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ULTRASONOGRAPHY;
DIAGNOSTIC ACCURACY IN FEMALE APPENDICITIS

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ABSTRACT... Acute appendicitis is a diagnostic dilemma in young female patients. Ultrasonography has an important role in making preoperative diagnosis and ruling out other gynecological pathologies in women. **Objectives:** (1) To determine the diagnostic accuracy of ultrasonography for acute appendicitis. (2) To compare it with impression, in female patients. **Design:** Cross-sectional comparative study. **Setting:** Female Surgical department. Combined Hospital, Rawalpindi. **Period:** Mar 2006 - Jun 2008. **Patients and Methods:** 214 consecutive female patients presenting with pain right lower abdomen were enrolled. The patients were assessed clinically. Blood complete picture and urine analysis was carried out in all patients. Ultrasonography was performed by radiologist with 7.5 MMz short-focused high-resolution probes. Patients were operated upon and appendicectomy was done. Specimens were sent for histopathology to confirm appendicitis. **Results:** Ultrasound supported the diagnosis of acute appendicitis in 163 (76.2%) patients. In ultrasound with positive findings, patients 161 (98.8%) had inflamed appendices on histopathology and 2 (1.2%) had normal appendices. The over all sensitivity of ultrasonography was 81.3% and specificity was 87.5%. Diagnostic accuracy of ultrasonography was 81.8%. The over all sensitivity of surgeon's clinical impression remained 81.8% and specificity was 62.5%. Diagnostic accuracy of ultrasonography was 81.8%. **Conclusions:** Ultrasound should be the initial diagnostic modality in females presenting with right lower abdominal pain. It is highly specific, effectively rules out other pathologies and helps in minimizing the avoidable surgical trauma.

Key words: Acute appendicitis: Ultrasonography: Female: Appendicectomy

INTRODUCTION

Acute appendicitis has been the most common indication for emergency surgery since decades. Although, no age group is immune, but is most frequent amongst young adults. It has a lower incidence in people of low socioeconomic groups with a higher intake of dietary fiber[1]. Ineffective lymphatic and venous drainage allows bacterial invasion of the appendicular wall.

Despite more than 100 year's experience, accurate diagnosis of acute appendicitis still evades the surgeon. Delay in the removal of a suppurative appendix may still lead to deleterious conditions[2].
However, appendectomy has postoperative morbidity of 10% to 15%[3] and negative appendicectomy rate is as high as 20%[4].

There are several scoring systems in practice to strengthen the clinical judgment of the surgeons. Aim is to reduce the unnecessary surgical trauma to the patients.

One of the most promising diagnostic aids is ultrasonography and in some hospitals, has become routine for patients with pain in the right lower quadrant. Since the first report of an ultrasonographically demonstrated inflamed appendix in 1981, there have been numerous publications on the use of this diagnostic tool. Whereas some recent studies[5] have shown that US can improve diagnostic accuracy and reduce unnecessary surgery, others[6] have failed to show its efficacy.

Acute abdominal pain in women often presents the clinician with an ordeal. It can be a manifestation of various gynecologic and non-gynecologic disorders from less alarming rupture of the follicular cyst to life threatening conditions such as rupture of ectopic

pregnancy or perforation of inflamed appendix[7].

Ultrasonography is an important adjunct in improving diagnostic accuracy in such cases. Prospective studies report sensitivities ranging from 77% to 100%, specificities ranging from 83% to 100%, and accuracies ranging from 88% to 98% for the diagnosis of acute appendicitis[8].

Aim of our study was to evaluate the role of ultrasonography in establishing the diagnosis of acute appendicitis in females; thus decreasing the rate of negative appendicectomies.

PATIENTS AND METHODS

It was a cross-sectional comparative study. The study was conducted at female surgery department at Military Hospital Rawalpindi from Mar 2006 to June 2008. 214 consecutive females presented with pain in right lower quadrant were included. Purposive non-probability sampling technique was used. All female patients with right lower quadrant pain and tenderness, between 12-40 years of age, were included. Female patients with established peritonitis or gynecological pathology diagnosed on ultrasonography were excluded.

