Comparison of Johnson's Method with Hadlock's Method for Estimation of Fetal Weight in Term Pregnancies

Peru Pradhan,[1] Binita Neupane,[1] Sona Shrestha,[1] Ganesh Dangal[2]

[1]Kirtipur Hospital Devdhoka, Kirtipur, Kathmandu, Nepal, [2]Kathmandu Model Hospital, Exhibition Road, Kathmandu, Nepal.

ABSTRACT

Background: Fetal weight estimation is of utmost need to determine the course of labour and complications for its management. This study intents to compare the fetal weight determined through Johnson's method and Hadlock's method with actual birth weight in term pregnancies.

Methods: This is an observational study carried out over a period of six months in Kirtipur Hospital among 200 samples of term, singleton pregnancy with cephalic presentation using convenience sampling technique.

Results: The mean maternal age was 25.9 ± 4.3 years whereas mean gestational age was 39.1 weeks. Less than half (49.1%) of the babies' weight ranged between 3.0 - 3.5 kgs. The mean error of estimated weight by Johnson's method was less compared to Hadlock's method 185.1 ± 191.1 grams and 355.8 ± 225.7 grams respectively. It was also observed that estimation of fetal weight by Johnson's method was closer to the actual birth weight than by Hadlock's method.

Conclusions: Johnson's method requires some basic skills and knowledge with flexibility to apply as and where needed beyond the health facilities irrespective of the availability of the equipment. Furthermore, it was also observed to be slightly more specific in its estimation of birth weight among the term pregnancies compared to Hadlock's method. Hence, it should be promoted widely among the clinicians. However, Hadlock's method is equally important for detection of anomalies and high-risk factors coupled with confirmation of the estimation made through Johnson's method.

Keywords: Actual birth weight; estimated fetal weight; hadlock's method; johnson's method.

INTRODUCTION

The accurate estimation of fetal weight is critical in modern obstetrics. Estimated fetal weight is incorporated as standard routine ante-partum evaluation to rule out high risk pregnancy. Management of diabetic pregnancy, vaginal birth after previous caesarean section and breech presentation are guided by the estimated fetal weight.[1,2] Necessary management required for preterm deliveries or intrauterine growth restriction should be coupled with counseling regarding baby's survival which is completely dependent on the estimated fetal weight. Precise fetal weight estimation helps to anticipate complications and leads to successful management of labor.[3-5] A large proportion of the problem is directly linked to the estimated fetal weight that plays a key role in the neonatal survival.[6-9] The two main methods for predicting birth weight are Johnson's method and Hadlock's method. This study aimed at estimation of fetal weight using Johnson's method and Hadlock's method with actual birth weight among term pregnancies to see which of the method is closer to the actual birth weight.

METHODS

This is a prospective, hospital-based study carried out over a period of six months (August 2015 to January 2016) in Kirtipur Hospital, Kirtipur, Nepal. It's a secondary hospital that largely provides services to the catchment population of Kirtipur. All women with term (37-42 completed weeks of gestation; according to her last menstrual period or confirmed by ultrasound before 12

Correspondence: Dr Peru Pradhan, Kirtipur Hospital Devdhoka, Kirtipur, Kathmandu, Nepal. Email: pradhanperu@gmail.com, Phone: +9779851170155.

weeks of gestation), singleton pregnancy with cephalic presentation were enrolled in the study after informed understood consent for participation. Ethical approval was obtained from Institutional Review Committee (IRC) of Public Health Concern Trust, Nepal (phect-NEPAL). Polyhydramnios, oligohydramnios, congenital malformations, pregnancy with uterine fibroids and abdominal masses and other co-morbid conditions were excluded from the study. The women were asked to lie in dorsal position on the examination table and with the examiner on her right side. Using a non-elastic tape, symphysiofundal height was measured from the top of symphysis pubis to the highest part of uterus. For the measurement of the symphysiofundal height (SFH), the woman was asked to empty her bladder and then made to lie in supine position with legs extended. Dextro-rotation of the uterus was corrected with the palmar aspect of the left hand. Palpation was started from the xiphisternum downwards by the ulnar border of the left hand. The first resistance felt was noted as the variable point i.e., fundal point. Fixed point i.e., the symphysis pubis was palpated next. Measurement was taken from the variable to the fixed point. With non-elastic measuring tape, the distance between these two points were measured keeping the inches on top. The tape was then turned to note the symphysiofundal height in centimeter. By careful examination, the station of the vertex was determined. All the cases enrolled in this study were examined by pre-identified clinicians trained to address the inter-observational bias for the mentioned study.

