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Trends in Usage of CT in the Early Detection and Diagnosis of Adnexal Torsion

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TRENDS IN USAGE OF CT IN THE EARLY DETECTION AND DIAGNOSIS OF ADNEXAL TORSION

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ABSTRACT:

Ovarian torsion (OT) is frequently considered in the differential diagnosis of women presenting to the ED with pelvic pain, but is a relatively uncommon occurrence. While ultrasound is considered the test of choice for OT, CT may be used as an initial imaging study with undifferentiated pelvic pain. The aim of this study was to determine the frequency of CT used in the diagnostic evaluation of women with proven OT. We hypothesized that all CTs of the pelvis in women with proven OT would be abnormal. This was a retrospective chart review from 500 bed urban teaching hospital. Patients were included who were admitted from 1985-2005and were discharged with ICD-9 code of ovarian or adnexal torsion. Those patients with no surgical evidence of OT after chart review were excluded from the study.

Data gathered were stratified into 4 five-year periods for analysis of imaging trends. 178 cases of surgically proven torsion over 20-year period were reviewed. The average age of the subjects was calculated as 32.2 years with a range from two weeks of age to 84 years. (24.7% of patients under age 18). 136 patients received ultrasounds and 58 patients received CT scans. The percent of patients who received CTs from 1985 until 2005 increased from 12.5% to 34.2%. The percent of patients who received ultrasounds from 1985 to 2005 increased from 37.5% to 58.9%.

From this study we concluded that CT scanning has increased in frequency as a diagnostic tool in the workup of ovarian torsion over the course of the past twenty years. In this study of 178 patients and 58 CT scans there were no normal pelvic CT scans in patients with surgically proven adnexal torsion. This suggests a possible role for CT in excluding the diagnosis of adnexal torsion

ACKNOWLEDGEMENTS:

I would like to thank Dr. Christopher Moore for all his help and for all his patience. I would also like to thank Jen Palermo for her continuing support and assistance with this project. Without her help this would have been excruciating. Many thanks to my family and friends without whom I wouldn't have made it through this past twenty years of school. Lastly, much love and many thanks to Pape Armand Boye (sama deugger bopp) for tolerating me and keeping me such good company while I worked on this project. Yow rekk laa am sama xol.

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INTRODUCTION:

Adnexal torsion is a well-known yet infrequent clinical entity that, if left untreated can lead to infertility, infection and rarely death. Preservation of gonadal function and health is contingent upon early diagnosis and treatment of the disease, most frequently via surgical intervention. The diagnosis of adnexal torsion is difficult due to a large variety of associated symptoms at presentation and a large differential for pelvic pain including appendicitis, diverticulitis, hernia, cyst rupture and others. Imaging can play a key role in sifting through a large differential diagnosis when suspicion of adnexal torsion is present. The objective of this thesis is to determine the trends in usage of CT scanning and its sensitivity during the workup of pelvic pain and suspected torsion. In addition we aim to describe patterns in the clinical presentation of the disease.

BACKGROUND:

The diagnosis of ovarian torsion can be exquisitely difficult and can only be definitively made based on surgical findings. In spite of this difficulty it is of great importance to identify torsion quickly and manage it immediately in order to prevent hemorrhagic infarction which can lead to infertility, peritonitis and death.

Some of the difficulty in establishing the diagnosis can be attributed to the diversity of clinical presentations with which the disease is associated. Because of the large differential diagnosis for acute pelvic pain it is important to characterize diagnostic tools that might be able to help in the rapid identification and management of adnexal torsion.

DEFINITION:

Adnexal torsion is defined as the twisting of the ovary and/or fallopian tubes on their supporting ligamentous structures. It can often lead to an impediment to vascular supply and subsequent necrosis and infertility. Hemorrhagic infarction is also a frequent consequence of adnexal torsion and can rarely lead to peritonitis and death.

EPIDEMIOLOGY:

In 1985 Hibbard et al.'s study of 128 cases the authors found that adnexal torsion was the fifth most common cause of gynecological emergencies reported in their subject population.[1] The diagnosis of torsion followed only ectopic pregnancy, corpus luteum emergency, pelvic inflammatory disease and appendicitis in frequency. A similarly large scale study on gynecological causes of acute abdomen showed that 3% of acute gynecological complaints were due to ovarian torsion.[2] In a ten year retrospective study conducted by Bouguizane et al. in Tunisia, ovarian torsion was found in 14.85% of the adnexal tumors that were treated with surgery.[3]

DEMOGRAPHICS:

The diagnosis of OT (ovarian torsion) affects a wide range of patients. Female neonates as well as post-menopausal women can present with the diagnosis with no age range being immune. According to various large-scale studies, average age at diagnosis has been reported to fall between 30-32 years with a range from 10 to 82 years.[4] Bouguizane et al. reported that 45.6% of their patients with the diagnosis of OT were

multiparous and they reported that 17.03% were associated with an intrauterine pregnancy. [3]

It has been shown that women that are still within the reproductive age range have the highest incidence of adnexal torsion.[5] This increased incidence is most probably related to the higher frequency of conditions that are associated with OT including pregnancy, ovarian neoplasm, cysts and malignancies, in addition to infertility treatments often associated with ovarian hyperstimulation syndrome.[3]

In spite of the fact that adnexal torsion is most commonly found among women of reproductive age it can occur in neonates and children. These patients often present within the first few months of life with irritability and vomiting as well as a low tolerance for feedings. It is also not uncommon for ovarian cysts to be diagnosed neonatally on routine obstetric sonographic exams. In addition to occurring in cyst-laden ovaries, adnexal torsion can occur in normal ovaries. The mechanism by which this occurs is still unknown but several cases have been reported in the literature.[6] Overall this information serves to emphasize the importance behind the serious evaluation of any complaint of pelvic pain in any age group.

ETIOLOGY:

OT can be a result of a variety of different causes varying in likelihood by age distribution and fertility as well as co-morbid conditions and medication (particularly hormone) regimens.

The basic mechanism of OT can be described with a ball and chain analogy. Lesions such as cysts and neoplasm present on the ovary add weight to the ovary. This

additional weight adds stress to the adnexa and makes it more likely that the ovary will move more vigorously and abnormally. This predisposes the ovary to a twisting motion that eventually leads to the wrapping of the ovary around its vascular pedicle. The size and weight of the ovary are associated with its proclivity to tort, with larger masses creating a greater potential for torsion. Once the ovary-mass lesion reaches a certain size however there is less potential for twisting because the weight immobilizes the structure and it is often anchored further by adhesions to surrounding structures.

