Original article:

The Cross-sectional area of umbilical cord and Wharton's jelly in pre-eclampsia

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Abstract

Objective: Assess the relation of fetal umbilical cord cross-sectional area and cross-sectional area of Wharton’s jelly and total vessel area in normal and pre-eclamptic pregnancies.

Methods: Umbilical cord obtained from thirty normal pregnancies and thirty pre-eclamptic pregnancies were studied. Morphological changes in umbilical cords were examined on formalin fixed paraffin embedded sections. Total umbilical cord area, jelly area, and total vessel area were measured by digital planimeter and correlated with other fetal parameters.

Results: Wharton’s jelly and total vessel area were altered with increase in umbilical cord cross-sectional area in pre-eclamptic and normal pregnancies. Correlation of Wharton’s jelly area with total umbilical cord area was more significant in normal pregnancies than pre-eclamptic pregnancies. Whereas, correlation of area of umbilical cord with total vessel area was insignificant in normal pregnancy and weak in significance in pre-eclamptic pregnancy.

Conclusion: Wharton’s jelly is main component which is going to increase in umbilical cord during 36-42 weeks in normal pregnancies as compared to pre-eclamptic pregnancies. Total vessel area is insignificantly variable in normal and pre-eclamptic pregnancy in this period. Current study provides parameters for further research on fetal characteristics.

Key words: Cross-sectional area, Wharton’s jelly, Pre-eclampsia, Total vessel area, Umbilical Cord

Introduction

Umbilical cord (UC) is the connecting link between fetus and mother. Umbilical cord contains umbilical vessels and Wharton’s jelly. Wharton’s jelly which is rich in glycosaminoglycans, proteoglycans and hyaluronic acids, functions as a protective layer for blood vessels.¹ Different studies have been reported for umbilical cord morphology is influenced by several maternal and fetal conditions including IUGR, gestational diabetes and pre-eclampsia.²,³,⁴ Changes in amount of Wharton’s jelly have been demonstrated in several conditions such as fetal distress⁵, maternal hypertension⁶, maternal diabetes², dismaturity⁵. Romanowicz et al found premature replacement of hyaluronic acid by sulphatedglycosaminglycans (GAGs), both in umbilical cord arteries and Wharton’s jelly in EPH- gestosis / Pre-eclampsia.⁷ Such phenomenon may be the result of reduction in degradation of these compounds.⁷ Because of these changes in Wharton’s jelly, umbilical vessels and parameters of baby will be affected in-utero and ex-utero.⁸,⁹,¹⁰ Changes in umbilical cord components are responsible for variations in umbilical cord dimensions¹¹ and in-turn to fetus. Aim of our study was to demonstrate the correlation of the umbilical cord components with umbilical cord responsible for variation in umbilical cord dimensions both in normal
and pre-eclamptic pregnancies during 36 to 42 weeks of fetal life.

**Material and method**

Out of sixty subjects, thirty were in Group I (consisted of umbilical cords obtained from normal pregnant) and other thirty in Group II. Group I (n=30) was with normal blood pressure (Systolic BP <140 mmHg and Diastolic BP <90mmHg), gestational age 37-40 weeks. Group II consisted of umbilical cord obtained from pre-eclamptic women. Women were diagnosed with pre-eclampsia if they had Systolic BP ≥140mmHg, diastolic BP ≥90mmHg measured on two or more occasions at least 4 hours apart after 20th week of gestation with proteinuria (at least 1+ on two separate occasions). After delivery preservation of umbilical cords were done five centimeters away from placental end, and were fixed in formalin. Two blocks were made from each umbilical cord. Slides obtained after section cutting and mounting, were stained with Haematoxiline and Eosin stain. Random samples of sections were taken for study. Digital planimeter were used to measure histomorphometric parameters of umbilical cord. The parameters measured for each umbilical cord were; total umbilical cord with Wharton’s jelly area and total vessel area. All morphometric measurements were done in a blind fashion, without prior knowledge of clinical data. The data obtained from the study was compiled and expressed as mean ± standard deviation. For paired variables having normal distribution, paired t test was used. A p value of <0.05 was taken as significant.

