriptive analysis of the studied patients divided into groups A, B and C is presented in Table 1. The highest value of the mean maternal age, gestational age, birth weight and fetal cranial circumference is in group B followed by group C.

Using One-Way ANOVA we have determined that the difference between the mean of the cranial circumference varies statistically among the three groups (p=0.023). However post-hoc test (multiple comparison tables) showed that there is a statistically significant difference between groups A and B, as well as between groups B and C, but not between A and C groups (Table 2).

Using discriminant analysis we were interested to check if the patients can be distributed into one of the three groups, according to the fetal cranial circumference. Tests of equality of group means were performed and Wilks' Lambda was calculated in relation to the fetal cranial circumference (p=0.989), which was statistically significant (p=0.023). Performing a canonical discriminant analysis a discriminant function, which can frame a patient into one of the three groups (A, B or C), based on the fetal cranial circumference, was extracted:

D = -19,058 + 0,566 X Fetal Cranial Circumference

The values of the centroids of each group are: 0.034 for Group A, 1.052 for Group B and 0.048 for Group C. The value of the calculated discriminant function closer to one of the centroids distributes the patient in one of the three groups.

About 43.4% of original grouped cases were correctly classified, using the discriminant function based on the fetal cranial circumference (Table 3). The accuracy of the discriminant function was of: 50.4% for Group A, 83.3% for Group B and 25.9% for Group C.

If a second variable is introduced - birth weight, the exactitude of the discriminant function increases for groups A and C, but remains constant for group B (Table 4). The highest augmentation of the accuracy of the function was observed for group C (25.9% vs.

Table 1 Obstetric characteristics of cases diagnosed with CPD

	Group A	Group B	Group C	Total
Number of patients	458	6	197	661
Frequency (%)	69.3	0.95	29.8	
Maternal age (year) Mean ± Standard deviation	28.43±5.08	30±6.23	28.01±5.06	28.32
Minim/Maxim	14/47	21/36	16/40	
Gestational age (week) Mean ± Standard deviation	38.58±1.67	39.50±0.55	38.81±0.93	38.66
Minim/Maxim	35/41	39/40	34/41	
Apgar score at 1 minute				
Mean ± Standard deviation	8.80±0.55	8.50±0.84	8.81±0.66	8.80
Minim/Maxim	6/10	7/9	4/10	
Birth weight (gram)				
Mean ± Standard deviation	3310.33±394.45	4266.67±508.59	3351.83±400.80	3331.38
Minim/Maxim	2080/4700	3750/5250	2100/4300	
Cranial circumference (centimeter) Mean ± Standard deviation	33.58±1.75	35.50±1.22	33.73±1.81	33.64
Minim/Maxim	29/38	33.5/37	29.5/37	

Table 2 Multiple Comparisons Tables - Fetal Cranial Circumference as Dependent Variable

	Group	Group	Mean Difference	Standard Error	p-value	95% Confidence Interval	
						Lower Bound	Upper Bound
Games-Howell	A	B	-1.91703*	.50664	.026	-3.5357	-.2983
		C	-.14546	.15280	.608	-.5051	.2141
	B	A	1.91703*	.50664	.026	.2983	3.5357
		C	1.77157*	.51639	.035	.1617	3.3815
	C	A	.14546	.15280	.608	-.2141	.5051
		B	-1.77157*	.51639	.035	-3.3815	-.1617

** The mean difference is significant at the 0.05 level*

Table 3 Predicting Group Membership using Fetal Cranial Circumference

	Group	Predicted Group			Total
		A	B	C	
Count	A	231	88	139	458
	B	1	5	0	6
	C	102	44	51	197
%	A	**50.4**	19.2	30.3	100
	B	16.7	**83.3**	0	100
	C	51.8	22.3	**25.9**	100

Table 4 Predicting Group Membership using both Fetal Cranial Circumference and Birth Weight

	Group	Predicted Group Membership			Total
		A	B	C	
Count	A	239	39	180	458
	B	0	5	1	6
	C	103	23	71	197
%	A	52.2	8.5	39.3	100.0
	B	.0	83.3	16.7	100.0
	C	52.3	11.7	36.0	100.0

36%). Also, the global exactitude of the discriminant function increased to 47.7%.

Discussion

Assessing the descriptive analysis (Table 1) one can observe that is highly unlikely that in only 0.95% of the cases CPD occurred due to strictly fetal complications, while in 69.3 due to strictly maternal complications. We consider that this error was determined by an incorrect diagnosis of the cause of CPD, due to the lack of a protocol in Romania.

