Fetal Kidney Length as an Independent Estimator of Gestational Age  |  Dr. Cletus Uche Eze, et al

Zinner Syndrome: The Role of Abdominal, Scrotal and Transrectal Sonography  |  Sohail Anwar and Linda Dénommé

Adolescent Systemic Hypertension  |  Carlos Barrios and Michael Giuffre

Ovarian Torsion  |  Emma Gillis
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Message from the Editor-in-Chief

Original Research

Fetal Kidney Length as an Independent Estimator of Gestational Age: A Cohort Study of a Population of Yoruba Women in Lagos Nigeria
Dr. Cletus Uche Eze, BSc, MHPM, MSc, PhD; Ernest Ruto Upeh, BSc, Cert. Med. US; Dr. Omodele A. Olowoyeye, MBBS, RVT, RDMS, MSc Physiology, PhD, FMCR

Peer Review Case Study

Zinner Syndrome: The Role of Abdominal, Scrotal and Transrectal Sonography
Sohail Anwar, RDMS, DMS and Linda Dénommé CRGS, CRVS, DMS, RDMS, RVT

Peer Reviewed Case Study

Adolescent Systemic Hypertension: Late Diagnosis of Coarctation of the Aorta
Carlos Barrios MSc, HBSc, RDCS, CRCS and Michael Giuffre, BSc, MD

Peer Reviewed Pictorial Essay

Ovarian Torsion
Emma Gillis, BHSc, CRGS, CRCS

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About the Cover

From the Ovarian Torsion article. Figure 13. A 16-year-old patient with acute onset of pelvic pain. The image on the right shows a grayscale image of a vascular ovarian pedicle. The image on the right shows the addition of power Doppler to the vascular ovarian pedicle, which is demonstrating the whirlpool sign, which is indicative of ovarian torsion. The whirlpool sign is the visible twisting of the vascular ovarian pedicle; the sign refers to the swirling appearance as seen while scanning in the short-axis of the ovarian pedicle, although vascular twisting can also be seen in the long axis.
Message from the Editor-in-Chief

This issue of *CJMS* includes an original research paper; case studies, and a pictorial essay to enrich the knowledge base of the generalist, cardiac, and vascular sonographer. Sohail Anwar introduces us to an interesting case of Zinner’s syndrome, this rare case is a good example of an evidence-based report. Dr Eze and his team have submitted an original research report on the “Usefulness of Fetal Kidney Length as an Independent Estimator of Gestational Age”; this research was conducted on a population of Yoruba women in Nigeria. I haven’t seen any Canadian research studies on fetal kidneys lengths in correlation with gestational age but have noted similar studies in different countries such as Britain, Turkey, and India which makes me wonder if we are missing out on a great research topic?

Emma Gillis presents a thorough review on the different findings in ovarian torsion and has included multiple cases making this an excellent read. Carlos Barrios reports on a case of adolescent systemic hypertension; this is an echocardiography case but I feel that the article will be of interest to all sonographers (cardiac, vascular and generalist).

This issue also brings you the 2019 Sonography Canada award winners who will be celebrated at the annual Sonography Canada conference in Toronto on May 24–26. Registration is open. The keynote speakers are world renowned and there are excellent workshops and presentations. The venue is on Toronto’s beautiful waterfront as well as the downtown core.

I will be attending the conference, send me an email at editorCJMS@sonographycanada.ca and I would be happy to meet with you to discuss submitting an article to the journal or to consult with you on your project.

For our meeting in Toronto I would like to acknowledge this land; “We acknowledge the land we are meeting on is the traditional territory of many nations including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples and is now home to many diverse First Nations, Inuit and Métis peoples. We also acknowledge that Toronto is covered by Treaty 13 with the Mississaugas of the Credit.”

Respectfully yours;
Sheena Bhimji-Hewitt MAppSc, DMS, CRGS, CRVS, RDMS, RVT
Editor-in-Chief

Reference

Message du rédacteur en chef

Ce numéro de la *RCSMC* comprend un article de recherche original, des études de cas et un essai illustré pour enrichir la base de connaissances des échographistes généralistes, cardiologues et vasculaires. Sohail Anwar nous présente un cas intéressant de syndrome de Zinner, ce cas rare est un bon exemple de rapport fondé sur des preuves. Le Dr Eze et son équipe ont soumis un rapport de recherche original sur l’utilité de la longueur du rein fœtal en tant qu’estimateur indépendant de l’âge gestationnel ; cette recherche a été menée sur une population de femmes yoruba au Nigeria. Je n’ai pas vu d’études de recherche canadiennes sur la longueur des reins fœtaux en corrélation avec l’âge gestationnel, mais j’ai remarqué des études semblables dans différents pays comme la Grande-Bretagne, la Turquie et l’Inde, ce qui me fait me demander si nous ne manquons pas un grand sujet de recherche?

De plus, Emma Gillis présente un examen approfondi des différents résultats sur la torsion ovarienne et a inclus plusieurs cas, ce qui en fait une excellente lecture. Carlos Barrios parle d’un cas d’hypertension systémique chez un adolescent ; il s’agit d’un cas d’échocardiographie, mais je pense que l’article intéressera tous les échographistes (cardiaque, vasculaire et généraliste).

Ce numéro vous présente également les lauréats des prix Sonography Canada 2019 qui seront célébrés lors de la conférence annuelle Sonography Canada qui se tiendra à Toronto du 24 au 26 mai. Et les inscriptions sont ouvertes. Les conférenciers d’honneur sont de renommée mondiale et il y a d’excellents ateliers et présentations. Le site se trouve sur le magnifique front de mer de Toronto ainsi qu’au centre-ville. Je serai présent à la conférence, envoyez-moi un courriel à editor@sonographycanada.ca et je serais heureux de vous rencontrer pour discuter de la soumission d’un article à la revue ou pour vous consulter sur votre projet.

Nous reconnaissons que le territoire sur lequel nous nous réunissons est le territoire traditionnel de nombreuses nations, y compris les Mississoaugas du Crédit, les Anishnabeg, les Chippewa, les Haudenosaunee et les Wendat, et qu’il abrite maintenant de nombreux peuples des Premières nations, Inuits et Métis divers. Nous reconnaissons également que Toronto est couverte par le Traité 13 avec les Mississoaugas du crédit 1.

Respectueusement vôtre ;

Sheena Bhimji-Hewitt MApPSc, DMS, CRGS, CRVS, RDMS, RVT
Rédacteur en chef

Référence

Fetal Kidney Length as an Independent Estimator of Gestational Age: A Cohort Study of a Population of Yoruba Women in Lagos Nigeria

About the Author

Dr. Eze is a lecturer in the Faculty of Clinical Sciences (Radiography) at the College of Medicine of the University of Lagos. Ernest Upeh is a senior sonographer at Ave Maria Hospital at Victoria Island, Lagos, Nigeria. Dr. Olowoyeye is a senior lecturer in Radiology at the College of Medicine at the University of Lagos and a consultant Radiologist and program coordinator of the radiology residency program at Lagos University Teaching Hospital (LUTH).

Abstract

Background: Fetal kidney length (FKL) can be used to estimate gestational age (GA) yet there is a paucity of data on its precision.

Aim: To determine the precision and usefulness of FKL as GA predictor.

Methods: In the prospective study, sonographically measured FKL was used to estimate GA while its standard error as GA estimator was calculated.

