Sonographical diagnosis and assessment of *Oesophagostomum bifurcum* induced colonic pathology: intra- and inter-observer variation studies


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ABSTRACT

To estimate the reliability of ultrasound for the detection of colonic wall pathology induced by the intestinal parasitic helminth O. bifurcum, three studies to assess the intra- and inter-observer variation of the technique were performed. In the endemic area of northern Ghana, 181 people from a low prevalence village and 62 people from a high prevalence village were examined twice by the same observer, and 111 people were independently investigated by two observers in a moderately endemic village.

Kappa for the prevalence observations in the three studies were 0.82, 0.87 and 0.81 respectively, and kappa for the intensity observations were 0.66, 0.63 and 0.71 respectively. The upper 95% confidence intervals of the average absolute difference in nodule size measurements in studies 1 and 3 were 3.6 mm and 4.5 mm. Ultrasound has a promising future for the diagnosis and management of O. bifurcum colonic pathology.
INTRODUCTION

Oesophagostomum bifurcum, an intestinal parasitic helminth, is highly and focally endemic in northern Ghana and Togo. An estimated 250,000 people are infected \(^{47-49}\), and village infection prevalence detected by stool culture varies between 0% and 79%.

The juvenile worms develop within the colonic wall, causing inflammatory lesions. The lesions contain thick yellow pus and a white, living oesophagostomum worm of approximately 11 mm in length \(^{152}\). Patients present with the ‘Dapaong tumour’, a painful abdominal mass, 30 - 60 mm in diameter, which is frequently adherent to the abdominal wall. Peritonitis secondary to nodule rupture, bowel obstruction secondary to inflammatory adhesions, and the formation of cutaneous abscesses and fistulas can result \(^{15,62,65}\). Multinodular oesophagostomiasis presents with diffuse abdominal pain, severe weight loss, and persistent diarrhoea. Hundreds of pea-sized nodules are found in a thickened oedematous submucosa and subserosa of the large intestine \(^{81,84,88}\). The colon gives a characteristic nodular ‘target’ appearance by ultrasound \(^{151}\). Preclinical colonic pathology can also be identified by ultrasound (Chapters 5 & 6). The characteristic nodular anechogenic lesions are a common finding in endemic villages, and have been shown to contain O. bifurcum juveniles. Detection of the colonic pathology before the development of symptoms is therefore now possible. Estimations of the sensitivity and specificity of the ultrasound diagnosis of O. bifurcum pathology cannot be made, because as soon as the ultrasound appearance of the pathology was described \(^{151,152}\), surgical diagnosis and management were superceded by conservative chemotherapeutic treatment using ultrasound to monitor colonic recovery \(^{151,152}\).

Sonography can be considerably handicapped by observer bias, irrespective of criteria previously agreed upon. Subjectivity is an inherent characteristic of the method, not only in the realtime appraisal of the findings, but also in the decision as to which view to represent photographically. An estimation of the diagnostic reliability of ultrasound is needed before it can be used to assess potential human disease.

This report evaluates the degree that inter- and intra-observer variation influences the diagnosis and assessment of O. bifurcum induced colonic pathology.
METHODS

Three village ultrasound studies were conducted within the endemic area of *O. bifurcum* in northern Ghana. Two of the studies were to evaluate the consistency of consecutive abdominal ultrasound observations for *O. bifurcum* pathology made by one observer (intra-observer variation), and the third study assessed the consensus between the ultrasound observations made by two observers (inter-observer variation). People were admitted into the study on a voluntary random basis after being fully informed of the purpose and nature of the tests, and they were treated for any minor illnesses.

A Siemens LX portable ultrasound machine with a 5 MHz linear array transducer was used to examine the colon for the characteristic anechogenic lesions. Observed nodules were counted and their largest diameter measured. The nodules were allocated to a section of the colon and a skin-surface abdominal sector. The second observations were made blind to the results of the first.

In the first study, two abdominal ultrasound tests were performed by the same observer (P.S.) on 181 people during the dry season of 1998. The examinations were completed within 28 days. In the second study, a group of 62 people was also examined twice by the same investigator (P.S.) on consecutive days during the late rainy season of 1998. Only the number of nodules were recorded in the second study.

In the third study, two investigators (P.S. and N.S.) performed abdominal ultrasonography on 111 people during the mid rainy season of 1998. The people were organized into groups of five and examined in turn by the two observers, both of whom have two years of field experience in *oesophagostomum* ultrasound. The individuals given a different diagnosis were later examined with both observers present.

**Statistical analysis**

The strength of agreement between the two sets of observations was determined using kappa statistics. Kappa was calculated in all three studies for the prevalence and number of nodules observed. A value of 1 indicates perfect concordance between the observations.

In the first and third studies on individuals given a diagnosis of one nodule in both tests, a Spearman's rank correlation test was used to calculate concordance in nodule size, and the Wilcoxon's signed rank test was used to analyse the difference in size measurements.
Observer variation

Figure 1a. Study 1: Number of nodules per person in two consecutive ultrasound tests by one observer.

