Accuracy of the Fetal Kidney Length Measurement by Ultrasonography in the Determination of the Gestational Age in Pregnancy

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Introduction

Accurate knowledge of gestational age (GA) is key for better antenatal care, planning, and successful management of all pregnancies. In high-risk pregnancies like preeclampsia, intrauterine growth retardation, gestational diabetes mellitus, and termination of pregnancy is planned considering the GA. Failure in accurate estimation of GA can result in iatrogenic prematurity or postmaturity, both of which are associated with increased perinatal mortality and morbidity.

Number of parameters have been in use to calculate GA. Depending on the trimester of pregnancy, first date of last menstrual period (LMP), gestational sac diameter and volume, crown–rump length (CRL) measurements, biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) are the traditional indices measured by ultrasonography to calculate GA.¹⁻⁹ But there exist limited value for first trimester parameters like LMP and CRL. And also there happens increasing unreliability in using the other second trimester fetal biometric indices like BPD, HC, AC, and FL in GA estimation.¹⁰⁻¹³

The quest of finding an accurate sonographic predictor of GA during late pregnancy beyond second trimester resulted...
in many studies which found fetal kidney length (FKL) as a potential index.\textsuperscript{12,14–20}

Rule of thumb states that “renal length in millimeter approximates fetal GA in weeks.” Studies have also noted a linear increase in FKL with increase in GA.\textsuperscript{21–31} The growth of fetal kidney was shown to be 1.07 to 1.1 mm by a couple of studies.\textsuperscript{25,33} The fetal kidneys were claimed to have a constant increase in length of 1.7 mm fortnightly.\textsuperscript{34} This constant growth pattern of fetal kidneys remains unaltered by fetal growth disorders and so this parameter stands as a more reliable index for calculating GA even for complicated pregnancy.\textsuperscript{13,17}

Limited Indian studies validating FKL and GA prompted this study. This study also compared the accuracy of FKL with other second trimester indices which are being used traditionally for GA estimation in late pregnancy.

Materials and Methods

The study was done prospectively in a convenient sample size of pregnant women who got registered to the antenatal clinical of a rural medical college hospital during November 2013 to March 2014. Only those pregnant women who knew their LMP with singleton fetus in their third trimester were enrolled in this study irrespective of their parity and maternal age. Women with doubtful LMP, having pregnancy associated with risk factors, anomalies, and who were in their first and second trimester were excluded even if they happened to be registered to antenatal care of the hospital.

All the enrolled women were subjected to blinded sonographic examination by two experienced sonologist using Mindray DC 70 expert ultrasound instrument with convex probe in a frequency of 3.5 to 5. Among them, one sonologist limited his examination to traditional biometric indices measured for calculating GA like AC, HC, FL, and BPD. From the measured indices the GA was calculated using Hadlock’s formula,\textsuperscript{25} while the other sonologist was made to measure only the FKL as described by Bertagnoli et al.\textsuperscript{15}

The measured indices were tabulated and descriptive statistics were applied. The correlation between GA and traditional indices and FKL was done by Pearson’s correlation method.

The study was done only after obtaining institutional ethical clearance and informed consent from enrolled participants.

Results

A total of 100 women with the age ranging from 21 to 36 years completed the study. Both right and left kidneys were measured and its average was used for computation of renal length which was found to be 28.12 and 40.1 mm in 28 and 40 weeks of gestation, respectively (\textsuperscript{\textbullet}Table 1). It was observed that the renal length in millimeters at any given GA corresponds to the GA of the fetus. The mean FKL for third trimester was 34.1 mm.

A positive correlation was observed between all indices and GA. The correlation between GA and mean FKL was seen to be highly significant with Pearson’s correlation ($p < 0.001$) (\textsuperscript{\textbullet}Table 2).

Discussion

Proper antenatal care depends largely upon GA measurement. When women register late and in particular those who are uncertain of their LMP, it is often difficult to date pregnancies. Clinical dating methods like LMP and uterine size and sonographic indices like CRL, BPD, HC, FL, and AC had been shown to fail in accurate GA calculation beyond 28 weeks of gestation.\textsuperscript{1–13}

FKL was reported to be a reliable index in late pregnancy GA estimation.\textsuperscript{12,14–20}