Result: The rate of kidney growth was 1.2 mm per week; mean FKL was 37.7 ± 2.9 mm. The mean right and left FKL was 37.5 ± 3.6 mm and 37.9 ± 3.1 mm, respectively. Correlation between GA and FKL was positive (r = 0.9870; p < 0.0001); FKL was more precise than the biparietal diameter and abdominal circumference as GA estimator (standard error of estimation = ±6.6 days).

Conclusion: Sonographically measured FKL was precise and useful as an independent GA estimator in the third trimester of pregnancy in a population of Yoruba women in Lagos Southwest Nigeria.

Keywords: Sonography; gestational age estimation; fetal kidney length; precision.
**Introduction**

Accurate estimation of GA is essential in planning antenatal care. It is used in the correct interpretation of fetal growth assessment necessary in making management decisions. Intra-uterine growth patterns such as growth restriction, macrosomia, or microsomia may be missed or incorrectly diagnosed if GA is not known or is not accurately estimated. Reliable GA estimation is necessary for calculating rates of preterm delivery and small-for-gestational-age neonates at delivery in different populations. Inaccurate GA estimation, particularly in geographical regions at the greatest risk of small-for-gestational-age (SGA) fetuses or preterm deliveries, implies that reported prevalence of such conditions are mere approximations. Viable and mortality caused by unnecessary induction, dysfunctional labor, and operative delivery, accurate GA estimation is important and is used to predict survival without major impairment in neonates born at the limit of viability.

The use of the first day of last menstrual period (LMP) which assumes that ovulation occurs on day 14 of the menstrual cycle or measurement of symphysio-fundal height to estimate GA may be inaccurate. Variability associated with ovulation is significant with 10-45% of pregnant women unable to provide useful information about their LMP, and there is a significant difference between menstrual and ultrasonographic dating in 18% of women with regular menstruation. Measurement of symphysio-fundal height is associated with significant intra-observer variability because the distance between the symphysis pubis and the umbilicus varies when women are pregnant and when they are not. First trimester (≤ 14 weeks’ gestation) ultrasound measurement of crown–rump length (CRL) is, therefore, recommended for dating of pregnancy where LMP and measurement of symphysio-fundal height are not reliable.

In late pregnancy where fetal growth disturbances become most noticeable, significant absolute errors are associated with sonographic estimation of GA using biparietal diameter (BPD), abdominal circumference (AC), femur length (FL) with underestimation of GA for macrosomia and overestimation for a macrosomic fetuses highly likely. In Lagos metropolis, most pregnant women visit antenatal care clinics for the first time in the late stage of pregnancy or at the time of delivery. This makes it difficult for obstetricians to evaluate fetal growth, decide on evidence-based intervention such as the administration of corticosteroids for fetal lung maturation in cases of threatened preterm labor and manage complications. Biparietal diameter, AC and FL are common fetal parameters used in sonographic estimation of GA during second trimester and late pregnancy in Lagos. Accuracy of sonographic measurement of BPD is, however, adversely affected by fetal anomalies such as hydrocephalus as well as fetal head shape such as plagiocephaly, dolichocephaly, and brachycephaly while the accuracy of sonographically measured FL and AC, is affected by “systemic” errors hence the need for a parameter that will be more precise when used independently or in combination with other parameters as GA and or fetal weight estimator.

Sonographic measurement of transverse cerebellar diameter (TCD) and scapula length have been used in GA estimation. While TCD is accurate in fetuses with extremes of growth abnormalities and in those with dolichocephaly and brachycephaly, it is difficult to measure in the late pregnancy because fetal cerebellum grows in a linear pattern in the second trimester with its growth curves flattening in the third trimester resulting in a two-fold increase in TCD size. Sonographic measurement of scapula length, on the other hand, is difficult, time-consuming and requires a lot of experience and skill in obese patients and its accurate measurement is adversely affected by chromosomal and congenital anomalies such as amelia, complete or partial duplication of the scapula, dysplasia of scapular neck, Sprengel’s deformity, congenital syphilitic osteitis of scapula and sickle-shaped scapulae in Pierre Robin syndrome.

The use of multiple parameters is more accurate than a single parameter in the sonographic estimation of GA. Hadlock’s formula which combines multiple parameters is commonly used in Lagos; despite significant variability associated with its use in a breech presentation, engaged head, macrosomia, and congenital anomalies. There is, therefore, a need for a single parameter...
usually not affected by changes in fetal growth that can be used in sonographic GA estimation in late pregnancy. A linear relationship exists between FKL and GA\textsuperscript{19} but ethnic differences are associated with kidney size.\textsuperscript{20,21} To determine its precision and usefulness as an independent GA estimator, we measured FKL in a population of pregnant women of Yoruba ethnic nationality in Lagos Nigeria and computed the standard error of estimation associated with it.

**Materials and Methods**

A convenience sample of 286 pregnant women of Yoruba ethnic origin was recruited to participate in the prospective cross-sectional study carried out between September 2017 and January 2018. Each participant gave written informed consent before being recruited, and ethical approval was obtained from the research ethics committee of the hospital located at Victoria Island. Only women with singleton pregnancies between 28 and 40 weeks and who were married to Yoruba men underwent an ultrasound examination.

Women with BMI >30 kg/m\textsuperscript{2} who were considered obese as well as fetuses with growth or ultrasound detected disorder were not included in the study.\textsuperscript{22} A sonographer with > 4 years’ experience in obstetric sonography used “Xario-200” ultrasound machine (Model TUS-X200; Toshiba Diagnostic Ultrasound Systems Ltd., Tokyo, Japan) and a 5 MHz curvilinear transducer to perform the sonographic examinations. Scanning was through either side of the dorsolumbar spine in the parasagittal and transverse axial sections. As was previously described, the fetal kidney was visualized in the longitudinal plane.\textsuperscript{23} Bilateral FKL was measured on frozen ultrasound images from outer to outer margin from one pole to the other (Figure 1) using the electronic caliper of the scanner. In line with the hospital’s antenatal routine, GA was estimated by using standardized sonographic methods to measure BPD, AC, and FL, respectively.

Data were managed using SPSS software (version 17.0; SPSS Inc; Chicago, Illinois, USA). Mean FKL plus standard deviation (SD) was computed for right and left kidneys for the population and for both sexes and for each week. The difference in FKL between pairs of weeks was used to determine kidney growth rate. Kidney length was compared between both sexes using paired \( t \) test. Unpaired \( t \)-test and the graphical method were used to compare mean FKL in the present study with the mean previously reported in different populations. The relationship between FKL and GA was determined using the graphical method and Pearson’s coefficient of correlation (R).

A linear regression equation was used to develop an algorithm for GA estimation. The standard error of estimation (SE\textsubscript{estimation}) was computed and used to determine the precision of FKL in GA estimation. Statistical significance was defined as \( P < 0.05 \).