**Results**

The mean ± SD age of the participants, weight of baby and umbilical cord parameters of normal and preeclamptic subjects are tabulated (Tab.1 and 2). Total umbilical cord area, jelly area, and total vessel area were minimally during 36-42 weeks period of gestation both in normal and pre-eclamptic pregnancies. The area of WJ increased according to area of umbilical cord in normal pregnancies and pre-eclamptic pregnancies (Fig.1a and 2a). But this correlation was more significant in normal pregnancies (R=0.938, R² =0.887 ) in comparison to pre-eclamptic pregnancy cases (R= 0.69 , R² = 0.523 ) (Fig.1aand 2a, Table 3). The correlation between umbilical vessel area and total area of umbilical cord were found to be week in normal pregnancy( R= 0.44, R²=0.055 ) in comparison pre-eclampsia cases ( R= 0.50, R²=0.283) (Fig.1b and 2b, Table 3).

**Figure 1 Graph showing relationship between (a) total umbilical cord area and jelly area (b) total umbilical cord area and total vessel area in normal pregnancies**
Figure 2: Graph showing relationship between (a) total umbilical cord area and jelly area (b) total umbilical cord area and total vessel area in pre-eclamptic pregnancies.
Table 1 Clinical characteristic of normal pregnancies with parameters of umbilical cord whose measurements were performed

<table>
<thead>
<tr>
<th>Case</th>
<th>POG</th>
<th>N=30</th>
<th>Age (In years)</th>
<th>Weight of baby</th>
<th>Total Umbilical Cord Area (mm²)</th>
<th>Jelly Area (mm²)</th>
<th>Total Vessel Area (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUC</td>
<td>35-36</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>36-37</td>
<td>1</td>
<td>20</td>
<td>3.2</td>
<td>46.28</td>
<td>37.51</td>
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<tr>
<td></td>
<td>37-38</td>
<td>12</td>
<td>24.16±2.85</td>
<td>2.78±0.29</td>
<td>49.40±10.00</td>
<td>42.05±8.97</td>
<td>7.11±1.96</td>
</tr>
<tr>
<td></td>
<td>38-39</td>
<td>9</td>
<td>22.88±2.14</td>
<td>2.6±0.36</td>
<td>59.65±16.75</td>
<td>48.52±14.94</td>
<td>10.36±6.67</td>
</tr>
<tr>
<td></td>
<td>39-40</td>
<td>8</td>
<td>24.12±1.88</td>
<td>2.88±0.37</td>
<td>46.33±8.71</td>
<td>36.15±9.046</td>
<td>10.17±4.04</td>
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</tbody>
</table>

Table 2 Clinical characteristic of pre-eclamptic pregnancies with parameters of umbilical cord whose measurements were performed

<table>
<thead>
<tr>
<th>Case</th>
<th>POG</th>
<th>N=30</th>
<th>Age (In years)</th>
<th>Weight of baby</th>
<th>Total Umbilical Cord Area (mm²)</th>
<th>Jelly Area (mm²)</th>
<th>Total Vessel Area (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUC</td>
<td>35-36</td>
<td>5</td>
<td>21.8±1.78</td>
<td>1.65±0.285</td>
<td>50.11±13.63</td>
<td>31.09±15.38</td>
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<td></td>
<td>36-37</td>
<td>3</td>
<td>23±1.73</td>
<td>2.166±0.80</td>
<td>44.01±10.95</td>
<td>33.27±6.02</td>
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<tr>
<td></td>
<td>37-38</td>
<td>7</td>
<td>23.16±1.83</td>
<td>2.89±0.33</td>
<td>48.00±16.65</td>
<td>32.2±11.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38-39</td>
<td>5</td>
<td>25.4±3.57</td>
<td>2.65±0.45</td>
<td>42.41±15.04</td>
<td>34.04±13.27</td>
<td>8.36±3.23</td>
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<tr>
<td></td>
<td>39-40</td>
<td>8</td>
<td>22.42±3.55</td>
<td>2.6±0.48</td>
<td>49.10±7.19</td>
<td>35.80±5.27</td>
<td>13.29±8.96</td>
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<td>40-41</td>
<td>2</td>
<td>22.5±2.12</td>
<td>2.92±0.24</td>
<td>43.71±3.09</td>
<td>25.89±10.55</td>
<td>17.81±7.45</td>
</tr>
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</table>