The patients were assessed clinically. History of shift of pain, fever, anorexia, nausea and vomiting was taken. Detailed menstrual history was also asked. On examination right lower quadrant tenderness, rebound tenderness, guarding and rigidity were assessed.

Total Leukocyte Count was analyzed from the blood sample. Consultant Radiologist specified for the study; to avoid operator depended bias; performed ultrasonography with Aloka SSD-630 machine equipped with 7.5 MMz short-focused high-resolution probes. Patients were operated upon and per operative inspection of appendix along with pelvic organs were done. Apendicectomy was carried out. Specimens were sent for histopathology to confirm the diagnosis.

Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography were calculated, taking histopathology as gold standard. Data was analyzed using SPSS version 11. Descriptive statistics were applied to calculate specificity, sensitivity, positive predictive value, negative predictive vale and diagnostic accuracy. Chi-Square Test of significance was applied.

RESULTS

Mean age was 23 years (range 12-40 years.). 66(31%) patients were between 12-20 years and 103(48%) patients were 21-30 years. 45 (21%) patients were between 31 to 40 years. Majority of the patients were from 3rd decade.

Post-operative histopathology confirmed inflammation in 198 (92.5%) cases where as 16 (7.4%) patients revealed normal appendices. The sensitivity and specificity of ultrasound was calculated by taking histopathology as gold standard.

Surgeon's clinical impression was recorded at admission as strong clinical suspicion (Group-1) that had Alvarado Score of $\geqslant$ 7 and observation group (Group-2) with Alvarado Score $\leqslant$ 6.

Surgeon's Clinical Impression at Admission

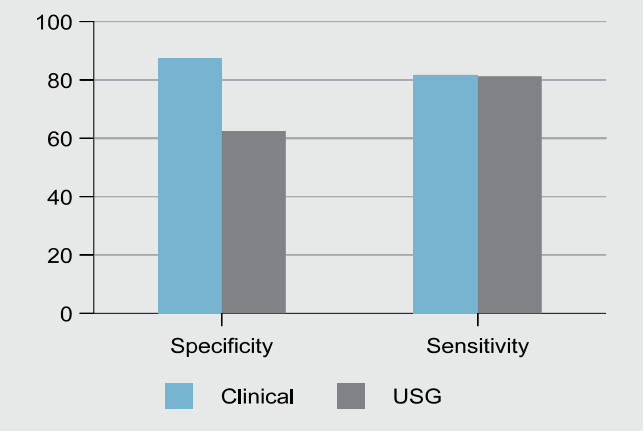
In Group-1 (strong clinical suspicion), 168 (78.5%) patients were included who had definite clinical diagnosis of acute appendicitis. Out of these patients, histopathology confirmed inflammation in 162 (96.4%) cases and appendix was found normal in 6 (3.6%) patients.

Out of 46 (21.5%) patients included in Group-2 (Observation group), appendix was found inflamed histologically in 36 (78.3%) patients and normal in 10 (21.7%) patients.

Overall Sensitivity and Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic accuracy of surgeon's clinical impression was calculated (Fig-I).

- Sensitivity: 81.8%
- Specificity: 62.5%

Fig-1. Comparison of Sensitivity and Specificity



Positive predictive value of clinical impression remained 96.4%, negative predictive value was 21.7 % and diagnostic accuracy was found to be 80.4% in this group (Table-I).

Ultrasound Examination in Admitted Patients

All the patients were subjected to ultrasound examination. Ultrasound supported the diagnosis of acute appendicitis in 163 (76.2%) patients. In 147 (90.2%) patients, inflamed appendix could be visualized on ultrasound while 16 (9.8%) patients had indirect evidence of acute appendicitis (localized ileus, fluid collection, distended caecum), which were considered as ultrasound positive.