**Results**

Kidney growth rate was 1.2 mm per week; mean FKL was 37.7 ± 2.9 mm in the population; 37.5 ± 3.6 mm and 37.9 ± 3.1 mm for right and left kidney, respectively (\( p < 0.05; \) Table 1). Correlation between FKL and GA was positive (\( r \) is 0.9870; \( p < 0.0001; \) Table 2); the relationship between FKL and GA is linear (Figure 2). Difference in KL between both sexes was not significant (\( p > 0.05; \) Table 3); \( y = 0.8048(x) + 3.8067 \) can be used to predict GA. The SE\textsubscript{estimation} for FKL was ± 6.6 days (Table 4) with the pattern of FKL increase with an advance in GA similar to what has been reported (Figure 3).
Table 1. Gestational Age with Corresponding mean FKL

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Right FKL Mean ± SD (mm)</th>
<th>Left FKL Mean ± SD (mm)</th>
<th>P Value</th>
<th>Mean FKL Mean ± SD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 Weeks</td>
<td>28.1 ± 3.0</td>
<td>30.2 ± 1.5</td>
<td>&lt; 0.05</td>
<td>29.1 ± 2.5</td>
</tr>
<tr>
<td>29 Weeks</td>
<td>31.3 ± 0.8</td>
<td>31.4 ± 2.1</td>
<td></td>
<td>31.4 ± 1.6</td>
</tr>
<tr>
<td>30 Weeks</td>
<td>33.3 ± 1.0</td>
<td>33.7 ± 1.5</td>
<td></td>
<td>33.5 ± 1.3</td>
</tr>
<tr>
<td>31 Weeks</td>
<td>33.5 ± 3.7</td>
<td>33.9 ± 2.6</td>
<td></td>
<td>33.7 ± 3.4</td>
</tr>
<tr>
<td>32 Weeks</td>
<td>34.4 ± 3.6</td>
<td>34.9 ± 3.7</td>
<td></td>
<td>34.7 ± 3.6</td>
</tr>
<tr>
<td>33 Weeks</td>
<td>36.1 ± 4.2</td>
<td>36.5 ± 2.8</td>
<td></td>
<td>36.3 ± 3.5</td>
</tr>
<tr>
<td>34 Weeks</td>
<td>38.6 ± 2.2</td>
<td>39.2 ± 5.1</td>
<td></td>
<td>38.9 ± 3.9</td>
</tr>
<tr>
<td>35 Weeks</td>
<td>38.8 ± 1.8</td>
<td>40.6 ± 4.4</td>
<td></td>
<td>39.7 ± 3.4</td>
</tr>
<tr>
<td>36 Weeks</td>
<td>39.5 ± 3.9</td>
<td>40.7 ± 6.1</td>
<td></td>
<td>40.1 ± 5.0</td>
</tr>
<tr>
<td>37 Weeks</td>
<td>40.5 ± 0.4</td>
<td>41.5 ± 5.2</td>
<td></td>
<td>41.0 ± 3.6</td>
</tr>
<tr>
<td>38 Weeks</td>
<td>40.8 ± 5.5</td>
<td>42.2 ± 2.2</td>
<td></td>
<td>41.5 ± 4.1</td>
</tr>
<tr>
<td>39 Weeks</td>
<td>42.7 ± 1.3</td>
<td>42.8 ± 1.2</td>
<td></td>
<td>42.7 ± 1.3</td>
</tr>
<tr>
<td>40 Weeks</td>
<td>44.6 ± 2.8</td>
<td>45.5 ± 2.6</td>
<td></td>
<td>45.1 ± 2.7</td>
</tr>
<tr>
<td>Mean FKL</td>
<td>37.5 ± 2.6</td>
<td>37.9 ± 3.1</td>
<td></td>
<td>37.7 ± 2.9</td>
</tr>
</tbody>
</table>

FKL = fetal kidney length; SD = Standard deviation

Table 2. Correlation between GA and Biometric Indices

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Coefficient of Correlation (r)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
<td>0.9580</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>0.9444</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>FL</td>
<td>0.9870</td>
<td></td>
</tr>
<tr>
<td>FKL</td>
<td>0.9731</td>
<td></td>
</tr>
</tbody>
</table>

AC = abdominal circumference; BPD = biparietal diameter; FL = femur length; FKL = fetal kidney length; GA = gestational age.

Discussion

In the study designed to evaluate the use of FKL in sonographic estimation of GA, there was a near-perfect linear relationship between FKL and advance in pregnancy as amply exemplified by the direction of the goodness-of-fit in the scatter graph plotted (Figure 2). This shows a steady increase in kidney size (albeit marginally at some intervals) as pregnancy advanced. The difference in weekly renal growth rate (1.2 mm) observed in the population is not significantly different from 1.1 mm that was earlier reported. As an independent GA estimator, the correlation between BPD, AC, FL, and FKL with GA was positive and highly significant (p < 0.0001). The FL, however, had a slightly stronger positive correlation coefficient (R = 0.99) with GA than FKL (R = 0.97). This study suggests that the FKL appears to be more precise than the BPD and AC as an independent GA estimator. This submission supports an earlier view that FKL is the most accurate measurement, while AC is the least accurate as an independent GA estimator. It is pertinent to point out that close clustering of individual plots around the line of best fit (Figure 2) equally demonstrated the close association between an increase
Table 3. Mean Fetal Kidney Length for Male and Female Fetuses

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Mean FKL ± SD (mm) Male</th>
<th>Mean FKL ± SD (mm) Female</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 weeks</td>
<td>29.1 ± 1.3</td>
<td>29.1 ± 1.5</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>29 weeks</td>
<td>31.4 ± 1.1</td>
<td>31.4 ± 1.5</td>
<td></td>
</tr>
<tr>
<td>30 weeks</td>
<td>34.6 ± 1.1</td>
<td>32.4 ± 1.6</td>
<td></td>
</tr>
<tr>
<td>31 weeks</td>
<td>35.8 ± 1.5</td>
<td>31.6 ± 2.2</td>
<td></td>
</tr>
<tr>
<td>32 weeks</td>
<td>34.8 ± 2.7</td>
<td>34.6 ± 3.0</td>
<td></td>
</tr>
<tr>
<td>33 weeks</td>
<td>36.3 ± 2.8</td>
<td>36.3 ± 3.3</td>
<td></td>
</tr>
<tr>
<td>34 weeks</td>
<td>38.9 ± 2.0</td>
<td>39.8 ± 2.0</td>
<td></td>
</tr>
<tr>
<td>35 weeks</td>
<td>39.8 ± 3.5</td>
<td>39.8 ± 3.9</td>
<td></td>
</tr>
<tr>
<td>36 weeks</td>
<td>40.3 ± 3.8</td>
<td>40.1 ± 4.6</td>
<td></td>
</tr>
<tr>
<td>37 weeks</td>
<td>41.0 ± 1.6</td>
<td>41.0 ± 1.6</td>
<td></td>
</tr>
<tr>
<td>38 weeks</td>
<td>41.5 ± 2.8</td>
<td>41.5 ± 2.8</td>
<td></td>
</tr>
<tr>
<td>39 weeks</td>
<td>42.7 ± 1.1</td>
<td>42.7 ± 1.1</td>
<td></td>
</tr>
<tr>
<td>40 weeks</td>
<td>45.2 ± 2.9</td>
<td>45.0 ± 3.1</td>
<td></td>
</tr>
<tr>
<td>Mean FKL</td>
<td>37.8 ± 2.2</td>
<td>37.3 ± 2.5</td>
<td></td>
</tr>
</tbody>
</table>

FKL = fetal kidney length; SD = standard deviation.