The fetal weight was estimated by using Johnson's formula: (symphysiofundal height in cm – n) x 155 grams where, n = 12 if vertex is at or above the level of ischial spines and n = 11 if vertex is below the ischial spines. After clinical measurement, the fetal weight estimation by Hadlock's method was calculated by a radiologist (having at least 2 years of experience in obstetric scan) using Hadlock's formula with a combination of bi-parietal diameter (BPD), abdominal circumference (AC) and femoral length (FL). Sonographic examination was performed in all patients using 3.5 MHz convex array and linear array transducer (Transverse Toshiba's Sonoline SL grey scale model with M and B mode for simultaneous imaging and calculating fetal heart rate). Bi-parietal diameter (BPD) abdominal circumference (AC) and femur length (FL) were measured in centimeters; the sonography machine calculated fetal weight. The fetal weight was calculated using the formula: Log10 (EFW) 1.4787 - 0.003343 AC × FL + 0.001837 BPD2 + 0.0458 AC + 0.158 FL

If the woman did not deliver within 72 hours of performing Johnson's and Hadlock's method of fetal weight estimation, both the procedures of fetal weight estimation were repeated. After the delivery of the baby, the actual weight was recorded using the digital weighing scale in the delivery note by the doctors engaged in the delivery process. Fetal weights estimated by Johnson's and Hadlock's method were compared with the actual birth weight to see the difference. Data collected were validated by the co-investigators of the study and entered in the excel spreadsheet for maintaining the dataset. The data entered in the spreadsheet was extracted into the Statistical Package for Social Sciences (SPSS) software version 16 .0 for further analysis and analyzed using paired t test whereas STATA version 15.0 to generate the ROC. Accuracy of the Johnson's method or Hadlock's method for determination of fetal weight versus (Vs) the actual birth weight was measured using percentage error, absolute error and proportion of estimates within 10% of actual birth weight (birth weight ± 10%). Percentage error of the method was calculated using the formula – percentage error = x/ A X 100; where x = error in grams, A = actual birth weight. The errors in predicting fetal weight were expressed as a percentage of actual weight by means of the following method:

Error (%) = (estimated weight – actual weight) ÷ actual weight x 100

RESULTS

A total of 200 pregnant women participated in the study; of these less than half (46.5%) were primigravida with mean maternal age of 25.9±4.3 years. The mean symphysiofundal height was calculated to be 31.4±2.5 cm with mean gestational age being 39.1 weeks. More than three quarters (72.1%) delivered normally whereas the rest delivered through caesarean section or vacuum. Nearly half (49.1%) of the babies' weight ranged between 3.0 - 3.5 Kgs. The demographic characteristic of the study population is depicted below (Table 1).

Table 1. Demographic characteristics of study population (data expressed in percentage or mean± standard deviation).	
Characteristics	Study Population (n=200)
Primigravida	46.5% (93)
Maternal age (years)	25.9 ± 4.3
Symphysiofundalheight (cm)	31.4 ± 2.5
Gestational age at estimation (weeks)	39 ± 1
Neonatal weight (grams)	3025.7 ± 468.3

Time duration between fetal weight estimation and delivery (days)	2 ± 1

**Table 2. Estimated fetal weight (in grams) by various methods (n=200).**

Methods	Minimum	Maximum	Mean	Std. Deviation
Johnson's Method	1860.0	4154.0	3401.4	391.7
Hadlock's Method	1987.0	3955.0	3046.3	362.0
Actual birth weight	1750.0	4200.0	3325.5	468.3

The mean error of estimation of weight by Johnson's method was 185.1±191.1 grams and that by Hadlock's method was 355.8±225.7 grams. The mean estimated weight by Johnson's method showed significantly less error than Hadlock's method compared to birth weight on delivery (Table 2 and 3).