Table 3 distribution as per correlation coefficient of parameter studied

<table>
<thead>
<tr>
<th>S N</th>
<th>Characteristics</th>
<th>Value of R</th>
<th>Value of R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Area of W J and area of UC Normal Pregnancies</td>
<td>0.938</td>
<td>0.887</td>
</tr>
<tr>
<td>2</td>
<td>Area of W J and area of UC Pre-eclamptic Pregnancies</td>
<td>0.69</td>
<td>0.523</td>
</tr>
<tr>
<td>3</td>
<td>Vessel area and area of UC Normal Pregnancies</td>
<td>0.44</td>
<td>0.055</td>
</tr>
<tr>
<td>4</td>
<td>Vessel area and area of UC pre-eclamptic Pregnancies</td>
<td>0.50</td>
<td>0.283</td>
</tr>
</tbody>
</table>

UC Umbilical cord, WJ Wharton’s jelly
Discussion

This study shows direct relationship between cross-section of umbilical cord and area of WJ both in normal pregnancies and pre-eclamptic pregnancies in 36-42 weeks gestation (Fig. 1a, 2a). There was increase in area of WJ as a function of cross-sectional area of UC during term of pregnancies both in normal and pre-eclamptic pregnancies. While area of umbilical vessels was not a function of cross sectional area of UC in the course of term of pregnancies both in normal and pre-eclamptic pregnancies (Fig.1b, 2b).

Moreover, a lower Wharton’s Jelly content in the growth retarded newborns in comparison to eutrophic infant has been shown by computerized microscope morphometry. Fetuses of patients with gestational diabetes have larger umbilical cord than nondiabetic patient and that is mainly due to higher content of WJ. Microscopically these authors’ found an alteration in distribution of Wharton’s jelly fibers with large empty spaces. The current study indicates that in pre-eclampsia significant decrease in content of WJ area than normal group that is mainly because of decrease in empty spaces and hypoplasia of cells and fibers of WJ in low magnification (Fig. 3). Various authors have found that progressive increase in UC diameter and cross sectional area UC upto 32 weeks of gestation followed by reduction/constant size of umbilical cord in later weeks of gestation. These are the sonographic conclusions. Our study corresponds with others findings (Table 1 and 2).

Vizza et al reported, the collagen fibrillar network of the Wharton’s jelly by scanning electron microscopy and shows the presence of a wide system interconnected cavities consisting of canalicular-like structures as well as cavernous and perivascular spaces. The authors postulated that this system of cavities might play a mechanical role allowing the storing of ground substance of the jelly and its diffusion during twisting or compression. Considering that the Wharton’s jelly lack of proper vasculature, this system of cavities may have an important role facilitating the diffusion throughout the jelly of water and trophic metabolites either from
or to the umbilical vessels and the amniotic fluid. Decrease in spaces and cells of WJ would be cause of change in vasculature and weight of fetus (Table 1, 2) in pre-eclampsia as compared to normal. The presence of thin umbilical cord during pregnancy is an indication for low birth weight baby or growth restricted baby. This appears to be a consequence of amount of WJ in umbilical cord.14 This is in agreement with our data which demonstrate that High WJ content in normal pregnancy would have normal birth weight baby as compared to low WJ content in preeclamptic pregnancy would have low birth weight baby (Table 1, 2). Moreover, it has been reported that the varied appearance of UC at term may be correlated to its water content and that the difference are mainly confined to the WJ.15

There was a positive correlation between area of WJ and area of umbilical cord. The correlation was more significant in normal pregnancies in comparison to pre-eclamptic pregnancy cases, but the correlation between umbilical vessel area and total area of umbilical cord was found to be weak, more so in normal pregnancy in comparison to normal pre-eclampsia cases (Table 3).

As authors did not find similar type of study while doing review of literature it was felt that intensive research in this field is required to get generalize view about relationship between area of Wharton’s jelly and area of umbilical cord, vessel area especially in pre-eclampsia cases. In brief current study can serve as a parameter for further study in pre-eclampsia cases to establish correlation with fetal growth.

Conflict of Interest
The authors have no conflict of interest.

References