Table 4. Fetal Biometric Indices and Computed Standard Error of Prediction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SE_{estimation} (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
<td>± 8</td>
</tr>
<tr>
<td>AC</td>
<td>± 9</td>
</tr>
<tr>
<td>FL</td>
<td>± 6</td>
</tr>
<tr>
<td>FKL</td>
<td>± 6.6</td>
</tr>
</tbody>
</table>

AC = abdominal circumference; BPD = biparietal diameter; FL = femur length; FKL = Fetal kidney length; SE_{estimation} = Standard error of estimation.

Fetal Kidney Length as an Independent Estimator of Gestational Age

This implies that FKL can be used to accurately estimate GA alone or in combination with other fetal parameters.

At term, mean FKL (37.7 ± 2.9 mm) in the present study was not significantly different from 37.9 mm earlier reported in an Asian population. Surprisingly, though, it was significantly different (p < 0.05) from 42.0 mm that was previously reported in Southeast Nigeria. It is equally significantly different from 35.3 mm, 31.6 mm, and 32.6 mm previously reported in Caucasian and Asian populations. These significant differences suggest the ethnic difference in renal size. In particular, it shows that kidney size among fetuses from purely Igbo and Yoruba ethnic nationalities in Nigeria is significantly different, thus highlighting the need for population-specific renal data for use in the country. We, however, concede that the quality of scanner used and intra-observer variability might have contributed to noted differences in FKL. The significant difference in the right and left kidney measurements observed in the present study supports previous reports in India. It is, therefore, not unlikely that one kidney grows at a significantly faster rate at some point during pregnancy. Although Ahmadi et
Figure 2. Scatter graph of gestational age plotted against fetal kidney length.

Figure 3. Scatter graphs obtained from different populations depicting a linear increase in fetal kidney length with the advance in pregnancy.

al. had reported no significant difference in KL of both kidneys, there is a need to measure bilateral FKL during sonographic evaluation of fetal renal growth.

The SEestimation (approximately ±7 days) observed in the present study is less than ±8.56, ± 9.04, 14.29 and 9.17 days previously reported. That FKL was a better GA estimator in the present study could be attributed to the fact that a single observer used a state-of-the-art ultrasound machine to perform sonographic measurements hence intra-observer and systemic errors were quite negligible. It is, therefore, our view that FKL has the potential to match CRL as an accurate GA estimator and that it could be deployed to advantage when fetal head is low in the maternal pelvis and BPD cannot be measured accurately or when a correct plane for AC measurement cannot be obtained in late pregnancy. A longitudinal study will most likely shed more light on the usefulness of FKL in sonographic GA estimation while results obtained using exact rather than estimated GA and FKL will be more generalizable.

Conclusion
Sonographically measured FKL was a more precise gestational age estimator than BPD and AC in a population of Yoruba women in the 3rd trimester of pregnancy. Sonographically measured FKL is, therefore, useful as a single GA estimator in the third trimester of pregnancy.

Conflict of Interest
Authors do not have any conflict of interest to declare.

References
### Article Title: Fetal Kidney Length as an Independent Estimator of Gestational Age
Authors: Eze et al.

1. This study showed that sonographically measured fetal kidney length is useful as an independent gestational age estimator in the __________
   - a) First month of pregnancy
   - b) First trimester of pregnancy
   - c) Second trimester of pregnancy
   - d) Third trimester of pregnancy
   - e) Last month of pregnancy

2. Accurate GA estimation is important to reduce
   1. Dysfunctional labor
   2. Perinatal morbidity
   3. Number of caesarian sections
   4. Mortality caused by unnecessary induction
   - a) 1.2.3.
   - b) 1.2.4
   - c) 1.3.4
   - d) 2.3.4
   - e) All the above

3. This research study was done on the __________ female population
   - a) Asian
   - b) Maasai
   - c) Yoruba
   - d) Canadian

4. BPD measurements to estimate GA may be affected by
   1. Iniencephaly
   2. Plagiocephaly
   3. Brachycephaly
   4. Dolichocephaly
   5. Hydrocephalous
   - a) 3.4.5
   - b) 1.2.3.4
   - c) 1.2.3.5
   - d) 2.3.4.5
   - e) All the above

5. Fetal Kidney lengths between boys and girls was different in this study
   - a) True
   - b) False
Zinner Syndrome: The Role of Abdominal, Scrotal and Transrectal Sonography

About the Author

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Abstract

Zinner syndrome is a rare, male congenital anomaly that becomes symptomatic in the second to third decade. Ultrasound is the gold standard for the diagnosis of this congenital malformation since the triad of findings of renal agenesis, dilated epididymis tubules and seminal vesicle cysts are easily identifiable on a transabdominal, pelvis and scrotal ultrasound. Since this anomaly presents in the reproductive stage ultrasound is optimal since its not known to have any bioeffects and is non-invasive.

Key words

Zinner syndrome, compensatory hypertrophy, transrectal ultrasound

Zinner syndrome is a rare male congenital malformation that was first described in 1914; to date only 200 cases have been reported in literature.1 Most patients with this anomaly are asymptomatic until the second or third decade of life, some have non-specific symptoms such as urinary frequency, urgency, dysuria, painful ejaculation, and perineal discomfort. Zinner syndrome consists of unilateral agenesis of the kidney, ipsilateral ejaculatory duct obstruction, and seminal vesicle cyst.

Embryologically the metanephros forms the definitive kidney; the metanephros appears in the fifth week of development and becomes functional around week 12. The ureteric bud from the mesonephric duct comes into contact with a caudal region of the intermediate mesoderm, the metanephric blastema. Collectively, this blastema forms the metanephric system, which has two components: the collecting and excretory system. Failure of the ureteral bud after its origin from the mesonephric duct to move dorsally to meet the metanephric blastema and induce its transformation into the definitive kidney results in agenesis of the kidney. Maldevelopment of the
distal part of mesonephric duct results in atresia of the ejaculatory duct which leads to the obstruction and dilatation of the seminal vesicle and vas deferens on the affected side.\textsuperscript{1} These developments cause the collective anomalies of unilateral kidney agenesis, ipsilateral ejaculatory duct obstruction, and seminal vesicle cyst.

This case describes the sonographic approach to the diagnosis of Zinner Syndrome.

Case Report
A 19-year-old male presented with perineal discomfort and occasional dysuria, urinary frequency and discomfort in the right scrotal region. Initial blood work was normal, and urinalysis was positive for microscopic hematuria. The patient was referred for an abdomen, pelvic, scrotal and transrectal ultrasound.

The first exam performed was an abdominal and pelvic ultrasound. For this examination, the patient fasted for 6–8 hours prior to the appointment. As a pelvic exam was also ordered the patient was asked to drink 20 ounces of water 45 minutes prior to the scheduled appointment and not to void.

After obtaining informed consent the patient’s abdomen and pelvis were exposed and the patient was appropriately draped to maximize privacy. The abdominal sonogram was performed in supine, oblique and decubitus positions. A curvilinear transducer with a frequency of 2.5–5 MHz was utilized on an IU22 Philips unit.

The transabdominal scan revealed non-visualization of the right kidney in the right renal fossa or elsewhere in the abdominal and pelvic cavity which suggested right renal agenesis (Figure 1 A & B). The left kidney showed compensatory hypertrophy (Figure 2).

The pelvic sonogram showed a normal urinary bladder, prostate, and left seminal vesicle (Figure 3A). The right seminal vesicle demonstrated a large simple cyst (Figure 3B), other differentials could be a ureterocele, urethral cyst, prostate, seminal vesicle cyst, or ejaculatory duct cyst.