We focused in determining the cause of CPD in these patients, in relation with fetal cranial circumference and secondary by using a combined method - fetal cranial circumference and birth weight. These variables can be objectively evaluated by trans-vaginal or trans-abdominal ultrasonography ante-partum or even intra-partum. Therefore, they could both be included, along with already demonstrated risk factors, in a protocol of evaluating the risk of CPD.

After performing canonical discriminant analysis, a discriminant function, which can frame a patient into one of the three groups (A, B or C), based on the fetal cranial circumference, was extracted. The discriminant function predicts with

an accuracy of 83.3% the patients in Group B, in which we observed the highest mean value of fetal cranial circumference (Table 1), but with rather poor results the patients in groups A and C, due to long ranges in these groups (minimum/maximum value - 29cm/38 cm in Group A and 29.5 cm/37 cm in Group C). Plus, analyzing the mean, minimum and maximum values of birth weight of the neonate (Table 1), one can observe once again long ranges in groups A and C. Due to these observations and statistically significant difference between groups A and B, as well as between groups B and C, but not between A and C groups (Table 2), we concluded that the discriminant function is valid.

If birth weight is introduced into the discriminant function its global accuracy and also the exactitude in predicting groups A and C increases (Table 4), but remains constant for Group B. Thus the accuracy of the discriminant function increases in predicting maternal causes of CPD. Thence the global accuracy increases when introducing a second variable, the demonstrated risk indicators for cesarean section due to CPD may be introduced into this discriminant function increasing its accuracy. Hence, a risk scoring system can be developed, to aid obstetricians in objectively predicting the causes and thenceforth CPD.

A potential error factor, an element which must not remain obscure, is the mechanism of moulding - a change in the shape of the fetal skull and lesser in the fetal cranial circumference, that occurs in late pregnancy and labor. Yet, as pointed, it has been demonstrated that the configuration of the fetal head majorly changes and not the cranial perimeter[26].

Because the retrospectively studied group was already diagnosed with CPD, we cannot conclude whether the discriminant function, based on fetal cranial circumference, is valid in the general population.

Khunpradit et al. developed a risk scoring scheme for prediction of cesarean section due to CPD based on maternal age, weight, parity, total weight gain and pubis-fundal height[27]. In the near future, using the results of this study and the ones in the literature, we strongly believe that a systematization of both maternal and fetal risk factors can be performed in order to predict the risk of CPD in the general population.

Conclusions

Using a discriminant function, fetal cranial circumference can determine the cause (fetal, maternal or mixed anomalies) and predict CPD. The global accuracy of the discriminant function increases if the birth weight is associated. Therefore the demonstrated risk indicators for cesarean section due to CPD may be introduced into this discriminant function and a risk scoring system can be developed, to aid obstetricians in objectively predicting CPD and its causes. ■

