THE USE OF ULTRASONOGRAPHY IN THE DIAGNOSIS OF AMBIGUOUS CASES OF APPENDICITIS IN ADULTS

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Appendicitis inflicts diagnostic difficulties, particularly in ambiguous morbidity symptoms defined in the scale ALVARADO in the section 4-6 pt.

The aim of the study was the comparison of the diagnostic values of the classic method of recognizing appendicitis and those improved by ultrasonographic examination.

Material and methods. Patients were classified in this investigation according to symptoms from the section compartment 4-6 pt of the ALVARADO scale. Qualification for the treatment was determined according to the medical investigation and laboratory examinations. Ultrasonography (US) was executed in all patients with the aim of the evaluation of the appendix. The percentage of correct recognitions by means of the classic diagnostics was compared to the percentage determined with the aid of US.

Results. It was affirmed that in ambiguous clinical cases of appendicitis, the addition of US to the traditional investigational diagnostics improves the percentage of correct recognitions of appendicitis from 62.8% to 86.2% (p<0.01).

Conclusion. With the US supplementing the classic diagnostics, the percentage of correct recognitions of appendicitis enlarges in adult patients with the suspicion of appendicitis with so-called “grey zone” symptoms comprised in the scoring 4-6 pt of the ALVARADO scale.

Key words: vermiform appendix, ultrasonography

Appendicitis recognition remains difficult for surgeons using the ALVARADO scale. These problems are mainly the result of the lack of typical symptoms or misrecognitions of illnesses producing similar symptoms to App. The basis for the diagnosis of the patient suspected of App is composed of the interview, clinical investigation, and the results of laboratory examination. According to the statistics, the percentage of incorrect recognitions of appendicitis is as high as 30% (1). Many methods exist to increase the correct and decrease the incorrect recognition of appendicitis in complaints of sharp pain of the right abdomen, including computer programs, computer scanning together with the use of leucocytes marked with technetium 99Tc, the cytologic investigation of the peritoneal liquid, and applying diagnostic punctual scales or the diagnostic laparoscopy.

The majority of these methods are inaccessible in everyday practice because of their experimental nature or high cost. Through-abdominal ultrasonography is a comparatively accessible and cheap method of investigation, and its usefulness in the diagnosis of App has been proved, particularly in the case of children. Demonstrating a healthy vermiform appendix is difficult. Healthy teenagers were demonstrated in various investigations at rates from 0-4 to 82% (2, 3). It is estimated that the sensi-
tivity of the US investigation of appendicitis is from 75 to 88.5%, and its accuracy ranges from 94 to 100% (4). In this work, the radiological features of the vermiform appendix in the inflammatory state, as well as the standard equipment and the methods of the investigation of App are described (5). The usefulness of the supersonic investigation was estimated in the majority of investigations regardless the degree of the clinical suspicion. The usefulness of US was studied only in ambiguous cases, seldom clinically, and particularly in cases of adults.

Conclusions drawn out on the basis of a large metaanalysis conducted in 2005 suggest that ultrasonography can mainly be useful in symptomatic appendicitis and is particularly useful in young persons with full symptoms (6). Standard investigations do have a sufficient predictive value in the recognition and undertaking of the treatment of App in such cases.

Diagnostic difficulties are created in patients with ambiguous symptoms or ambiguous results of laboratory investigations. There are many punctual scales used to facilitate the establishment of the correct diagnoses through the standardization of the symptoms. Among them are the ALVARADO scale, MANTRELES, and others (tab. 1). The accuracy of the ALVARADO scale is estimated to be 69.2 to 92% in cases exceeding 6 points (7). The disadvantage of all of the table scales is that a considerable number of the patients have an intermediate number of the points which classifies patients for the observation. As a result, some patients risk not being operated on when needed, and others are hospitalized unnecessarily. As it seems, the combination the use of punctual scales together with additional investigations and US can constitute the optimum diagnostics of the ambiguous cases of appendicitis.

The aim of the work was the comparison of the diagnostic values of the classic method of recognizing appendicitis and those improved by ultrasonography (US) examination in adults in section 4-6 in the ALVARADO scale.

**MATERIAL AND METHODS**

Forty-nine patients were included in this study hospitalized because of the suspicion of App with symptoms scoring from 4-6 pt in the ALVARADO scale between 2005-2006. They were operated on or subjected to hospital observation exceeding 24 hours. The study excluded patients with different ailments whose symptoms suggested App in the preliminary diagnostics. The patients with different scores were excluded. The investigation of US was undertaken in patients by means of the linear head 5-10 MHz with the possibility of illustrating of harmonic and the investigation of Color and Power Doppler flows and applied to the head in adult persons - Convex 3.5-5 MHz. Patients were qualified to undergo either operation or observation only on the basis of clinical and laboratory investigations by the on duty doctor without contact with the person making the investigation of US. App was confirmed by positive histopathological investigation, and the lack of App was confirmed by the negative hospital observation or negative histopathological investigation.