Upon completion of the pelvic exam, the patient was asked to void their urinary bladder so that they would be more comfortable for the scrotal exam. Scrotal ultrasound was performed after obtaining informed consent and appropriate positioning and draping of the patient. Utilizing a linear 12 MHz transducer and sonographic gel the scrotal examination was conducted as per the departmental protocol. The scrotal ultrasound demonstrated a normal left testis and epididymis (Figure 4B); the right epididymis had dilatation of tubules (Figure 4A). This may be related to the compression of the proximal vas deferens by the large simple cyst in the right seminal vesicles.

The transrectal exam was scheduled on a different day since the preparation for this test requires a fleet enema or glycerin suppository 2 hours prior to the appointment.

Figure 1. (A) Sagittal: Absent right kidney in right renal bed. (B) Transverse: Absent right kidney in right renal bed
Zinner Syndrome

Figure 2. Sagittal right kidney: Compensatory hypertrophy of the left kidney (12.8cm)

Figure 3. (A) Sagittal urinary bladder and normal left seminal vesicle. (B) Sagittal urinary bladder and large simple cyst in the right seminal vesicle

Figure 4. Scrotal ultrasound. (A) Right testis and epididymis: dilated tubules in epididymis (head, body, and tail). (B) Left epididymis tail: normal
Transrectal sonography provides better characterization of the urogenital structures. The ultrasound procedure was explained to the patient and any questions by the patient were answered. As well, the sonographer confirmed that the patient had no latex allergies. A written consent was obtained. Complete privacy, appropriate draping and reassurance are an important part of this exam since the patient may be quite nervous.

A transrectal probe of 8–10 MHz was dressed using sterile technique. The patient was scanned in the left lateral decubitus position with knees fully flexed and touching the abdomen, the patient was advised to inhale and exhale slowly during insertion of the transducer and throughout the exam enabling the relaxation of anal canal muscles making for a less painful procedure. The anal region was visually inspected to rule out anal fissures and hemorrhoids before inserting the transducer. The sonographic findings were a normal homogenous prostate with a normal volume of 13.5 mL (normal range is 10–30 mL). The left seminal vesicle was normal and the right seminal vesicle had a complex cyst filled with low-level internal echoes. The right ejaculatory duct and most proximal part of the right vas deferens was not identified due to the overlying large right seminal vesicle cyst.

Magnetic resonance imaging (MRI) of the pelvis and inguinal/ scrotal region was ordered to validate the ultrasound findings. The MRI confirmed agenesis of the right kidney, distended, and cystic right seminal vesicle (Figures 6–9).

**Discussion**

Zinner’s syndrome is a mesonephric duct, male congenital anomaly comprising of a triad of unilateral renal agenesis, ipsilateral seminal vesicle cyst and ejaculatory duct obstruction. Insult to maldevelopment of the mesonephric duct usually happens in the first trimester. Most patients with this syndrome appear asymptomatic till the end of the second and third decades of their life. Clinical symptoms depend on the size of the seminal vesicle cyst and the frequency of sexual activity. If the seminal vesicle cyst is more than 5 cm, patients are more likely to have perennial pain, dysuria, urinary frequency, urgency and or microscopic hematuria. Obstruction of the vas deferens results in painful ejaculation, infertility, and epididymitis. Larger seminal vesicle cysts can also cause bladder outlet obstruction and colonic obstruction.

Ultrasound plays an important and effective role for the initial baseline diagnosis of Zinner Syndrome as it is a non-ionizing, non-invasive, cost-effective, dynamic, readily available diagnostic imaging and readily modality. In addition to a diagnostic imaging modality, ultrasound may also be used for guidance for aspiration of the seminal vesicle cyst for symptomatic relief. Transrectal sonography is effective in determining mass characteristics, location and extent of the seminal vesicle cyst and its communication to the urinary system. In addition, transrectal ultrasound can also provide information about the prostate, vas deferens, and ejaculatory duct status. Assessment of the ejaculatory duct by transrectal sonography, in this case, was difficult due to the large seminal vesicle cyst. MRI is the best modality to confirm this diagnosis due to its multi-planar capability to define anatomy, is not ionizing radiation and it can accurately differentiate the seminal vesicle cyst from other pelvic cystic malformations.

Diagnostic workup consists of urinalysis, digital rectal examination, transabdominal, scrotal and transrectal sonography, cystoscopy, CT or MRI. Large symptomatic seminal vesicle cysts can be aspirated under transrectal ultrasound guidance or can be removed by open surgery or a transurethral resection approach. A vasectomy of the affected side can be offered as the most minimally invasive procedure to relieve the symptoms during ejaculation.

**Conclusion**

Zinner’s syndrome is a rare male congenital anomaly consisting of ipsilateral agenesis of the kidney, and same side atresia of ejaculatory duct, resulting in seminal vesicle cyst formation. This syndrome presents in males during the second to third decades of their life. Symptomology depends upon the size of seminal vesicle cyst. Smaller sized seminal vesicle cysts may present with dysuria, urinary frequency, urgency and microscopic hematuria, larger cysts may include bladder irritation, bladder or bowel obstruction as well as pain in perineum and scrotum. There is increased frequency of epididymitis
Zinner Syndrome

Transrectal ultrasound. (A) Right seminal vesicle with a complex cyst filled with internal echoes. (B) Normal homogenous prostate. (C) Right seminal vesicle with complex cyst, normal left seminal vesicle. (D) Right seminal vesicle with complex cyst.

Figure 6. Magnetic resonance imaging: parasagittal plane. (A) Absent right kidney. (B) Prominent left kidney.
Figure 7. Magnetic resonance imaging: coronal excretory view. (A) Absent right kidney. (B) Prominent left kidney

Figure 8. Magnetic resonance imaging, T1 Images. (A) Coronal view: Right seminal vesicle cyst. (B) Axial view: Right seminal vesicle cyst

Figure 9. Magnetic resonance imaging T2 images. (A) Coronal view: Right seminal vesicle cyst. (B) Axial view: Right seminal vesicle cyst
and scrotal pain on the affected side during sexual activity due to the proximal blockage of the vas deferens.  

Sonography is the primary screening modality for Zinner syndrome since the patients are males in the reproductive age. Sonography has no known bioeffects, is non-invasive, dynamic, easy and accurate in demonstrating renal agenesis as well as seminal vesicle cysts. Transrectal ultrasound may also be utilized to better characterize the genitourinary system and aspirate seminal vesicle cysts for the relief of patient symptoms.

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Article: Zinner Syndrome: The Role of Abdominal, Scrotal and Transrectal Sonography
Authors: Sohail Anwar and Linda Dénommé

1. Zinner syndrome is found in
   a) Males
   b) Females
   c) Both males and females

2. Zinner Syndrome symptomology usually presents in
   a) Year 1 to 3
   b) Birth to 2nd decade
   c) 2nd to 3rd decade
   d) 5th to 6th decade

3. The triad of findings in Zinner Syndrome is
   1. Testicular cyst
   2. Renal agenesis
   3. Seminal vesicle cyst
   4. Bilateral renal agenesis
   5. Ipsilateral ejaculatory duct obstruction
   a) 1.2.3
   b) 1.3.5
   c) 2.3.4
   d) 2.3.5

4. Symptoms associated with Zinner syndrome may be
   1. Scrotal pain
   2. Painful ejaculation
   3. Microscopic hematuria
   4. Perineal discomfort or pain
   5. Bladder or bowel obstruction
   6. Urinary frequency, Urgency, Dysuria
   a) 2.3.4.5.
   b) 1.3.4.5
   c) 1.2.3.4.5
   d) 1.2.3.5.6
   e) All of the above

5. Symptomology depends upon the
   a) Size of prostate
   b) Size of epididymis
   c) Age of the patient
   d) Size of seminal vesicle cyst
   e) Sexual activity of the patients
Coarctation of the aorta accounts for 5–7% of all the cases of congenital heart disease, with an estimated incidence of approximately 3 cases per 10,000 births. First described repairs of this lesion were in 1944, and since then surgical and nonsurgical techniques have developed. The morbidity and mortality rates are low for patients undergoing treatment, for both surgical or catheter interventions, though long-term follow-up is required for complications.