Table 3. Error in estimation of weight by various methods (n=200).

Error	Johnson's Method	Hadlock's Method	p-value
Mean Error	185.1±191.1	355.8±225.7	< 0.047
Maximum Error	+785 – 321.9	+990 – 596.2	
Minimum Error	+35.6 – 11.7	+18 – 13	
Mean Percentage Error	11.9±10.8	28±4.1	<0.039

It was also observed that over-estimation of fetal weight was more in Hadlock's method whereas under-estimation of fetal weight was more in Johnson's method compared to actual fetal weight on delivery (Figure 1).
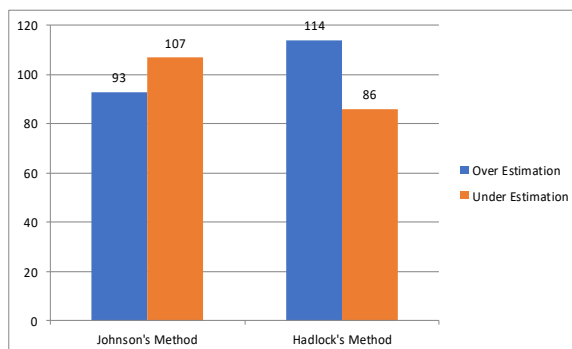

Figure 1. Over and under-estimation of cases by various methods (n=200).

Our study reported that Johnson's method was reliable method for fetal weight estimation compared to Hadlock's method (Table 4).

The sensitivity and specificity of Johnson's method and Hadlock's method for estimation of fetal birth weight above 3000 grams was 89.4, 85.1 and 67.2; 89.3 respectively. Larger babies were slightly better estimated by Johnson's method (AUC- 0.70, CI- 0.63 - 0.77) compared to Hadlock's method (AUC - 0.78 CI –0.71 - 0.84) as determined by area under the curve ROC method (Figure 2).

Johnson's method ROC area: 0.7067
Hadlock's method ROC area: 0.7811
Reference
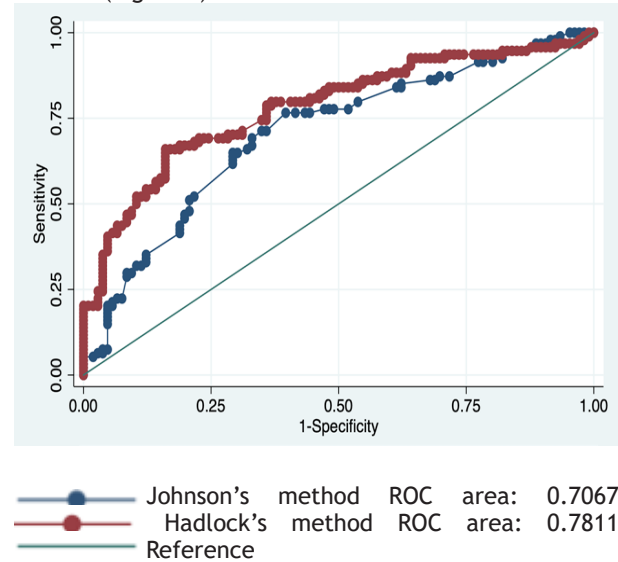
Figure 2. ROC curve for Johnson's and Hadlock's method for estimation of fetal weight in term pregnancies.