In all cases, it was the aim to demonstrate vermiform appendix in the US investigation, and the criterion for confirmation of the inflammatory state was the thickening of the App above 6 mm with the lack of the deformation under the pressure of the head. The presence of free liquid was also estimated in the peritoneal pit, the presence of stool, the appearance of the fat surrounding the appendix and vasculature of its walls. Thorough abdominal US of the remaining organs was also made with the head Convex 3.5-5 MHz.

The patients were diagnosed according to two methods:

1) using the standard medical investigation (the physical investigation plus the laboratory investigations), marking the quantity of points in the ALVARADO scale,

2) standard investigation broadened with the US diagnosis. The investigation of US was in those cases decisive. The patients with recognised App during radiological examina-

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**Table 1. ALVARADO scoring system**

<table>
<thead>
<tr>
<th>Features</th>
<th>Score</th>
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<tbody>
<tr>
<td>Migratory right iliac fossa pain</td>
<td>1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>1</td>
</tr>
<tr>
<td>Right iliac fossa tenderness</td>
<td>2</td>
</tr>
<tr>
<td>Rebound pain in right iliac fossa</td>
<td>1</td>
</tr>
<tr>
<td>Fever &gt;37.3°C</td>
<td>1</td>
</tr>
<tr>
<td>Leucocytosis (&gt;10 x 109/L)</td>
<td>2</td>
</tr>
<tr>
<td>Neutrophilic shift to the left &gt;75%</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
</tr>
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The correctly recognized cases were assumed to be those in which the decision about the possible intervention was made after at most a few hours’ observation and in which the recognition was confirmed by the histopathological investigation. Operated cases were recognised to be falsely positive when histopathological investigation confirmed appendicitis or patients were hospitalized above 24 hours and were disqualified from the operation. The falsely negative patients were disqualified from the intervention initially but after hospital observation lasting above 24 hour were operated on with the histopathological confirmation of App. For both diagnostic methods, the percentages of the correct and false recognitions (total positive and negative) were compared.

Statistical method

For marking the percentage of correct recognitions for appointed investigative groups, the hierarchic beta-binominative model was applied:

\[ p \sim \text{beta}(a, b) \]
\[ r \sim \text{binominative}(p, n) \]

were \( p \) is the probability of the proportional part of ill patients \( r \) in the total population studied \( n \), where, with the simultaneous foundation of schedule a priori beta, about the definite parameters of the schedule \( a \) and \( b \) (8). The calculations were conducted in the packet BUGS (9).

The results of the proportion of correct recognitions with the use of criteria comprised in the range of the scale ALVARADO \([p(1)]\) and ALVARADO + the US \([p(2)]\) are introduced in tab. 2. The statistical analysis of the probability shows a statistical significance among the appointed average near \( p<0.01 \).

DISCUSSION

In the diagnosis of App, physical investigation plays a role along with the biochemical investigations. During the examination, the data from the interview are evaluated – nausea, vomiting, the migration of the pain to the right hip plate, the abdominal symptoms (Blumberg symptom, muscular defense), and the temperature of the body. In laboratory investigations, data suggesting the response of the organism in terms of inflammation are first of all taken into consideration, such as the increased level of leukocytosis and the enlarged percentage of granulocytosis in the smear of the blood. In order to standardise these findings, the results of these studies were organised according to different punctual scales. The ALVARADO scale was used in the present work.

According to the standards of the scale, the patients in the section between 4 and 6 points require observation, and this is defined as not considerably characteristic. Among the above mentioned examinations and symptoms, it is the combination of laboratory investigations and the physical examination that offers the highest distributive efficiency (10). In most cases in the group studied, the section appointed according to the scale is related directly to the intuitions of the examining surgeon. The data described in the literature on the subject demonstrate that the percentage of appendectomies of the App without inflammation of the Appendix in the classic diagnosis is 5.2% to 42.2% (falsely positive recognitions) (10). It is suggested that the patients should be subjected to several hours of observation, which is to reduce the percentage of unnecessarily performed appendectomies (11).

Ultrasonography has been mentioned as the most efficient method in the diagnosis of App. This is related to the accessibility and comparatively low cost of the investigation. The basic advantage of this method of examining is the very high sensitivity and high accuracy. The basic ultrasonographic feature of App is the exposure of a channel structure devoid of peristaltic movements, with the diameter above 6 mm staying in the contact with the caecum. (fig. 1 and 2). Such a picture is 100% sensitive and 64% accurate (12).