A large study of 135 cases reported that the dominant causative pathology of the OT cases investigated was benign organic ovarian cysts. Benign cystadenoma and mature teratomas were the most frequently reported causes, followed by functional ovarian cysts. 34% of the cases were caused by serous cysts, 25.2 % by dermoid cysts and 5.2% of the OT cases studied were caused by mucinous cysts.[3]

A similarly large series of torsion cases confirmed with surgery described 94% of the cases studied to be caused by neoplasms (46%) and cysts (48%) with the remaining 6% of the OT cases occurring in normal-appearing adnexa.[1]

PRESENTATION:

Although the etiology of ovarian torsion seems to be somewhat clear in many cases, the diagnosis at presentation is still extremely challenging. The “classic” presentation of adnexal torsion includes a clinical history of abrupt onset pain located in a unilateral lower abdominal quadrant. Classically the pain is characterized as sharp and radiating to the groin. Accompanying symptoms in the classic presentation often include

nausea and vomiting and physical exam findings often include guarding, localized peritoneal signs and palpable mass on pelvic exam.

In a fifteen year retrospective study of 87 cases 59% of patients described pain of sudden onset with 70% describing the pain as sharp and 51% describing radiation to another anatomical site different from the site of origin. In addition 70% of these subjects also reported nausea and vomiting.[4] In a different ten year retrospective review 51% of their patients with ovarian torsion reported experiencing nausea and vomiting.[3]

Yet despite the description of a "classic" ovarian torsion presentation, many patients present with a wide variety of symptoms and physical exam findings not classically associated with torsion. In a study of 135 cases, 126 patients (93.3%) presented with pelvic pain and, while 77.1% of the patients described acute pain, 32.9% reported pain that was chronic or subacute. [3]

Furthermore a large scale review of over 100 subjects with gynecological emergencies showed that 24% of their subjects were minimally symptomatic or asymptomatic and were only diagnosed with ovarian torsion as a consequence of elective surgery performed for presumed tumor/cyst.[1] This wide variety of pain presentation varying in character, location, severity, onset and radiating quality often leads to a delayed diagnosis of ovarian torsion and add considerably to the difficulty of making the diagnosis.

IMAGING:

ULTRASOUND and Doppler sonography: Ultrasound can be very useful in the detection of ovarian and adnexal cysts and in tracking their growth and progression over time. As mentioned earlier many cases of childhood torsion are diagnosed by fetal detection of cysts on routine obstetric ultrasounds. In a review of 15 confirmed cases of torsion it was found that masses were described in 70% of the surgically confirmed torsion cases. In the same review over 50% of the cases also demonstrated free fluid in the cul de sac, further showing the utility of ultrasound in supporting the diagnosis of adnexal torsion.[7] Yet while the presence of a mass can support the diagnosis of torsion one must keep in mind that torsion can occur in the normal ovary and in the absence of lesions or masses.

Doppler ultrasound is gaining popularity among tests for OT but still remains controversial as a test of choice. The absence or decreased flow of blood in the ovarian vessels on color, 2D or 3D Doppler can be very helpful in narrowing the diagnosis in the case of pelvic pain.

In a 15 case review of surgically confirmed torsion it was demonstrated that only one of the fifteen patients exhibited normal arterial flow in the ovarian vessels in her pre-operative Doppler ultrasound. A striking eleven out of fifteen (73.3%) had absent flow and the remaining three of fifteen patients demonstrated a decrease in arterial flow in the ovarian vessels.[7]

In 2004 a study that developed the term the “whirlpool sign” to describe the torturous twisted vascular pedicle associated with adnexal torsion, twenty-one cases were reviewed. Out of the 21 cases 20 had a positive “whirlpool sign” and were subsequently treated surgically for torsion.[8]

A larger series of 32 cases was conducted in 1998 and described 28 out of the 32 subjects as having twisted pedicles visualized on ultrasound. Out of those 28 subjects twelve had absent arterial flow.[9]

A more recent study of 65 cases of suspected torsion with 15 out of the 65 surgically proven showed that 1 out of the 50 cases of patients without torsion had abnormal Doppler findings consistent with those found in torsion. Of the fifteen with confirmed torsion, ten had no signs of arterial or venous ovarian vessel flow, and the remaining five had absent venous flow in the presence of arterial flow. These results subsequently suggest that in the presence of normal venous flow torsion is unlikely. The study thus demonstrated a sensitivity of 100% for Doppler ultrasound and a specificity of 98 percent. [10]

While the utility of ultrasound and Doppler ultrasound has been supported by various studies often its availability can be limiting. In addition the wide differential diagnosis of pelvic pain can often include entities that are better evaluated with other imaging modalities such as CT or MR imaging. Next we review the literature on CTs and adnexal torsion.

CT imaging: In 1994 Kimura et al published a small study describing the features of ovarian torsion on CT ad MR imaging.[11] This study is still one of the most influential in terms of establishing diagnostic findings for adnexal torsion on CT. The study consisted of the scans of ten patients that had surgically proven torsion. The two authors Kimura and Takakura reviewed these scans and described both non specific and specific CT and MR findings.

Some of the nonspecific common findings included deviation of the uterus toward the side that held the torsed adnexal mass, the presence of engorged blood vessels on the side containing the torsed adnexa, and small amounts of free fluid or ascites.

In addition to these general characteristics of the MR and CT images reviewed, there were also three specific findings that the team described as diagnostic for adnexal torsion in the presence of hemorrhagic infarction. One of the diagnostic findings was seen on MR and consisted of the protrusion of the lesion on the twisted side to which the uterus was continuous or engorged vessels converged. The second finding was a result of the vascular congestion that is often one of the sequelae associated with torsion and it was defined as the presence of thick, straight blood vessels that draped around the lesion. The third imaging finding, found on CT, was described as the complete absence of enhancement with contrast. This was deemed diagnostic because it correlated with the obstruction of vascular supply by the twisted adnexa.