DISCUSSION

Estimation of fetal weight by ultrasonography (USG) is in increasing trend in the urban areas of our country whereas the clinical birth weight estimation is practiced only in the health facilities manned by paramedics and midwifery or in the outreach clinics under the public health services of the country. In government setting, the access to USG is available in secondary hospitals and above; however, USG is routinely done in all pregnant mothers in the antenatal clinic of private hospitals. This intervention has been promoted by private healthcare providers as added benefits.

Our study demonstrated significant difference in mean weight between Hadlock's method and actual birth weight, however, no significant difference was observed between clinically estimated fetal weight and actual birth weight, thus demonstrating Johnson's method estimation to be more reliable than Hadlock's method; this observation was statistically significant. Several studies comparing estimated birth weights

by Johnson's and Hadlock's method exhibit varying results, some showing no significant advantage of Hadlock's method over Johnson's methods[10,11] whereas some favoring Hadlock's method.[12,13] Birth weight is a critical element that determines the fetal morbidity and mortality.[13]Johnson's method was found to be more reliable method for estimation of fetal weight. This finding was like the study done by Johnson et al[14] and the mean error reported by this study is even less than their finding. Symphysiofundal height measurement is one of the important parameters to be considered for estimating fetal weight as in Abdominal Girth (AG) X Symphysiofundal height (SFH)method, Johnson's formula, Dawn's formula and the formula developed by Mhaskaret al.[15] This study corresponds to their findings as we observed Johnson's method for estimation of fetal weight to be more precise. This outlines the fact that Johnson's method clearly had an edge to Hadlock's method for estimation of fetal weight. Additional advantage to Johnson's method of fetal estimation is that it is convenient and cost effective on pragmatic terms. This is a method that allows the clinicians to assess the growth of the baby in the womb and the nutritional status of the mother during pregnancy but the chances of interobserver variation or bias cannot be ruled out.[16]Though Hadlock's method has been found to be inferior compared to Johnson's method the use of USG has been routinely practiced intervention for the determination of fetal weight and its well-being. Study by Bajacharya et al[12] reported error in estimation of fetal weight by Hadlock's method to be more than the acceptable range (>10.0%) in 40.0% of the cases which is almost similar to our finding (37.0%). Two-dimensional ultrasound is routinely used, and the estimated fetal weight is calculated using appropriate tables or integrated computer programmes. The most frequently used parameters include the biparietal diameter, abdominal circumference and femur length. There is a cumulative error inherent in each of the fetal dimensions measured. This requires expertise; lack of necessary skills might lead to measurement errors. Ultrasound formula measurements can be inaccurate as they are not representative of the genetic background. Besides acoustic shadowing inhibits anatomical vision.[17]

Most pregnant mothers with access to modern health facilities opt for USG if possible. With its increased trend dependence on USG findings has been observed among the clinicians for further clinical management. Availability of USG services facilities are mostly found in private health care sector and government facilities above secondary level. Considering its cost and the financial status of general population in our country; recognition of USG as a primary routine investigation needs to be really thought upon on strategic terms before the formulation of national policy. Thus, cost effective clinical method like Johnson's method which has been found to be precise compared to Hadlock's method needs to be well promoted by the government for routine antenatal checkup.

In the study, head circumference was not taken as the method of Hadlock calculation, so there can be some variation in the weight of fetus. As fetal weight by USG is operator dependent, there can be some limitation on accuracy of the weight. In comparison between clinical method and ultrasound technique in fetal weight estimation, clinical method is also comparatively good where ultrasound is not available.

CONCLUSIONS

It was observed that the Johnson's method of fetal weight estimation was more accurate than Hadlock's method. Thus, it should be routinely practiced by all the health workers working in the antenatal out-patients or ward to avoid overdependence on the use of electronic devices for the estimation of fetal weight as these facilities are limited in developing countries. Cost effective methods like Johnson's method should be included in the training programs targeted to paramedics and female community health workers as skilled health workers to these kinds of methods will yield better outcomes with no financial implications. The use of sophisticated interventions like ultrasound requires trained human resources, regular maintenance with period updates of the devices which can be a burden for the health system.