In ultrasound positive patients, 161 (98.8%) (True Positive) had inflamed appendices and 2 (1.2%) (False Positive) had normal appendices on histopathology.

Among 51 (23.8%) ultrasound negative patients, 37 (72.5%) (False Negative) had inflamed appendices on histopathology where as 14 (27.5%) (True Negative) had normal appendices. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography are calculated, taking histopathology as gold standard (Fig-I).

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- Sensitivity: 81.3%
- Specificity: 87.5%

Positive predictive value of ultrasound group remained 98.7%, negative predictive value was 27.5 % and diagnostic accuracy was found to be 81.8% in this group (Table-I).

Table-I.

Results	Clinical Impression	Ultrasonography
Diagnostic Accuracy	80.4 %	81.8 %
Positive Predictive Value	96.4 %	98.7 %
Negative Predictive Value	21.7 %	27.5 %

Chi-Square Test of significance was applied and p- value was found to be >0.05.

DISCUSSION

Early appendicectomy, was first performed for non-perforated acute appendicitis in the 1880s[9]. Despite recent advances in medical treatment, delay in the removal of a suppurative appendix may still lead to deleterious conditions. The life time risk of appendectomy is 12% for men and 25% for women, making it the most commonly performed emergency operation in the world and accounting for a million hospital days per year in the United States[10].

A recent population-based analysis revealed that 15% of performed appendectomies failed to show pathologic evidence of appendicitis. In some high-risk populations, such as women of reproductive ages, the population-based rate of unnecessary appendectomy is as high as 26%[11]. The most common misdiagnoses, in women, include pelvic inflammatory disease, gastroenteritis, and abdominal pain of unknown origin, urinary tract infection, ruptured ovarian follicle, and ectopic pregnancy.

Approximately 70 to 90 percent of patients with acute appendicitis have an elevated leukocyte count. Leukocytosis is also characteristic of several other acute abdominal and pelvic diseases and thus has poor specificity for the diagnosis of acute appendicitis especially in females[12]. Use of the leukocyte count alone to make management decisions in cases of suspected appendicitis may result in missed diagnoses or unnecessary surgery.

The use of an objective scoring system such as the Alvarado system can reduce the negative appendicectomy rate to 0-5%[13]. The simple expedient of close observation and repeated re-evaluation has in itself been shown in several studies to reduce the unnecessary exploration rate.

Body imaging as a diagnostic adjunct for appendicitis has enhanced sensitivity, specificity, and accuracy. Ultrasound (US) is portable, fast, free of radiation exposure, and of modest incremental cost; however, it is of limited use in obese adolescents, and it is highly user-dependent.

There are four sonographic diagnostic criteria for appendicitis, (1) any visualization, (2) appendiceal diameter greater than 6.0 mm, (3) muscular wall thickness greater than or equal to 3.0 mm, and (4) presence of a complex mass[14]. A carefully performed ultrasonographic study has a sensitivity of 75 to 90 percent, a specificity of 86 to 100 percent[15]. In addition, ultrasonography may identify alternative diagnoses, such as pyosalpinx or ovarian torsion, in as many as 33 percent of female patients with suspected appendicitis.

Douglas et al[16] randomized 302 patients with suspected acute appendicitis to graded compression ultrasound or clinical evaluation. The only difference they found was slightly earlier operation in the ultrasound group. The negative appendicectomy rates remained 9% and 11% respectively. Computed tomography (CT) as an adjunct for the diagnosis of acute appendicitis was first described 10 years ago. Its immediate impact was substantial, reducing negative appendectomy rates to 4.1% and perforative rates to 14.7%[17].

Use of CT scan is gaining popularity in modern world for the diagnosis of acute appendicitis since than. Impressive though CT results are, they are not without radiation exposure. The availability of CT scan and cost are major issues in our set up and under developed countries.
“AuntMinnie" general radiology discussion revealed around 100 CT scans each night; 20% of these scans were for ruling out appendicitis. Another contributor stated a rate of up to 3–4 appendicitis scans each hour[18].