The mean FKL measured in this study was observed to linearly increase with increasing GA (\textsuperscript{\textbullet}Table 1). The mean FKL with GA was compared with previous studies. It was found to coincide with most studies except two studies which reported slightly higher values (\textsuperscript{\textbullet}Table 3). The higher values seen in those two studies could be due to ethnicity. The mean FKL for pregnancy beyond 28 weeks obtained from this study was found well within reported range of 33.8–to 39.5 mm.\textsuperscript{26,30}

GA was correlated with different fetal biometric indices and the correlation coefficient compared with that of FKL correlation coefficient. In this study, correlation coefficient showed more accurate GA with FKL compared with other in late pregnancy. Similar findings were shown in literature reports.\textsuperscript{21–31}

During the first 10 weeks of pregnancy, LMPs and sonographic indices were claimed to predict GA to within 4.7 days\textsuperscript{1,2} and between 12 and 24 weeks, to within 6 to 10 days.\textsuperscript{3–9} The unreliability of the fetal biometric indices like BPD, HC, AC, and FL in calculating GA in late pregnancy have left place for using FKL as a reliable index. In third trimester using traditional fetal biometric indices, studies have reported GA with error of 6 to 9.45 days.\textsuperscript{19,36,37}

Meanwhile with FKL added as an additional index, it was shown to increase accuracy with standard error of 5.54 days only.\textsuperscript{36}

<table>
<thead>
<tr>
<th>Gestational age (wk)</th>
<th>No. of cases</th>
<th>Mean kidney length (mm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>8</td>
<td>28.12</td>
<td>0.08</td>
</tr>
<tr>
<td>29</td>
<td>4</td>
<td>29.00</td>
<td>0.54</td>
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<tr>
<td>30</td>
<td>2</td>
<td>30.17</td>
<td>0.00</td>
</tr>
<tr>
<td>31</td>
<td>7</td>
<td>31.22</td>
<td>0.10</td>
</tr>
<tr>
<td>32</td>
<td>8</td>
<td>32.00</td>
<td>0.00</td>
</tr>
<tr>
<td>33</td>
<td>7</td>
<td>32.64</td>
<td>0.00</td>
</tr>
<tr>
<td>34</td>
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</tr>
<tr>
<td>37</td>
<td>14</td>
<td>37.14</td>
<td>0.00</td>
</tr>
<tr>
<td>38</td>
<td>4</td>
<td>37.86</td>
<td>0.26</td>
</tr>
<tr>
<td>39</td>
<td>2</td>
<td>39.15</td>
<td>0.02</td>
</tr>
<tr>
<td>40</td>
<td>2</td>
<td>40.10</td>
<td>0.02</td>
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</table>

Abbreviation: SD, standard deviation.
Even though this study validated and showed linear increase of FKL with progression of gestation, limited sample size and convenient sampling technique used might prove to be a limiting factor.

Conclusion
With a constant increase, FKL has shown a strong correlation with GA in third trimester pregnancy. Even though it could be used as standalone index in calculating GA beyond 28 weeks, it might be of advantage if it was added to other sonographic fetal biometric indices to bring in more accuracy to GA calculation.

Conflict of Interest
None.

Funding
None.

References

Table 2 Correlation of gestational age with kidney length and other parameters

<table>
<thead>
<tr>
<th>Variables</th>
<th>Test statistics</th>
<th>AC</th>
<th>HC</th>
<th>BPD</th>
<th>FL</th>
<th>Kidney length</th>
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<tbody>
<tr>
<td>Gestational age</td>
<td>Pearson’s correlation</td>
<td>0.882*</td>
<td>0.902*</td>
<td>0.924*</td>
<td>0.950*</td>
<td>0.962*</td>
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<tr>
<td>Significance (two-tailed)</td>
<td>&lt; 0.05</td>
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<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td>&lt; 0.05</td>
<td></td>
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<tr>
<td>No. of cases</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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</tbody>
</table>

Abbreviations: AC, abdominal circumference; BPD, biparietal diameter; FL, femur length; HC, head circumference.

*Correlation is significant at the 0.05 level (two-tailed).

Table 3 Comparison of mean FKL among different studies

<table>
<thead>
<tr>
<th>Gestational age (wk)</th>
<th>Sagi et al23</th>
<th>Kansaria and Parulekar29</th>
<th>Cohen et al16</th>
<th>Bertagnoli et al15</th>
<th>Ahmadi et al22</th>
<th>Present study</th>
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<tr>
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<tr>
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<td>36.2</td>
<td>44</td>
<td>36.0</td>
<td>42.45</td>
<td>37.86</td>
</tr>
</tbody>
</table>

Abbreviation: FKL, fetal kidney length.