ACKNOWLEDGEMENTS

REFERENCES

1. Sherman DJ, Arieli S, Tovbin J, Siegal G, Caspi E, Bukovsky A. A comparision of clinical and ultrasound estimation of fetal weight. Obstet Gynaecol.1998;91:212-7.[PubMed]

2. Chauhan SP, Hendrix NW, Magann EF, Morrison JC, Jenney SP, Devoe LD. Limitations of clinical and sonographic estimation of birth weight: experience

with 1034 parturients. Obstet Gynecol.1998; 91:72-7. [PubMed]

3. Nzeh DA, Oyawoye O, Adetoro OO. Ultrasound estimation of birth weight in late pregnancy among African women. West African J ultrasound.2000;1:9-14.[FullText]

4. Hanretty KP, Neilson JP, Fleming EE. Re-evaluation of clinical estimation of fetal weight: a comparison with ultrasound. J Obstet Gynaecol.1990;10:199-201. [FullText]

5. Hendrix NW, Grady CS, Chauhan SP. Clinical versus sonographic estimates of birth weight in term parturients. A randomized clinical trial. J Reprod Med. 2000; 45:317-22.[PubMed]

6. Raman S, Urquhart R, Yusof M. Clinical versus ultrasound estimation of fetal weight. Aust N Z J Obstet Gynaecol.1992;32:196-9.[PubMed]

7. Watson WJ, Soissons AP, Harlass FE. Estimated weight of the term fetus. Accuracy of ultrasound vs. clinical examination. J Reprod Med.1988; 33:369-711.[PubMed]

8. Dawn CS, Modale GC, Galosh A. A simple procedure for determination of antenatal fetal weight. J Obstet gynecol.1983; 33:133-7.[Google Scholar]

9. Tiwari R, Sood M. Comparative study of various methods of fetal weight estimation at term pregnancy. J Obstet Gynaecol.1989;39:279-86.[FullText]

10. Njoku C, Emechebe C, Odusolu P, Abeshi S, ChukwuC, Ekabua J. Determination of accuracy of fetal weightusing ultrasound and clinical fetal weight estimationsin Calabar South, South Nigeria. Int Sch Res Notices.2014;10:970-3. [PubMed]

11. Ugwu EO, Udealor PC, Dim CC, Obi SN, OzumbaBC, Okeke DO, et al. Accuracy of clinical andultrasound estimation of fetal weight in predictingactual birth weight in Enugu, Southeastern Nigeria. Niger J Clin Pract. 2014;17(3):270-5.[PubMed]

12. Bajracharya J, Shrestha NS, Karki C. Accuracy of Prediction of Birth Weight by Fetal Ultrasound. Kathmandu UnivMed J. 2012;38(2):74-6. [PubMed]

13. Joshi A, Panta OB, Sharma B. Estimated Fetal Weight: Comparison of Clinical Versus Ultrasound Estimate. J Nepal Health Res Counc. 2017;15(35):51-5.[Link]

14. Nahum GG. Estimation of fetal weight, emedicinespecialities. Apr 15,2010:1-27[Link]

15. Johhnson RW, Toshac CE. Estimation of fetal weight using longitudinal mensuration. Am J Obstet Gynaecol.1954;68(3):891-6[PubMed]

16. Mhaskar R, Mhaskar A, Molly SR. Symphysiofundal height (SFH) measurement for prediction of birth weight - A new formula. J Obstet Gynecol Ind.2001; 51:73-6.[Link]

17. Cunningham FG, Williams JW, editors. Williams Obstetrics. 21st ed. New York: McGraw-Hill; 2016.

18. Sharma N, Srinivasan K J, Sagayaraj MB, Lal DV. Foetal weight estimation methods – Clinical, Sonographic and MRI imaging. Int J of Sci and Res Pub. 2014;4(1):1-5. [FullText]