Today the diagnosis is often made prenatally with the advent of fetal echocardiography; however, approximately 30% of neonates with coarctation remain undiagnosed upon discharge after delivery. This cardiac defect generally results in left ventricular pressure overload and the patient presentation often varies with the severity of the left ventricular outflow tract obstruction. Additionally, coarctation may be associated with other cardiac defects, as well as chromosomal abnormalities such as Turner syndrome.

Case Description
A 14-year-old boy was referred to our community pediatric cardiology outpatient clinic for an incidental finding of systemic hypertension that was noted by the patient’s family physician on routine evaluation. The patient was completely asymptomatic, with no visual changes, no headaches, and had a normal activity profile by history. He had an unremarkable past medical history and also had a family history of late-onset hypertension.

Abstract
Coarctation of the aorta accounts for 5–7% of all the cases of congenital heart disease, with an estimated incidence of approximately 3 cases per 10,000 births. Coarctation of the aorta typically presents in the neonatal or early childhood period. The less severe coarctation patients may have subtle clinical findings such as elevated upper limb blood pressure, diminished femoral pulses, and a systolic ejection murmur that often transmits to the back. This case demonstrates that coarctation can be seen in the otherwise healthy adolescent population.

Key words
congenital heart defects, coarctation
On examination, he was not dysmorphic, not in distress, was somewhat anxious, and was warm and well perfused. There was no evidence of cyanosis or clubbing. His heart rate was 80 beats per minute and regular with a respiratory rate of 20 breaths per minute. Peripheral upper limb pulses were easily palpable. Femoral and pedal pulses were decreased bilaterally, while radial pulses were notably prominent in the right and left arms. There was the presence of a brachial femoral pulse delay. The blood pressures in the right and left arm were elevated at 154/70. The blood pressure in the right leg using a proper sized cuff was 80/58. The chest was clear with good air entry bilaterally.

On cardiac examination, the precordium was quiet. The apex was somewhat prominent but was normally placed. There was a normal first and normally split-second heart sound with no additional heart sounds. There was a harsh sounding mid-pitched 2/6 systolic ejection murmur best heard at the right and left upper sternal border, radiating toward the neck but not appreciated in the back, nor in the left or right scapular area. There was no gallop and no diastolic component to the murmur.

Abdominal exam was normal with no hepatosplenomegaly. An electrocardiogram performed at presentation showed normal sinus rhythm, normal intervals and demonstrated a frontal QRS axis of 90 degrees. The increased QRS voltages in V5 and V6 were consistent with left ventricular hypertrophy, and these voltages were accompanied by normal T waves.

An echocardiogram was performed. The situs was normal and there was levocardia. The subcostal images showed a blunted abdominal aortic Doppler pattern with diastolic runoff, both of which are the typical features seen in coarctation of the aorta. The parasternal short and long axis views of the echocardiogram showed normal ventricular function and moderate concentric left ventricular hypertrophy, with normal subaortic, aortic valve and supravalve aortic anatomy. There was no intracardiac shunt defined. The suprasternal images showed colour flow acceleration in the post-ductal region. Careful imaging of the arch showed a normal sized ascending aorta and transverse arch, measuring 11 mm. There was a distal discrete coarctation of the aorta measuring 5 mm at the isthmus. Using colour flow Doppler, the turbulent flow was again noted in this region, and the continuous flow Doppler showed flow acceleration and a diastolic tail with a peak systolic gradient of 70 mmHg.

The family and patient were informed of the findings and the choices for intervention. The patient was preoperatively started on a cardio-selective beta blocker and the patient was subsequently presented to a surgical centre for semi-urgent coarctation repair. The surgical repair was an end-to-end anastomosis of the aorta and the patient had postoperative hypertension that required management with antihypertensive therapies. The patient is now followed at regular intervals to observe for resolution of the left ventricular hypertrophy and to monitor the healing and growth of the aorta, and to monitor for possible complications.

**Discussion**

Coarctation of the aorta typically presents in the neonatal or early childhood period. The severe coarctation patients are duct dependent and can become acutely unwell when the ductus closes. The less severe coarctation patients may have subtle clinical findings such as elevated upper limb blood pressure, diminished femoral pulses, and a systolic ejection murmur that often transmits to the back.

This case demonstrates that coarctation can be seen in the otherwise healthy adolescent population. The patient presented with no symptoms but had systemic upper limb hypertension and diminished femoral pulses with a brachial femoral delay, and a prominent precordial systolic murmur.

The late diagnosis of adolescents and adults with coarctation of the aorta may be due to the fact that collateral circulation to the lower body developed and the first symptom may be mistaken as isolated increased blood pressure. It is crucial that a proper diagnosis occurs with appropriate investigation and management to follow. A complete clinical exam and assessment is required including a four-limb blood pressure assessment. Echocardiography and an ECG are appropriate investigations and they must be performed in a
centre with experience in diagnosing congenital heart disease.

When the diagnosis is missed or left untreated, coarctation of the aorta can result in late aortic aneurysm formation, and/or premature coronary and cerebrovascular disease. More specifically, some of the complications of coarctation of the aorta are: aortic dissection, thoracic aortic aneurysm, infective endocarditis, endocardial fibroelastosis, cerebral aneurysm rupture, impaired left ventricular systolic/diastolic function progressing to congestive cardiac failure among others.

**Conclusion**

This case demonstrates that coarctation can be seen in the otherwise healthy adolescent population. It is recommended that patients with repaired and unrepaired coarctation obtain follow-up throughout their lifetime by a cardiologist, with specific attention to baseline and exercise-induced hypertension. Modifications of various surgical techniques have led to low mortality and morbidity rates, and recent additions of transcatheter balloon angioplasty and endovascular stent placement have expanded treatment options. Hypertension is common in postoperative patients with aortic coarctation, even in the presence of no residual coarctation, which requires appropriate follow-up and treatment.

### Common Echocardiography Features of Coarctation of the Aorta Image Comparison of Normal versus the Case Study Patient

![Figure 1A. Normal abdominal aortic flow.](image1.png)

![Figure 1B. Abnormal abdominal aortic flow (diastolic runoff).](image2.png)

![Figure 2A. Normal Left Ventricular (LV) wall thickness.](image3.png)

![Figure 2B. Abnormal LV wall thickness (concentric LVH).](image4.png)
Figure 3A. Normal flow pattern in descending aorta. Normal peak gradient = 13 mmHg.

Figure 3B. Abnormal flow pattern in descending aorta. Significant increase in peak gradient = 70 mmHg.