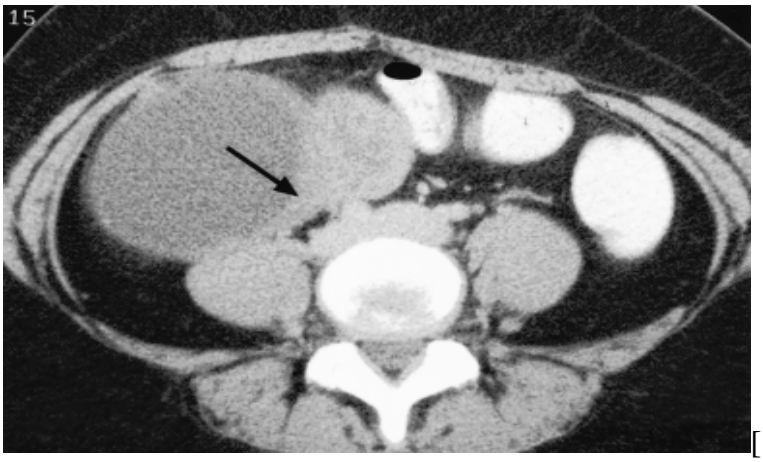
This study was followed two years later by a case report in which the finding of intravascular gas within a large ovarian mass was described as diagnostic for ovarian torsion. [12] In this study only one of Kimura et al's diagnostic criteria was seen in that only an absence of enhancement was observed. However it was noted that there was intravascular gas within the ovarian tumor which was attributed to the complete occlusion of the arteries feeding the ovary. It was hypothesized that this gas was oxygen released from oxyhemoglobin within the tumor vessels. It was thought that because of the large size of the tumor (13.5 x 10.5 cm) and its hypervascularized nature there was most likely a great deal of trapped oxyhemoglobin within the torsed tumor vessels which might have been related to the gas formation.[12]

Another case report of a 38 year old woman with a history of laparoscopic detorsion of the right ovary was described by Zissin in 2001.[13] In this report the author describes the presence of multiple peripheral follicles in an enlarged ovary as specific for adnexal torsion. Similar findings were described in a case report of a ten year old girl for whom a CT was diagnostic of ovarian torsion in the context where appendicitis was suspected. [14] In his report, Zissin also describes a hyperdensity of the torted ovary on CT most likely related to the venous congestion associated with torsion and goes on to affirm more of Kimura et al.'s diagnostic criteria by describing the presence of free peritoneal fluid.[13]

Low et al's case report of a 12 year old postmenarchal girl who's tubo-ovarian torsion was diagnosed by computed tomography again reiterates the utility of Kimura et al.'s findings.[15] The CT performed in this case showed a tortuous thickened tubular structure leading from the cystic lesion of the ovary into the uterine cornu as well as smoothing of the tube. Both of these are characteristic of adnexal torsion and were described by Kimura et al. in their earlier study.[15]

[15]

Figure 1: Axial CT image showing a tortuous tubular structure (arrow) leading from R. uterine cornu to the region of the inferior aspect of the cystic lesion & ovary, representing the torsed fallopian tube. This measured approx. 9mm in diameter.



[15]

Figure 2: Smooth eccentric thickening of the wall of the cyst in close proximity to the torsed tube and ovary, presumably representing congestion of the wall of the paratubal cyst. Approx 13 mm in width, specific for the presence of hemorrhagic infarction.

Another study of 25 patients done by Rha et al. in 2002 reiterated and added to the first descriptive study of CT and torsion done by Kimura et al in 1994.[16] In this retrospective review common CT imaging features of torsion were described including fallopian tube thickening which occurred in 21 (84%) of the 25 patients. In addition new findings were described that were suggested to provide further evidence of hemorrhagic infarction associated with adnexal torsion. These findings included eccentric smooth wall thickening of the twisted adnexal cystic mass which occurred in 19 (76%) cases out of 25. Ascites, a third finding, along with uterine deviation to the twisted side were found in 16 (64%) and nine (36%) patients respectively. [16]

OBJECTIVE: The aim of this study is to analyze and describe the trends in usage of CT scanning for the early detection and diagnosis of adnexal torsion. An additional aim is to describe patterns in clinical presentation.

METHODS: This is a retrospective chart review of 178 patient records labeled with the ICD-9 code for adnexal torsion. The charts gathered were from the twenty year time period between 1985 and 2005. Patients were included in the study only if there was confirmation of the diagnosis of adnexal torsion by surgical pathology or operative reports. Those who did not undergo imaging studies with documented findings were excluded.

A Microsoft Access database was designed and formatted to include over 125 queries including, but not limited to: age, OCP use, gravidy, parity, previous pelvic surgeries, history of PID, CT results, and ultrasound results. The data gathered was then analyzed for trends in clinical presentation, patient demographic information, laboratory findings, physical findings and imaging. The data was then further divided into four five year periods and analyzed for trends in usage. All database creation and analysis and review of over 189 charts done by student researcher Juliana Capatosto under the supervision of Dr. Christopher Moore. There was additional assistance provided by student aide Jennifer Palermo. Miss Palermo reviewed and entered data into the existing database for ten charts and collected data concerning sudden onset. She also helped by printing out official CT and ultrasound reports from ImageCast to verify data collected from charts by the thesis author.

RESULTS:

Age: The mean age of the subjects was calculated as 32.2 years with a range from two weeks of age to 84 years. Forty four (24.7%) of the subjects were under the age of 18 years and 47.2% were between the ages of 18 yrs old and 40 years old. Four patients were 12 months old or less.

Race: Twenty eight (15.7%) of the subjects were of African American heritage , 49.4% were Caucasian, 7.87% were Latina American and 5% were "Other" including Native and Asian American. Fifty two (29.2%) of the records used did not have available data on race.

Gravida/Parity/Intrauterine gestations: Eighty (44.9%) of the patients studied were multigravida with two or more pregnancies in their lifetime. Twenty two (12.3%) patients had been pregnant once and sixty four (36.0%) of the patients were nulligravida. Data about gravidy was unavailable for 10.8% of the subjects.

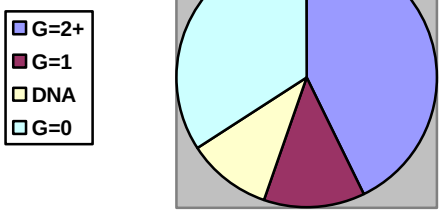


Figure3: Gravida

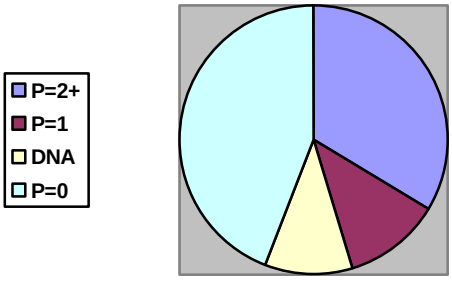


Figure 4: Parity

In terms of parity, sixty two (34.8%) of the subjects were multiparous with two or more births, while twenty one (11.8%) had a single live birth. Eighty one (45.5%) of the patients were nulliparous and 10.7% of subjects did not have data available about their parity status. Thirteen of the patients were pregnant at the time of the adnexal torsion diagnosis with estimated gestation dates ranging from eight weeks to thirty-five weeks.