References

1. Gregory K. D., Curtin S. C., Taffel S. M., Notzon F.C. - Changes in indications for cesarean delivery: United States, 1985 and 1994. American J of Public Health. 1998; 88(9):1384–7.
2. Shields S. G., Ratcliffe S. D., Fontaine P., Leeman L. - Dystocia in nulliparous women. American Family Physician. 2007; 75(11):1671–8.
3. Betran A. P., Gulmezoglu A. M., Robson M., Merialdi M., Souza J. P., Wojdyla D., et al. - WHO global survey on maternal and perinatal health in Latin America: classifying caesarean sections - Reprod Health 2009; 29; 6:18.
4. Lumbiganon P., Laopaiboon M., Gülmezoglu A. M., Souza J. P., Taneepanichskul S., Ruyan P., et al. - Method of delivery and pregnancy outcomes in Asia: the WHO global survey on maternal and perinatal health 2007-08. Lancet 2010; 6; 375: 490-9.
5. Cunningham F. G., Leveno K. J., Bloom S. L., Hauth J. C., Rous D. J., Spong C. Y. - Williams obstetrics. 23rd ed. New York: McGraw-Hill; 2010: 544-64.
6. Souza J. P., Gülmezoglu A., Lumbiganon P., Laopaiboon M., Carroli G., et al. - Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004- 2008 WHO global survey on maternal and perinatal health. - BMC Med 2010; 10; 8:71.
7. World Health Organization - Partograph in management of labour. World Health Organization Maternal Health and Safe Motherhood Program. Lancet 1994; 343: 1399-404.
8. Royal Thai college of obstetricians and gynaecologists - Clinical practice guideline for cesarean section due to cephalopelvic disproportion or failure to progress of labor - Obstet Gynaecol Bull 2001;10:17-22.
9. Petmanee P., Kengpol C., Pinjaroen S., Krisanapan O. - Effect of clinical practice guideline on cesarean section by the indication of cephalopelvic disproportion. - Int J Qual Health Care 2004; 16:327-32.
10. Chittithavorn S., Suwanrath C., Pinjaroen S., Soonthornpun K. - Clinical practice guideline for cesarean section due to cephalopelvic disproportion. - J Med Assoc Thai 2006 ; 89:735-40.
11. Sheiner E., Levy A., Katz M., Mazor M. Short stature-an independent risk factor for Cesarean delivery. - Eur J Obstet Gynecol Reprod Biol 2005; 120: 175-8.
12. Prasad M., Al-Taher H. - Maternal height and labor outcome. - J Obstet Gynaecol 2002; 22: 513-5.
13. McGuinness B. J., Trivedi A.N. - Maternal height as a risk factor for caesarean section. -Arch Gynecol Obstet 2005; 271: 336-7.
14. Brabin L., Verhoeff F., Brabin B. - Maternal height, birth weight and cephalopelvic disproportion in urban Nigeria and rural Malawi - Acta Obstet Gynecol Scand 2002; 81: 502-7.
15. Oboro V. O., Ande A. B., Olagbuji B. N., Ezeanochie M. C., Aderoba A., Irhibogbe I. - Influence of maternal height on mode of delivery in Nigerian women. - Niger Postgrad Med J 2010; 17: 223-6.
16. Chan B. C., Lao T. T. - The impact of maternal height on intra-partum operative delivery: a reappraisal. - J Obstet Gynaecol Res 2009; 35: 307-14.
17. Wongcharoenkiat N., Boriboonhirunsarn D. - Maternal height and the risk of cesarean delivery in nulliparous women. - J Med Assoc Thai 2006; 89: 65-9.
18. Kara F., Yesildaglar N., Uygur D. - Maternal height as a risk factor for caesarean section. - Arch Gynecol Obstet 2005; 271: 336-7.
19. Wianwiset W. - Risk Factors of Cesarean Delivery due to Cephalopelvic Disproportion in Nulliparous Women at Sisaket Hospital - Thai J Obst-Gyn 2011; 19:158-64.
20. Kovavisarach E., Buddeewong P. - Diagnosis of Cephalopelvic Disproportion or Failure to Progress of Labor in Rajavithi Hospital Compare with The Criteria of Royal Thai College of Obstetricians and Gynaecologists - Thai J Obst-Gyn; 2010,18:77-81.
21. Nuthalapaty F. S., Rouse D. J., Owen J. - The association of maternal weight with cesarean risk, labor duration and cervical dilation rate during labor induction. - Obstet Gynecol 2004; 103: 452-6.
22. Tanprasertkul C., Somprasit C. - Effect of high gestational weight gain on birth weight and cesarean section rate in pregnant women with a normal prepregnant body mass index - J Med Assoc Thai 2004; 87: 24-8.
23. Surapanthapisit P., Thitadilok W. - Risk Factors of Caesarean Section due to Cephalopelvic Disproportion - J Med Assoc Thai 2006; 89:105-11.
24. Khunpradit S., Patumanond J., Tawichasri C. - Risk indicators for cesarean section due to cephalopelvic disproportion in Lamphun Hospital - J Med Assoc Thai 2005; 88: 63-8.
25. Navolan B. D., Andrei C., Badiu D., Tigla A. E., Constantinescu S., Vladareanu R. - The implications of pre-pregnancy overweight in the pregnancy outcomes and further development – Gineco.eu 2013; 31(1):47-9.
26. Lapeer R. J., Prager R. W. - Fetal head moulding: finite element analysis of a fetal skull subjected to uterine pressures during the first stage of labour - J Biomech 2001; 34:1125–33.
27. Khunpradit S., Patumanond J., Tawichasri C. - Development of risk scoring scheme for prediction of cesarean delivery due to cephalopelvic disproportion in Lamphun Hospital, Thailand. J Obstet Gynaecol Res 2007; 33(4):445-51.