The risk: benefit issues surrounding radiation are now at the top of the agenda especially in females of reproductive age group. Appendicitis had a mortality of 26% in the early part of the last century. With modern management, mortality is reduced to virtually zero. Serious doubt exists whether radiation techniques with a measurable risk of cancer induction are ever justified except when complications have set in. There is no evidence in surveys of populations that current use of CT has improved morbidity and retrospective studies have shown no change in the negative appendicectomy range[19].

Though some prospective studies; directly comparing the efficacy of CT with that of ultrasonography in adults; have shown the superiority of CT in diagnosing appendicitis[20]. Where as, other studies have shown similar accuracy for the diagnosis of acute appendicitis amongst both.

In our study conducted in females confirmed the high sensitivity and specificity of ultrasonography in the diagnosis of appendicitis. During patient selection, 46 females were excluded from the study as gynecological pathologies were detected by sonography which itself was a great contribution to reducing the negative appendicectomy rate.

Post-operative histopathology confirmed inflammation in 198 (92.5%) cases where as 16 (7.5%) patients revealed normal appendices. Negative appendicectomy rate was 7.5% in this study.

Almost all patients who underwent surgery after a positive result on ultrasonography proved to have appendicitis on histopathology. Patients with equivocal signs of appendicitis, who were admitted to hospital for observation, were also operated upon after diagnosis by sonography without regret.

When assessed by the surgeon at admission, 168 (78.5%) patients had signs and symptoms strongly suggestive of acute appendicitis. Whereas

ultrasonography was able to detect appendicitis in 163 (76.2%) patients thus the sensitivity (81.8%) of surgeons clinical impression was superior to sonography (81.3%) alone. However only two patients detected positive on sonography were proved negative on histopathology making it more specific (87.5%) than surgeons clinical impression (62.5%).

Positive predictive value of sonography was nearly 100% which is commendable. Diagnostic accuracy of the sonography (81.8%) was slightly higher than that of surgeon's clinical impression (80.4%). The sensitivity and specificity of the sonography remained the same in both groups regardless of clinical impression of surgeon.

D. S. Wade[22] conducted a similar study but it was not gender specific. The ultrasound-derived diagnosis of appendicitis had a sensitivity of 85.5%, a specificity of 84.4%, and an overall accuracy of 85.0%. The surgeon's clinical impression at the time of admission had a sensitivity of 62.9%, a specificity of 82.2%, and an overall accuracy of 71.2%.

It is important to emphasize that sonography is a reliable indicator for surgery once it picks up the appendicitis. However ultrasound negative patients need further observation and repeated clinical evaluation. 37 patients with normal ultrasound findings were ultimately found to have appendicitis at operation; emphasizing the point that ultrasonography cannot be relied on to the exclusion of the surgeon's careful and repeated evaluation.

Surgeons clinical impression was more sensitive in picking up the tenderness in the right lower quadrant but it could not identify the exact cause of tenderness as the 46 excluded patients were also selected initially on clinical suspicion but had to be excluded once diagnosed otherwise by sonography.

Overall, negative appendicectomy rate was 7.4% which is acceptable once compared to other experimental studies but can be further reduced by more efficient clinical examination and interpretation of sonographic findings by a senior consultant radiologist.

We recommend a larger base study, especially in females, for further evaluation of the role of sonography in acute appendicitis.

CONCLUSION

It is suggested that ultrasonography is slightly superior to the surgeon's clinical impression in females. Once suggested by sonography surgeon should not hesitate to embark upon surgery. However ultrasound negative patients should be subjected to repeated and careful clinical examination by the surgeon for final decision. Ultrasound should be advised in all female patients with pain right lower abdomen as it effectively rules out other pathologies and helps in minimizing the avoidable surgical trauma.