Past Medical/Surgical History: The vast majority (93.2%) of subjects had a negative of history of pelvic inflammatory disease, but there were seven subjects that had a positive history with only five subjects without available data. Similarly 89.6% of subjects had a negative history of ectopic pregnancy with only eight cases documented with previous ectopic pregnancies.

Forty (22.5%) of patients had a positive history of ovarian cysts, while 77.0% had a negative history and 3.37% did not have available data. Sixty-six (37.1%) of the subjects reported a positive history of pelvic surgery. These surgeries included, but were not limited to; tubal ligation, cesarean section, salpingoophorectomy for prior torsion and ectopic pregnancy, dilation and curettage for endometriosis, and lysis of adhesions.

Exogenous Hormones: Of the 178 subjects only thirteen (7.3%) were actively taking oral contraception. Twelve subjects were taking hormonal therapy for fertility purposes or post-menopausal hormone replacement therapy.

History of Present Illness:

Pain Location: The most common presentation of pain location was in a unilateral lower quadrant. 62.9% of patients presented with this distribution. Forty seven (26.4%) of the subjects presented with left lower quadrant pain, while another sixty-five (36.5%) presented with right lower quadrant pain. Another 11.8% presented with pain that was localized to the lower midline and 11.2% of patients described their pain as diffuse in distribution. Sixteen subject records did not contain sufficient data to describe pain location.

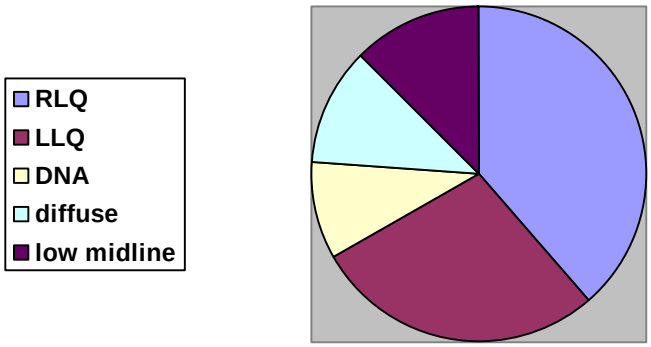


Figure 5: Distribution of Pain Location

Pain Quality: Although sixty eight of the 178 patient records lacked sufficient data about the quality of the pain at presentation, seventy-one (39.9%) of the subjects reported a pain that was constant in nature. This number represented 64.5 percent of the patients for whom we had reliable data about quality of pain. Twenty-four (13.5%) of the patients (or 21.8 % of patients with reliable data) described their pain as intermittent and another 8.4% of total patients, or fifteen patients, said their pain was colicky in nature. Forty-two

(23.6%) of the subjects said their pain was sharp in nature and another 19.7% described their pain as having a radiating quality. A final 11.8 % reported the pain as dull.

Pain Severity: Data was unavailable for fifty-one of our subjects but the overwhelming majority of subjects, 63.5% stated that their pain was severe in nature. Those that reported mild pain made up only 1.12% of included subjects, while only 6.74% described their pain as moderate in severity.

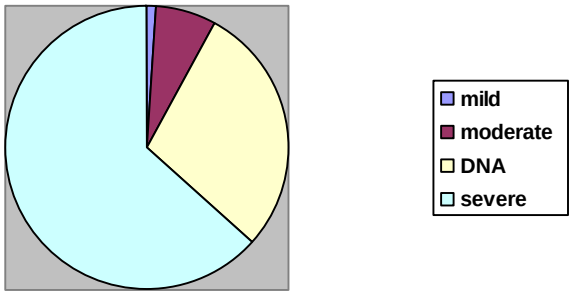


Figure 6: Pain Severity

Onset of Pain: Data about the onset of pain was unavailable for 34.8% of the charts. However of the remaining patients that did have descriptive information about pain onset 60.3% (39.3% of the total participants) experienced sudden onset symptoms of pain, while the remaining 39.7% (25.8% of total study participants) experienced symptoms of pain that came on gradually.

Nausea/Vomiting: 24.7 percent of our charts were missing data on nausea and vomiting but of the remaining 75.3 percent, thirty one (17.4% of total cases) did not experience nausea while another 57.9 percent of our total patients did indeed experience nausea

associated with their torsion. 52.2 percent also reported emesis at least once while 23.0 percent denied emesis as an associated symptom.

Vaginal Discharge on history: Only seven of the 178 patient charts reflected a patient history of blood in vaginal discharge with five patients reporting a history of frank blood and two reporting blood-tinged discharge. Eighty seven patients (48.9 percent) reported a negative history for vaginal discharge with eighty three of the charts yielding insufficient data about this element of the history.

Urinary Symptoms: Out of the 178 records reviewed eighty eight patients (49.4 percent) reported no problems with urination while 13.5 percent of patients described dysuria as one of their symptoms. One patient reported experiencing hematuria.

Systemic Symptoms: 55.6 percent of subjects reported no systemic symptoms. Nineteen subjects (10.7 percent) did experience some measure of systemic discomfort with eleven reporting history of unmeasured or subjective fever, three reporting measured fevers and five describing a history of chills.

Diarrhea: 56.7 percent of subjects reported no history of diarrhea or loose stool. Only eleven patients reported positive symptoms and sixty six of the patient records did not have any documented history of diarrheal symptoms or history.

Constipation: Sixty six records did not have data available regarding symptoms of constipation. 10.7 percent of patients reported experiencing constipation but the majority of patients (52.2%) reported no history of such symptoms.

Anorexia: Data regarding anorexia was unavailable in 84 records reviewed. 37.6 percent of the 178 patients did not experience anorexia while 15.2 percent they did have a decrease in appetite.

Mention of OT in differential diagnosis: Over 46% of physicians mentioned adnexal torsion as a potential diagnosis during the initial presentation of the patient to a provider. Another 26% of charts did not have enough information about the differential.