On the basis of the independent investigation of US, therefore, one can exclude appen-

<table>
<thead>
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<th>Table 2. The percentage of tight diagnosis results</th>
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<tr>
<td>-------------------</td>
</tr>
<tr>
<td>( p(1) )</td>
</tr>
<tr>
<td>( p(2) )</td>
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</table>
appendicitis when the diameter of the appendix is smaller than 6 mm. One cannot confirm, however, the inflammation with the diameters exceeding that border value. There are, for example appendices with diameters up to 14 mm without the inflammatory state. Demonstrating the stool is a factor raising the accuracy of the investigation considerably. Another factor is the shape of the appendix in section. The recognition of the round shape is 100% sensitive and 37% accurate (13). The latter factor, however, was not taken into account during this study because of the difficulty in demonstrating the appendix in its whole length in persons with excessively developed fat tissue. The inflammatory reaction of the tissue near the appendix and the vasculature of the appendix walls was estimated in the vermiform appendix border diameters of 5-7 mm (14). In these cases the investigation of the vasculature allowed the confirmation of the radiological state of App.

With the use of the classic diagnostics in the study conducted, 36.7% of the patients were diagnosed mistakenly. These results are worse than those referred to in the literature on the subject. This is a result of:

- the elimination from the study of the patients with evident features of appendicitis in section (7-10) in the ALVARADO scale
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– admitting that the patients unnecessarily hospitalized above 24 hours have been mistakenly diagnosed

Having compared the diagnostic methods described, it is affirmed statistically that there is a variably higher percentage of correct recognitions in the case of the use of combined diagnostic methods in comparison with the use of classic diagnostics (86.2% vs 62.8% p<0.01).

CONCLUSION

Ultrasonography, as the investigation supplementary to the classic diagnostics, increases the percentage of the correct recognitions in adult patients with the suspicion of appendicitis with symptoms of the so-called “grey zone” scoring 4-6 pt in the ALVARADO scale.

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Received: 6.06.2007 r.
Adress correspondence: 45-372 Opole, ul. Katowicka 53

COMMENTARY

Acute appendicitis was first described in 1886 by the pathologist R. Fitz. One year later, T.G. Morton excised a perforated appendix (1). Acute appendicitis is diagnosed in 1.5-1.9/1000 subjects, appendectomy being one of the most common procedures performed during emergency surgical shifts. More than 100-years of clinical experience had no influence on the existence of erroneous diagnosis concerning acute appendicitis. Classical diagnostics of acute appendicitis are based on the history and physical examination and are supplemented by laboratory results and clinical patient observation. An atypical clinical picture is often connected with an increased percentage of misdiagnosis. The accuracy of the clinical diagnosis ranges between 25-90%, and misdiagnosis is observed in 9-40% of cases (2, 3). On the other hand, the delayed decision concerning surgical intervention is associated with the risk of perforation, as well as other complications (2).

In order to improve results, objectivization of symptoms and results through the introduction of scales facilitating the clinical evaluation has been proposed, supplemented by additional imaging examinations such as CT and ultrasonography. One such scale - the ALVARADO scoring system - is supposed to facilitate the de-
cision concerning diagnostics and therapy. Its value increases in association with ultrasonography, especially in the cases of patients with a “medium number of points” (3, 4). Unfortunately, the Authors did not distinguish the gender of investigated patients and mentioned no other clinical diagnoses, such as adnexitis. Another question concerns the meaning of a negative histological examination.

One should consider the acceptance of novel diagnostic methods by the surgical society. Sarkaria and co-authors demonstrated that 62.2% of surgeons saw the need for CT in the diagnosis of appendicitis, although only 36% would consider CTA (computed tomography appendicular) in the diagnostic algorithm of acute appendicitis (2). One should not forget about ultrasonography as an additional examination improving proper diagnosis results.

Surgeons have a skeptical attitude towards supplemental examinations, finding the surgical examination and patient observation most valuable. However, young surgeons should have the potential to become more objective in their diagnosis, on the basis of additional imaging examinations.

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COMMENTARY

The presented study is one more dissertation concerning the value and usefulness of ultrasonography in the diagnostics of appendicitis, considering the adult population.

Of the diagnostics of appendicitis in children, ultrasonography has been proven highly useful, both in the confirmation and exclusion of the above-mentioned disease entity.

In the case of adults, where the anatomical conditions for the penetration of ultrasonic waves are worse, different opinions exist concerning the usefulness of ultrasonography, especially in the exclusion of appendicitis.

Most doubts concerning the decision whether to perform surgery arise in case of non-specific clinical symptoms of appendicitis.

The commented study is an important contribution to the role and value of ultrasonography in the increased percentage of proper appendicitis case diagnoses. This important and practical observation has one reservation. The ultrasound examination is only an additional examination, not a decisive one.

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