REFERENCE

1. Kozar RA, Roslyn JJ. The appendix. In: Schwartz SI, Shires GT, Spencer FC, Daly JM, Fischer JE, Galloway AC, eds. **Principles of Surgery.** 7th ed. New York, NY: McGraw-Hill Health Professions Division; 1999:1383-94.
2. Hardin DM. **Acute appendicitis: review and update.** Am Fam Physician 1999;60:2027-34.
3. Lau W, Fan S, Yui T, Wong S. **Negative findings at appendectomy.** Am J Surg 1984;148:375-78.
4. Chan MY, Teo BS, Ng BL. **The Alvarado score and acute appendicitis.** Ann Acad Med Singapore 2001;30:510-12.
5. Galindo Gallego M, Fadrique B, Nieto MA. **Evaluation of ultrasonography and clinical diagnostic scoring in suspected appendicitis.** Br J Surg 1998;85:37-40.
6. Franke C, Bohner H, Yang Q, Ohmann C, Roher HD. **Ultrasonography for diagnosis of acute appendicitis: results of a prospective multicenter trial.** World J Surg 1999;23:141-146.
7. Rahili A, Delotte J, Desprez B, Bongain A, Benchimol D, Ejnes L. **Thrombosis of the right ovarian vein.** Presse Med. 2004;33:937-9.
8. Neumayer L, Kennedy A. **Imaging in Appendicitis: A Review with Special Emphasis on the Treatment of Women.** Obstetrics & Gynecology 2003;102:1404-9.
9. Roosevelt GE, Reynolds SL. **Does the use of ultrasonography improve the outcome of children with appendicitis?** Acad Emerg Med 1998;5:1071-75.

10. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. **The epidemiology of appendicitis and appendectomy in the United States.** Am J Epidemiol 1990;132:910-25.

11. Flum DR, Morris A, Koepsell T, Dellinger EP. **Has diagnostic accuracy in appendicitis improved with time?** JAMA 2001;286:1748-53.

12. Hale DA, Molloy M, Pearl RH, Schutt DC, Jaques DP. **Appendectomy: a contemporary appraisal.** Ann Surg 1997;225:252-61.

13. Lamparelli MJ, Hoque HM, Pogson CJ, Ball AB. **A prospective evaluation of the combined use of the Modified Alvarado score with selective laparoscopy in adult females in the management of suspected appendicitis.** Ann R Coll Surg Engl 2000;82:192-195.

14. Worrell JA, Drolshagen LF, Kelly TC, Hunton DW, Durmon GR, Fleischer AC. **Graded compression ultrasound in the diagnosis of appendicitis.** A comparison of diagnostic criteria. J Ultrasound Med 1990;9:145-50.

15. Birnbaum BA, Wilson SR. **Appendicitis at the millennium.** Radiology 2000;215:337-348.

16. Douglas CD, Macpherson NE, Davidson PM, Gani JS. **Randomized controlled trial of ultrasonography in diagnosis of acute appendicitis, incorporating the Alvarado score.** BMJ 2000;321:919-22.

17. Garcia BM, Mandl KD, Kraus SJ. **Ultrasonography and limited computed tomography in the diagnosis and management of appendicitis in children.** JAMA.1999;282:1041–1046.

18. Brenner DJ, Elliston CD, Hall EJ, Berdon WE. **Estimated risks of radiation-induced fatal cancer from Pediatric CT.** AJR 2001;176:289–96.

19. Rothrock SG, Green SM, Dobson M, Colucciello SA, Simmons CM. **Misdiagnosis of appendicitis in nonpregnant women of childbearing age.** J Emerg Med 1995;13:1-8.

20. Poortman P, Lohle PN, Schoemaker CM, Oostvogel HJ, Teepen HJ, Zwinderman KA et al. **Comparison of CT and Sonography in the Diagnosis of Acute Appendicitis: A Blinded Prospective Study.** AJR 2003;181:1355-59.

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