PHYSICAL EXAM FINDINGS:

Bowel sounds: Data was unavailable for 36.5 percent of patients. 48.3 percent of the total charts reviewed revealed normal and present bowel sounds. Twenty six patients (14.6%) did however exhibit decreased and hypoactive bowel sounds on physical exam. One patient was reported to have had hyperactive bowel sounds on exam.

Tenderness: Twenty six (14.6 percent) of the subjects demonstrated mild tenderness upon examination of the abdomen. Another 27.5 percent or forty nine subjects exhibited moderate tenderness according to their examiners, while fifty subjects (28.1%) exhibited severe pain on exam. A surprising twenty one (11.8%) had no pain at all on exam.

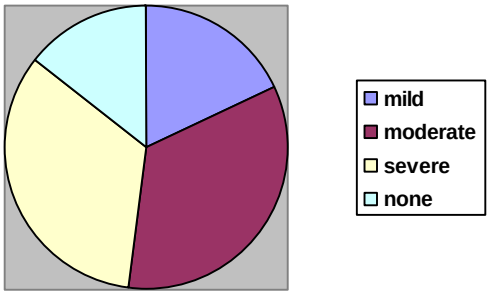


Figure 7: Tenderness to Abdominal Exam

Guarding/ Rebound/Peritoneal Signs: Fifty five or 30.9 percent of subjects had guarding on exam while another 29.2% had exams free of guarding. Seventy four patients (41.6 percent) had no rebound on exam. 21.9% exhibited positive rebound on exam. 42.7% of charts reviewed did not mention peritoneal signs. 39.3 percent of the charts reported no peritoneal signs and 18.0 percent reported positive peritoneal signs on physical exam.

Pelvic Exam Findings: Eighty two patient charts had no available data regarding the pelvic exam. 29.8 percent of the patients did indeed have a palpable mass on exam and another 24.2 did not. Another fifty two patients did not have mention of vaginal discharge on their exam yielding 132 patients without sufficient data on the presence or absence of vaginal discharge on presentation. Out of the 51 patients that had information in their charts about cervical motion tenderness, 16 tested positive for CMT and 35 tested negative. Fifty of the 178 patients (28.1%) exhibited adnexal tenderness on their pelvic exams and fourteen had no tenderness.

White Blood Cell Count: 56.2 percent of all studied patients had a white blood cell count of 10.0 or greater. Sixty six patients (37.1%) had a normal WBC and 12 records did not have sufficient data.

IMAGING: Four imaging modalities were observed in this review. As expected only 5.1 percent of the patients underwent MR imaging. Data about MR was unavailable for four patients while 92.7 percent did not undergo such testing. 82.6 percent of the subjects did not undergo pelvic or abdominal plain films leaving only 12.9 percent to undergo such testing.

Ultrasounds performed:

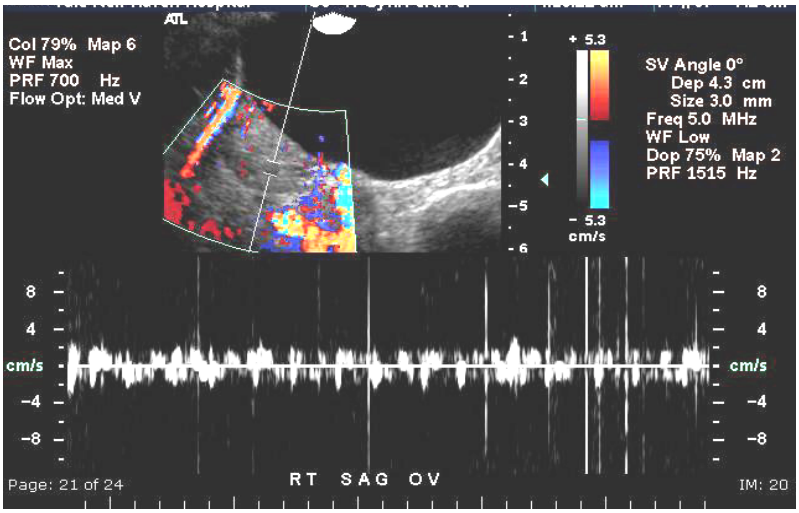


Figure 8: Ultrasound performed on one of the study patients demonstrating Doppler techniques.

Of the 178 patients 136 (76.4 percent) underwent ultrasound imaging. Data was unavailable for 4 patients and 38 patients did not undergo ultrasound. Of the 136 subjects

that received an ultrasound 64 (47.1 percent) were transvaginal and another 33 (24.3 percent) were transabdominal with thirty-nine patients without available data for this record.

CTs performed:

Figure 9: Axial CT of study patient demonstrating large pelvic mass.

Fifty eight of the 178 patients (32.6 percent) received CT scans as part of their workup for pelvic pain. 116 subjects did not receive CTs and four were missing data about this fact. Of the 58 scans done only 7 specifically mentioned ovarian torsion, all were abnormal but there was no mention of intravascular gas, tube thickening, or absence of enhancement with contrast in any scans. Forty of the subjects (22.5%) received both an ultrasound and a CT as part of their workup.

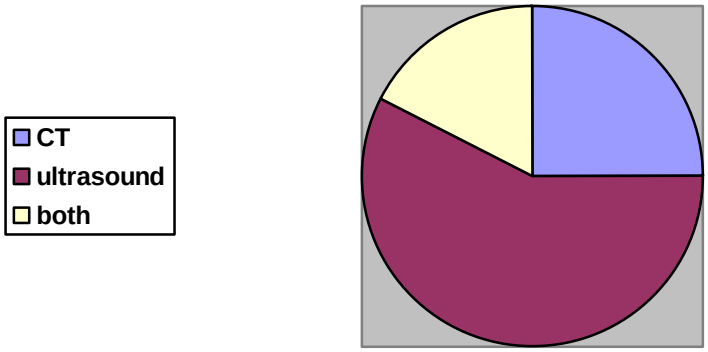


Figure 10: Distribution of Scans Performed

TRENDS in imaging: The twenty year period of the review was broken up into five year clusters from 1985-1989, 1990-1994, 1995-1999, and 2000-05. For the period between 1985 and 1989 three CTs (12.5%) were done and nine ultrasounds (37.5% of patients at that time period). During the years of 1990 until 1994 five CTs (13.5%) were done and 22 ultrasounds (62.2%). From 1995 until 1999 seven CTs (15.9%) were done in our patient group while 23 ultrasounds (53%) were ordered. And finally between 2000 and 2004 twenty five CT scans (34.2% of patients) were ordered as part of the patients' evaluations and 43 ultrasounds were done (58.9%).