Figure 1b. Study 2: Number of nodules per person (>5 grouped) in two consecutive ultrasound tests by one observer.

Figure 2. Study 3: Number of nodules per person by two ultrasound observers.

The average absolute difference in the nodule diameter measurements and its 95% confidence interval were calculated. The variance of nodule position allocation is expressed. The selection of individuals with one nodule was made in order to ensure that the same nodule is being compared.

RESULTS

The approximate prevalence of ultrasound visible pathology varied between the three communities studied, 20%, 60%, and 30% respectively, and the intensity followed the same trend. The number of nodules as recorded in both observations during the three studies are compared in Figures 1a, 1b and 2. The numbers in the diagonal boxes indicate perfect agreements.
between the two observations.

The value of kappa for a positive or negative diagnosis of *O. bifurcum* colonic pathology (prevalence) was 0.82, 0.87 and 0.81 in the three studies respectively. Analysis of the total number of nodules recorded per person (intensity of pathology) gave values for kappa of 0.66, 0.63 and 0.71 respectively. In Study 3, the nine individuals given a different diagnosis were later examined with both observers present. The differences in diagnosis were attributed to two distinct reasons. An ‘observer error’ had been made in seven individuals, resulting in a nodule being seen by one of the observers but missed by the other. Interpretation errors were made in the other two individuals, the same feature being observed but a different diagnosis given: a fluid collection in the angle between the psoas and the iliacus bone as opposed to an oesophagostomum nodule in the caecum.

![Figure 3: Measurement variation in Study 1. Line indicates perfect agreements.](image)

![Figure 4: Measurement variation in Study 3. Line indicates perfect agreements.](image)

The individuals diagnosed as having one nodule in both observations (Study 1: n = 16, Study 3: n = 17) were selected to analyze the uniformity of nodule diameter measurement and the reliability of position allocation. Figures 3 and 4 illustrate the measurement variation, the line indicating the position of perfect agreements. The nodule sizes observed showed a significant correlation, both in Study 1 (rho=0.96) and Study 3
Observer variation

(rho=0.95). The nodule sizes were comparable in the two sets of observations in Study 1, but in Study 3, the average size measured by observer 2 was significantly lower as compared with observer 1 (p = 0.03). Three and four nodules were given the same sizes in Study 1 and 3 respectively. The average absolute difference in diameter measurement between the two observations was 2.6 mm (Study 1) and 3.3 mm (Study 3), showing a maximum difference of 6 mm and 7 mm respectively, and the upper 95% confidence intervals are 3.6 mm and 4.5 mm respectively.

In Studies 1 and 3, nodules were allocated to a different section of the colon in 25% (four) and 12% (two) of the observations, and to a different skin-surface sector of the abdomen in 44% (seven) and 47% (eight) of the observations respectively.

DISCUSSION

To analyze the usefulness of ultrasound for the diagnosis and assessment of *O. bifurcum* induced colonic pathology, these inter- and intra-observer variation studies were evaluated. There is a modest degree of variation seen in all 3 studies. The degree of consistency between the observations is aided by the clear characteristic appearance of the nodules by ultrasound: anechogenic ovoid lesions within an echogenic colon (Chapters 5 & 6).

The prevalence variation in all three studies is negligible, and this is the most important factor in analysis of potential *O. bifurcum* induced disease: a positive or negative diagnosis. However, exclusion diagnosis within an air filled organ is optimistic.

The pathology was hard to quantify when multiple nodules were present. This difficulty is clearly outlined by the ‘moderate’ agreement in number of nodules in Study 2, performed in a village with a high intensity of pathology. However, the usefulness in clinical practice of being able to differentiate between a person having five or six nodules is negligible.

During post-treatment monitoring of patients, the measurement accuracy (with our machine) of 4 - 5 mm should be considered. Ultrasound has a lower resolution for diameter measurement compared with depth measurement, and flattening of the nodules occurred as pressure was applied to the abdomen to maintain a good skin-transducer contact. Certainty in the allocation of a nodule to a definitive section of colon was ambitious, given the normal diversity of colon length and position, and it was particularly
difficult when nodules were at the hepatic and splenic flexures. The variability of the skin surface relations of the colon is large, and the borders of the abdominal sectors are not definitive to within a few millimeters. Precise localisation of pathology in preparation for surgical intervention would be difficult in some cases.

Observer errors are inevitable, regardless of the resolution of the ultrasound machine. Seven out of the nine differences in diagnosis made by the two observers in Study 3 were errors of this kind. Diagnosis, quantification, dimension characterization, colon section allocation and image differentiation would be improved with high resolution equipment.

The minor degree of variation shown in this study for the essential aspects of the sonographical identification and assessment of *O. bifurcum* related colonic pathology suggests that it is reliable as a diagnostic test. We feel confident therefore that ultrasound can significantly contribute to the diagnosis of oesophagostomiasis in the northern Ghana, especially since all Regional Hospitals have recently been equipped with high quality equipment and local personnel have been trained.

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