References
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**Article: Adolescent Systemic Hypertension: Late Diagnosis of Coarctation of the Aorta**  
Authors: Carlos Barrios and Michael Giuffre

1. **How is coarctation of the aorta repaired?**
   - a) Surgical end to end anastomosis
   - b) Stent implantation
   - c) Balloon angioplasty
   - d) All of the above

2. **How is the blood transferred from the heart to the lower limbs in an adult with severe coarctation of the aorta?**
   - a) Through the pulmonary artery
   - b) Collateral circulation
   - c) Through the pulmonary valve
   - d) Coronary circulation
   - e) Pulmonary circulation

3. **Complete assessment for coarctation of the aorta should include:**
   - a) An electrocardiogram (ECG)
   - b) An echocardiogram (Echo)
   - c) Four limb blood pressure measurements
   - d) Auscultation (listening with a stethoscope for abnormal heart sounds)
   - e) All of the above

4. **What is a feature of severe coarctation of the aorta seen by echocardiography?**
   - a) Abnormal heart sounds
   - b) Blunted abdominal aortic Doppler pattern with diastolic runoff
   - c) Higher blood pressure in the lower limbs compared to the upper limbs
   - d) Shortness of breath
   - e) Chest pain

5. **Which patients can have the diagnosis of coarctation of the aorta?**
   - a) Newborns and toddlers only
   - b) Only children
   - c) Children and adolescents
   - d) Only teenagers
   - e) Patients of all ages
Ovarian torsion involves the twisting of ovarian tissue on its pedicle, which leads to decreased venous return, internal hemorrhage, and infarction.\textsuperscript{1,2} In most cases, the ovary and fallopian tube are involved.\textsuperscript{1} Ovarian torsion typically occurs unilaterally due to a pathologically enlarged ovary and is most commonly found in young children.\textsuperscript{1,2}

Due to the nonspecific clinical presentation associated with ovarian torsion, the diagnosis is frequently delayed, resulting in delayed surgical administration.\textsuperscript{1,2}

The use of ultrasonography with colour and power Doppler analysis is a popular technique in the assessment of torsion of the ovary and pedicle because it can display morphologic and physiologic changes in the ovary while determining whether blood flow is compromised.\textsuperscript{1,2}
Sonographic Appearance
Grayscale Evaluation

Figure 1. A 28-year-old with right-lower quadrant pain. Enlarged heterogeneous, multicystic ovarian mass (7×5 cm) with septations and complexities (low-level internal echoes), which suggested torsion of the right ovary.  

Figure 2. A 6-year-old with left flank pain radiating to the left-lower quadrant. The patient had nausea and vomiting and was focally tender with transducer pressure. The left ovary was displaced from the left side of the body to the midline superior to the bladder. The left ovary appears enlarged.  

Figure 3. A 25-year-old with right-lower quadrant pain, patient tender with transducer pressure. The patient also had free fluid in their pelvis. Right ovary is seen posterior to the uterus and appears large, as it is almost the same size as the uterus in this image. (Red arrow = uterus, Yellow arrow = ovary). The transvaginal approach gave a more detailed representation of the right ovary compared to the uterus. This patient had the right ovary surgically removed and diagnosed as an intermittent torsion.  

Figure 4. A 27-year-old with a sudden onset of right-lower quadrant pain and vomiting. The patient was 9 weeks post-partum with known bilateral dermoid cysts. This sagittal image of the right ovary displays a bilobular lesion (red arrows) of soft tissue echotexture with posterior enhancement from the right ovary. These 2 lesions have enlarged the right ovary (8 × 5 cm) and have caused variable degrees of torsion and ischemia, which was confirmed at surgery. 
Figure 5. A 14-year-old patient with right-lower quadrant pain. This sagittal image is demonstrating a complex mass in the right ovary, which is causing enlargement of the right ovary, that in turn led to right ovarian torsion. The right ovary is measuring $10.3 \times 5.5 \times 10.4 = 354.2$ mL. The cystic area measured $6.2 \times 4.8 \times 5.6$ cm.$^6$

Figure 6. An 18-year-old patient with right-lower quadrant pain. This transverse image is demonstrating a twisted Rt. ovarian pedicle (red arrow). The twisting of the ovarian pedicle is key in the diagnosis of ovarian torsion. The use of a higher frequency linear transducer (such as the 6–15 linear probe in this image) aids in greater detail of the pedicle and surrounding adnexal matter.$^6$

**Colour/Power Doppler Evaluation**

Figure 7. A 28-year-old patient with right-lower quadrant pain. Enlarged heterogeneous, multicystic ovarian mass (7x5 cm) with septations and complexities, which suggested torsion of the right ovary. Application of power Doppler reveals no flow in right ovary or mass. Choosing power Doppler over colour Doppler ensures that blood flow should be seen, as it is more sensitive than colour Doppler.$^6$

Figure 8. A 6-year-old patient with left flank pain radiating to the left-lower quadrant. Patient had nausea and vomiting and was focally tender with transducer pressure. The left ovary was displaced from the left side of the body to the midline superior to the bladder. The left ovary appears enlarged. The addition of colour Doppler demonstrated a lack of blood flow in the left ovary helping to confirm torsion.$^6$
Figure 9. A 12-year-old patient with a 6-day history of abdominal pain. Right ovary is midline and contains a large cyst, which caused torsion of the right ovary. The application of colour Doppler validates the absence of flow in the right ovary.6

Figure 10. A 25-year-old with right-lower quadrant pain, patient tender with transducer pressure. The patient also had free fluid in their pelvis. This image represents an edematous vascular pedicle of the right ovary that measured 1.3 cm (yellow arrow). This patient had the right ovary surgically removed and diagnosed as an intermittent torsion. The transvaginal approach gave a more detailed representation of the right pedicle.6

Figure 11. A 27-year-old patient with sudden onset of right-lower quadrant pain and vomiting. The patient was 9-weeks post-partum with known bilateral dermoid cysts. This transverse image of the right ovary displays a dermoid cyst on the right ovary, as well as a lack of blood flow within the right ovary when colour Doppler is applied. An echogenic area (dermoid plug) can be appreciated in this image (red arrow). This ovary has undergone variable degrees of torsion and ischemia, most notably due to the large dermoid cyst, which was confirmed at surgery.6

Figure 12. A 14-year-old patient with right-lower quadrant pain. This image is demonstrating a complex avascular mass in the right ovary (both cystic and solid components), which is causing enlargement of the right ovary, that in turn led to ovarian torsion. The addition of colour Doppler showed minimal flow to the right ovary, which assisted in the diagnosis of ovarian torsion.6
Figure 13. A 16-year-old patient with acute onset of pelvic pain. The image on the right shows a grayscale image of a vascular ovarian pedicle. The image on the right shows the addition of power Doppler to the vascular ovarian pedicle, which is demonstrating the whirlpool sign, which is indicative of ovarian torsion. The whirlpool sign is the visible twisting of the vascular ovarian pedicle; the sign refers to the swirling appearance as seen while scanning in the short-axis of the ovarian pedicle, although vascular twisting can also be seen in the long axis.\(^3\)