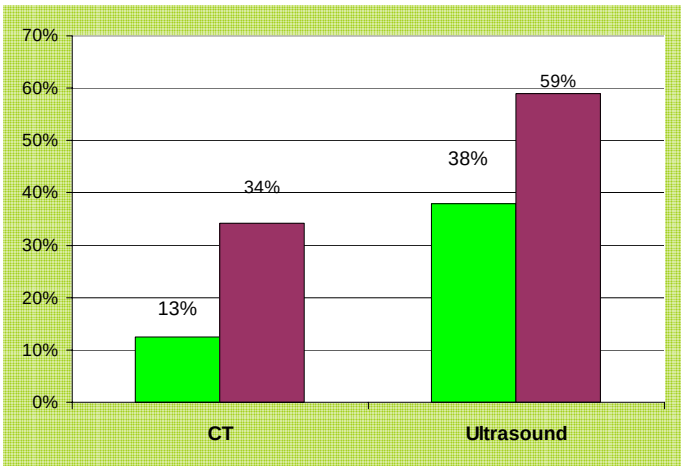


Figure 11: Percentage of scans per patient increase over twenty years

Surgical Data: 131 of the surgeries performed (73.6%) were performed open and forty seven (26.4%) were performed laparoscopically. Seventy of the 178 procedures (39.3%) revealed left adnexal torsion and 108 (60.7%) revealed right adnexal torsion.

DISCUSSION:

Adnexal torsion is a rare yet well-known clinical entity that occurs in all ages, neonatal to postmenopausal, although most commonly in women of reproductive age. Because of its elusive presentation it can often lead to a great deal of confusion. Its clinical presentation can be fairly non-specific and can often mimic acute abdomen. It begins by obstructing and interfering with the vascular flow of the ovarian vessels starting with the venous and lymphatic systems and can progress to impede the arterial flow to the ovary and its surrounding structures. The product of this obstruction is often edema, hemorrhagic infarction, severe congestion and necrosis within the adnexa leading to the clinical picture of an acute abdomen. This gynecological emergency is often the

caused by underlying ovarian lesions and neoplasms but can also occur in the normal adnexa. The early detection and proper emergent treatment of this condition is critical in preserving fertility by salvaging damaged but not dead ovarian structures and in avoiding infection in the form of peritonitis and sepsis.

The range of symptoms and signs associated with adnexal torsion can be wide and confusing. In the existing literature the majority of patients have described pain that is of sudden onset, sharp, and that radiates to another site of the body. [1, 4] In our study we found that 60.3 percent of the subjects for whom we had reliable data concerning onset did indeed have sudden onset pain. The majority of our patients (63.5 percent) reported their pain as severe and yet on exam only 28.1 percent exhibited severe pain on physical exam, with a surprising 11.8 percent experiencing no tenderness at all during the abdominal exam.

In terms of pain quality however, although a significant number of our subjects did experience sharp pain (23.6 percent) and radiation of their pain (19.7 percent) we had such a large number of charts that did not provide adequate data that recognizing patterns was difficult.

The existing literature also describes from 51 percent up to 70 percent of study subjects experiencing nausea and vomiting as part of the associated symptoms of their torsion.[3, 4] In our subjects we had clear data that 57.9 percent of our patients presented with a history of nausea and 52.2 percent had experienced at least one episode of vomiting as part of their clinical presentation.

In patients with symptoms like these that are highly suggestive of a possible diagnosis of torsion authors often recommend the use of color Doppler ultrasound and

this is usually the first test ordered and performed in an emergency setting. However the literature is controversial and there have been normal adnexal arterial waveforms reported in patients that have gone on to receive surgical treatment for torsion.[10]

In light of this controversy CT has been shown to provide some extra clarity by demonstrating certain diagnostic findings regarding tubal thickening, smoothing of tubal surfaces and absence of enhancement on contrast CT. In our study it was demonstrated that there has been a significant increase in the use of CT as a diagnostic tool in the work up of patients with pelvic and abdominal symptoms that eventually are diagnosed and treated for adnexal torsion.

We demonstrated that in a twenty year period CT went from occurring in 13 percent of patients to occurring in over 34 percent of patients. In light of this increase it is important to consider the utility of such an exam. In our study none of the fifty eight CT reports revealed any discussion of the diagnostic findings of torsion discussed earlier. No mention, either concerning absence nor presence of tubal thickening, smoothing of tubal structures, enhancement patterns, intravascular gas or uterine deviation was made in any of the reports and out of the 58 reports reviewed only seven mentioned torsion.

Of significance however is the fact that none of the CTs were normal and each described some type of abnormality within the pelvis although flow and vasculature were not discussed. We might be able to suggest thus that although CT might not be a first choice tool in detecting adnexal torsion due to an apparent lack of specificity it could prove useful in the diagnostic process due to its sensitivity. With an abnormal CT it would thus be difficult to rule adnexal torsion completely out as a potential diagnosis.

CONCLUSIONS: CT scanning has increased in frequency as a diagnostic tool in the workup of ovarian torsion over the course of the past twenty years. In this study of 178 patients and 58 CT scans there were no normal pelvic CT scans in patients with surgically proven adnexal torsion. This suggests a possible role for CT in excluding the diagnosis of adnexal torsion.

Additional information in the form of radiologist review of the CTs in this study might prove extremely lucrative as a means of further determining the sensitivity and specificity of CT scans in the diagnosis of torsion. It would be interesting to see if the findings established in the literature as diagnostic for torsion, such as uterine deviation to the side of the lesion, tubal thickening, intravascular gas, smoothing of the adnexa, absence of enhancement, presence of multiple peripheral cysts and overt signs of congestion with enlarged vessels would be a part of the findings in a radiological review of the original scans.

Bibliography

1. Hibbard, L.T., *Adnexal torsion.* American Journal of Obstetrics & Gynecology. 152(4):456-61, 1985 Jun 15.
2. Burnett, L.S., *Gynecologic causes of the acute abdomen. [Review] [22 refs]*. Surgical Clinics of North America. 68(2):385-98, 1988 Apr.
3. Bouguizane, S., et al., *[Adnexal torsion: a report of 135 cases]. [French]*. Journal de Gynecologie, Obstetrique et Biologie de la Reproduction. 32(6):535-40, 2003 Oct.
4. Houry, D. and J.T. Abbott, *Ovarian torsion: a fifteen-year review.* Annals of Emergency Medicine. 38(2):156-9, 2001 Aug.
5. Varras, M., et al., *Uterine adnexal torsion: pathologic and gray-scale ultrasonographic findings.* Clinical & Experimental Obstetrics & Gynecology. 31(1):34-8, 2004.
6. Worthington-Kirsch, R.L., V. Raptopoulos, and I.T. Cohen, *Sequential bilateral torsion of normal ovaries in a child.* Journal of Ultrasound in Medicine. 5(11):663-4, 1986 Nov.
7. Albayram, F. and U.M. Hamper, *Ovarian and adnexal torsion: spectrum of sonographic findings with pathologic correlation.* Journal of Ultrasound in Medicine. 20(10):1083-9, 2001 Oct.
8. Vijayaraghavan, S.B., *Sonographic whirlpool sign in ovarian torsion.* Journal of Ultrasound in Medicine. 23(12):1643-9; quiz 1650-1, 2004 Dec.
9. Lee, E.J., et al., *Diagnosis of ovarian torsion with color Doppler sonography: depiction of twisted vascular pedicle.* Journal of Ultrasound in Medicine. 17(2):83-9, 1998 Feb.
10. Ben-Ami, M., Y. Perlitz, and S. Haddad, *The effectiveness of spectral and color Doppler in predicting ovarian torsion. A prospective study.* European Journal of Obstetrics, Gynecology, & Reproductive Biology. 104(1):64-6, 2002 Aug 5.
11. Kimura, I., et al., *Ovarian torsion: CT and MR imaging appearances.* Radiology. 190(2):337-41, 1994 Feb.
12. Kawahara, Y., et al., *Intravascular gas within an ovarian tumor: a CT sign of ovarian torsion.* Journal of Computer Assisted Tomography. 20(1):154-6, 1996 Jan-Feb.
13. Zissin, R., *Torsion of a normal ovary in a post-pubertal female: unenhanced helical CT appearance.* British Journal of Radiology. 74(884):762-3, 2001 Aug.
14. Gittleman, A.M., et al., *Ovarian torsion: CT findings in a child. [Review] [8 refs]*. Journal of Pediatric Surgery. 39(8):1270-2, 2004 Aug.
15. Low, S.C., et al., *Paratubal cyst complicated by tubo-ovarian torsion: computed tomography features.* Australasian Radiology. 49(2):136-9, 2005 Apr.
16. Rha, S.E., et al., *CT and MR imaging features of adnexal torsion.* Radiographics. 22(2):283-94, 2002 Mar-Apr.
17. Hurh, P.J., J.S. Meyer, and A. Shaaban, *Ultrasound of a torsed ovary: characteristic gray-scale appearance despite normal arterial and venous flow on Doppler.* Pediatric Radiology. 32(8):586-8, 2002 Aug.

18. Jain, K.A., *Magnetic resonance imaging findings in ovarian torsion.* Magnetic Resonance Imaging. 13(1):111-3, 1995.
19. Jeong, Y.Y., et al., *CT features of uterine torsion.* European Radiology. 13 Suppl 4:L249-50, 2003 Dec.
20. Cass, D.L., *Ovarian torsion. [Review] [75 refs].* Seminars in Pediatric Surgery. 14(2):86-92, 2005 May.
21. Coulson, C.C., C.J. Kasales, and G. Devi, *Antenatal doppler diagnosis of fetal ovarian torsion.* Obstetrics & Gynecology. 95(6 Pt 2):1039, 2000 Jun.
22. Davis, L.G., et al., *Ultrasound and Doppler in the diagnosis of ovarian torsion.* European Journal of Radiology. 20(2):133-6, 1995 Jul.
23. Decker, P.A., J. Chammas, and T.T. Sato, *Laparoscopic diagnosis and management of ovarian torsion in the newborn.* Journal of the Society of Laparoendoscopic Surgeons. 3(2):141-3, 1999 Apr-Jun.
24. Desai, S.K., G.N. Allahbadia, and A.K. Dalal, *Ovarian torsion: diagnosis by color Doppler ultrasonography.* Obstetrics & Gynecology. 84(4 Pt 2):699-701, 1994 Oct.
25. Dolgin, S.E., *Acute ovarian torsion in children.[comment].* American Journal of Surgery. 183(1):95-6, 2002 Jan.
26. Eftekhar, Z., et al., *An ovarian torsion in severe spontaneous ovarian hyperstimulation syndrome associated with a singleton pregnancy.[comment].* Journal of Obstetrics & Gynaecology. 25(4):393-4, 2005 May.
27. Garcia-Cubillana y de la Cruz, J.M., et al., *[Ovarian torsion in early childhood]. [Spanish].* Anales Espanoles de Pediatria. 25(3):205-7, 1986 Sep.
28. Ghossain, M.A., et al., *Adnexal torsion: magnetic resonance findings in the viable adnexa with emphasis on stromal ovarian appearance.* Journal of Magnetic Resonance Imaging. 20(3):451-62, 2004 Sep.
29. Alrabeeah, A., et al., *Neonatal ovarian torsion: report of three cases and review of the literature. [Review] [22 refs].* Pediatric Pathology. 8(2):143-9, 1988.
30. Anders, J.F. and E.C. Powell, *Urgency of evaluation and outcome of acute ovarian torsion in pediatric patients.* Archives of Pediatrics & Adolescent Medicine. 159(6):532-5, 2005 Jun.
31. Antoniou, N., et al., *Isolated torsion of the fallopian tube: a case report and review of the literature. [Review] [20 refs].* Clinical & Experimental Obstetrics & Gynecology. 31(3):235-8, 2004.
32. Buy, J.N., et al., *Cystic teratoma of the ovary: CT detection.* Radiology. 171(3):697-701, 1989 Jun.
33. Buy, J.N., et al., *[Malignant tumors of the ovaries: role of imaging]. [Review] [21 refs] [French].* Journal de Radiologie. 81(12 Suppl):1833-43, 2000 Dec.
34. Buy, J.N., et al., *Characterization of adnexal masses: combination of color Doppler and conventional sonography compared with spectral Doppler analysis alone and conventional sonography alone.* Ajr, (1996 Feb): p. American Journal of Roentgenology.
35. Buy, J.N., et al., *Epithelial tumors of the ovary: CT findings and correlation with US.* Radiology. 178(3):811-8, 1991 Mar.