 Comparison Images – Affected Ovary to Non-Affected Ovary

Figure 14. A 12-old patient with 6-days of abdominal pain. The right ovary was midline and contained a large cyst, which caused torsion of the right ovary. The comparison of these 2 images shows the size difference between the right and left ovaries (left ovary - normal, right ovary - torsion). Right ovary is 11.8×7.7 cm, left ovary is 1.9×0.8 cm.\(^6\)
Figure 15. A 25-year-old patient with right-lower quadrant pain, patient tender with transducer pressure. The patient also had free fluid in their pelvis. There are 2 sagittal and 2 transverse images of the left and right ovaries, comparing the sizes of both the left (normal) and right (torsion) ovaries. These images are demonstrating that the right ovary is double the size of the left ovary, which is of normal measurements. A transvaginal approach was used to obtain more accurate measurements of both ovaries due to the higher frequency and closer location of the transducer to the ovary. The right (torsion) measured: 6.3×3.0×5.5 cm = 52.9 mL, the left (normal) measured: 3.9×1.5×2.7 cm = 8.1 mL. This patient had the right ovary surgically removed and diagnosed as an intermittent torsion.6
Figure 16. A 7-year-old patient with left-lower quadrant pain. This image shows that there is no power Doppler flow present in the left ovary when compared to the right ovary. The left ovary is also quite sizeable when compared to the right ovary. These sonographic findings are highly indicative of ovarian torsion of the left ovary.6

Figure 17. A 27-year-old patient with sudden onset right-lower quadrant pain and vomiting. The patient was 9-weeks post-partum and has known bilateral dermoid cysts. The top 2 images are of the right ovary (torsion) and the bottom 2 images are of the left ovary (normal). These images are being compared to one another to show the difference in the size of the right ovarian torsion and normal left ovary. The right ovary (torsion) measures 7.9×5.0×6.7 cm = 139 mL; the left ovary (normal) measures 2.4×1.3×2.3 cm = 4 mL.6
Discussion

Etiology
Torsion of the ovary and fallopian tube is a result of partial or complete rotation of the ovary on its vascular pedicle.\(^1,2\) This rotation results in compromised arterial and venous flow, congestion of the ovarian parenchyma, and hemorrhagic infarction.\(^1,2\) Ovarian torsion can occur in normal ovaries; however, it is commonly caused by a cyst or tumour on the ovary, which produces a significant increase in the size of the ovary.\(^1\) Ovarian tumours are involved with 50–60% of torsion cases, with dermoid tumours being the most common.\(^2\)

Involved masses are nearly all larger than 4-6 cm.\(^2\) In children, torsion can occur in normal ovaries due to the fallopian tube being relatively long and the ovary being more mobile.\(^1\) Patients with a history of pelvic surgery, especially tubal ligation, are at increased risk for torsion.\(^2\)

Epidemiology
Ovarian torsion is the fifth most common gynecologic surgical emergency and most cases occur in the early reproductive years.\(^2\) Most ovarian torsion cases occur in patients who are under 30 years old.\(^2\) Approximately 20% of cases of torsion occur during pregnancy.\(^2\)

Symptoms
The main symptoms that occur with ovarian torsion are pain, tenderness, nausea, vomiting, and low-grade fever; experiencing these symptoms typically indicates that the torsion has caused complications.\(^1,3\) Approximately 25% of patients experience bilateral lower quadrant pain described as sharp and stabbing or, less frequently, crampy. Nausea and vomiting occur in approximately 70% of patients.\(^2\) The typical presentation is acute onset of acute lower abdominal pain, nausea, vomiting and leukocytosis.\(^1,2\)

Sonographic Findings
The main sonographic findings associated with ovarian torsion are, ovarian enlargement, fluid in the cul-de-sac, and other adnexal pathologies, such as a cyst or tumour.\(^1\) The twisting of a pedicle appears as concentric hypoechoic structures that can be identified as vascular structures with the addition of colour Doppler.\(^3\) This twisting appearance of the pedicle is otherwise known as the “whirlpool” sign.\(^1,3\) The images above portray most of the classic sonographic findings associated with ovarian torsion, from: enlarged ovaries, ovarian pathologies, lack of blood flow, and the whirlpool sign.

Pathophysiology
Ovarian torsion characteristically occurs unilaterally in a clinically enlarged ovary.\(^1,2\) The pathology and increased size of the ovary likely forms a point around which the pedicle rotates.\(^1,2\) Torsion can involve the ovary alone but usually affects both the ovary and the fallopian tube.\(^1\) Torsion of a normal ovary is most common among young children who have long fallopian tubes or absent mesosalpinx.\(^1,2\) The presence of a corpus luteum cyst during pregnancy may also cause an ovary to undergo torsion, due to increased ovarian size.\(^1\)

Treatment
The treatment for ovarian torsion can include surgical procedures such as laparoscopy, laparotomy, oophorectomy, and salpingo-oo- phorectomy.\(^4\) These surgeries involve making small incisions in the abdomen to allow a physician to insert a laparoscope and surgical tools to fix the torsion, or completely remove an ovary or both the ovary and tube.\(^4\)

Prognosis
With early diagnosis and appropriate treatment, the prognosis of ovarian torsion is good, unfortunately, most patients with ovarian torsion have a delayed diagnosis, often resulting in infarction and necrosis of the ovary.\(^5\) The use of laparoscopic techniques has helped surgeons salvage ovaries that have undergone torsion.\(^5\)

Summary
Ovarian torsion is a pathology in young females that involves an ovary twisting around its pedicle, causing a restriction of blood flow to and from the ovary, which may lead to necrosis, ovarian congestion, and hemorrhagic infection. The ovary may undergo torsion due to a pathological or physiological change which increases the size of the ovary. Due to advances in laparoscopic surgeries, a lot of ovarian torsion cases can be corrected surgically, which has led to a good prognosis for torsion. There are many sonographic findings indicative of ovarian torsion including a single enlarged ovary, low or no blood flow, a whirlpool sign, fluid in the cul-de-sac, and other adnexal pathologies, such as a cyst or tumour. Ultrasound has been shown to be a beneficial modality in diagnosing cases of ovarian torsion.
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6. Queen Elizabeth Hospital, Prince Edward Island – Diagnostic Imaging Department; 2018.

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Article: Ovarian Torsion
Authors: Emma Gillis

1. Torsion of the ovary may result in
   a) compromised venous flow
   b) compromised arterial and venous flow
   c) compromised arterial flow and hemorrhagic infarct
   d) compromised arterial and venous flow, congestion of the ovarian parenchyma, and hemorrhagic infarct

2. Ovarian torsion can occur in ovaries that have cysts or masses, the most common tumor to cause ovarian torsion is
   a) Desmoid tumor
   b) Dermoid tumor
   c) Stromal tumors
   d) Epithelial tumors

3. Ovarian torsion is more likely to occur in:
   a) Post-menopausal females
   b) Females with amenorrhea
   c) Females with painful menstrual cycles
   d) Female patients with a history of pelvic surgery especially tubal ligation

4. The typical presentation of ovarian torsion is:
   a) Acute onset of chronic lower abdominal pain, nausea, and vomiting
   b) Acute onset of acute lower abdominal pain, nausea, vomiting and leukocytosis
   c) Acute onset of right upper quadrant pain, nausea and vomiting
   d) Acute onset of back pain, nausea and vomiting

5. The main sonographic findings of ovarian torsion are:
   1) Fluid in the cul-de-sac
   2) Increased vascularity within the ovary with color and/or power Doppler
   3) Enlarged ovary
   4) Ovarian pathologies such as cysts or tumors

   a) 1.2.3
   b) 1.2.4
   c) 1.3.4
   d) 2.3.4
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