36. Ghossain, M.A., et al., *CT in adnexal torsion with emphasis on tubal findings: correlation with US.* Journal of Computer Assisted Tomography. 18(4):619-25, 1994 Jul-Aug.
37. Ghossain, M.A., et al., *CT findings before and after adnexal torsion: rotation of a focal solid element of a cystic adjunctive sign in diagnosis.* Ajr, 1343(1997 Nov): p. American Journal of Roentgenology.
38. Graif, M. and Y. Itzchak, *Sonographic evaluation of ovarian torsion in childhood and adolescence.* Ajr, (1988 Mar): p. American Journal of Roentgenology.
39. Guileyardo, J.M., *Neonatal ovarian torsion.* American Journal of Diseases of Children. 136(10):945-6, 1982 Oct.
40. Guinet, C., et al., *Mature cystic teratomas of the ovary: CT and MR findings.* European Journal of Radiology. 20(2):137-43, 1995 Jul.
41. Guinet, C., et al., *Fat suppression techniques in MR imaging of mature ovarian teratomas: comparison with CT.* European Journal of Radiology. 17(2):117-21, 1993 Sep.
42. Haque, T.L., et al., *Adnexal torsion: MR imaging findings of viable ovary.* European Radiology. 10(12):1954-7, 2000.
43. Helvie, M.A. and T.M. Silver, *Ovarian torsion: sonographic evaluation.* Journal of Clinical Ultrasound. 17(5):327-32, 1989 Jun.
44. Kawakami, K., et al., *Hemorrhagic infarction of the diseased ovary: a common MR finding in two cases.* Magnetic Resonance Imaging. 11(4):595-7, 1993.
45. Kim, Y.H., et al., *CT features of torsion of benign cystic teratoma of the ovary.* Journal of Computer Assisted Tomography. 23(6):923-8, 1999 Nov-Dec.
46. Kokoska, E.R., M.S. Keller, and T.R. Weber, *Acute ovarian torsion in children.[see comment].* American Journal of Surgery. 180(6):462-5, 2000 Dec.
47. Kurzrock, E.A. and D. Nudell, *Neonatal pelvic mass. Neonatal ovarian torsion.* Clinical Pediatrics. 38(7):415; discussion 415-6, 1999 Jul.
48. Meyer, J.S., et al., *Ovarian torsion: clinical and imaging presentation in children.* Journal of Pediatric Surgery. 30(10):1433-6, 1995 Oct.
49. Mugel, T., et al., *[Value of CT scan and MRI in primary tumors of the ovary].[French].* Journal de Chirurgie. 130(11):486-91, 1993 Nov.
50. Nagayama, M., et al., *Fast MR imaging in obstetrics. [Review] [59 refs].* Radiographics. 22(3):563-80; discussion 580-2, 2002 May-Jun.
51. Pena, J.E., et al., *Usefulness of Doppler sonography in the diagnosis of ovarian torsion.[see comment].* Fertility & Sterility. 73(5):1047-50, 2000 May.
52. Press, H.C., Jr., et al., *Pregnancy complicated by ovarian torsion.* Ajr, (1991 Apr): p. American Journal of Roentgenology.
53. Roy, C., et al., *Acute torsion of uterine leiomyoma: CT features.* Abdominal Imaging. 30(1):120-3, 2005 Jan-Feb.
54. Schlaff, W.D., et al., *Diagnosing ovarian torsion with computed tomography. A case report.* Journal of Reproductive Medicine. 43(9):827-30, 1998 Sep.
55. Semlali, S., et al., *[Emergency ultrasound diagnosis of ovarian torsion in children : nine case reports].[French].* Archives de Pediatrie. 11(4):304-7, 2004 Apr.
56. Shimada, K., et al., *Ovarian torsion: preoperative diagnosis with MR imaging.* Rofo: Fortschritte auf dem Gebiete der Rontgenstrahlen und der Nuklearmedizin. 168(6):628-30, 1998 Jun.

57. Stark, J.E. and M.J. Siegel, *Ovarian torsion in prepubertal and pubertal girls: sonographic findings.* Ajr, 1479(1994 Dec): p. American Journal of Roentgenology.
58. Templeman, C., S.P. Hertweck, and M.E. Fallat, *The clinical course of unresected ovarian torsion.* Journal of Pediatric Surgery. 35(9):1385-7, 2000 Sep.
59. Tepper, R., et al., *Diagnostic value of transvaginal color Doppler flow in ovarian torsion.* European Journal of Obstetrics, Gynecology, & Reproductive Biology. 68(1-2):115-8, 1996 Sep.
60. Torbati, S.S. and S.J. Krishel, *Dermoid tumor with ovarian torsion masking as appendicitis.* Journal of Emergency Medicine. 18(1):103, 2000 Jan.
61. Treasure, J. and J. Kerin, *Recurrent ovarian torsion.* Australian & New Zealand Journal of Obstetrics & Gynaecology. 37(3):365-6, 1997 Aug.
62. Van Voorhis, B.J., et al., *Early diagnosis of ovarian torsion by color Doppler ultrasonography.* Fertility & Sterility. 58(1):215-7, 1992 Jul.
63. Varras, M., *Benefits and limitations of ultrasonographic evaluation of uterine adnexal lesions in early detection of ovarian cancer. [Review] [61 refs].* Clinical & Experimental Obstetrics & Gynecology. 31(2):85-98, 2004.
64. Varras, M., et al., *Internal hemorrhage caused by a twisted malignant ovarian dysgerminoma: ultrasonographic findings of a rare case and review of the literature.* Clinical & Experimental Obstetrics & Gynecology. 31(1):73-8, 2004.
65. Villalba, M.L., et al., *An ovary with a twist: a case of interesting sonographic findings of ovarian torsion.* Journal of Emergency Medicine. 29(4):443-6, 2005 Nov.
66. Wachsberg, R.H., *Accuracy of using Doppler sonography to diagnose ovarian torsion.[comment].* Fertility & Sterility. 75(5):1041-2, 2001 May.
67. Willms, A.B., J.F. Schlund, and W.R. Meyer, *Endovaginal Doppler ultrasound in ovarian torsion: a case series.* Ultrasound in Obstetrics & Gynecology. 5(2):129-32, 1995 Feb.
68. Yaman, C., T. Ebner, and K. Jesacher, *Three-dimensional power Doppler in the diagnosis of ovarian torsion.* Ultrasound in Obstetrics & Gynecology. 20(5):513-5, 2002 Nov.