Assessment of routine inspection methods for porcine cysticercosis in Zambian village pigs

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Abstract

The value of tongue and meat inspection as diagnostic tools for porcine cysticercosis was assessed in 65 Zambian village pigs by comparing the results with carcass dissections. In addition, the intensity of infections, distribution and viability of cysts in infected pigs were measured. Five pigs (7.7%) were positive on tongue examination, while routine meat inspection showed 12 (18.5%) positives. However, carcass dissections detected cysticerci in 31 (47.7%) pigs. The range in number of cysticerci was 1 to 14,662 per carcass. Cysticerci were distributed throughout the carcass with the highest concentration in the heart, tongue and hind legs. In one animal 13 viable cysts were detected only in the brain. Fourteen pigs had more than 100 viable cysts, six between 2 and 100, and four had single cyst infections. Seven animals harboured only calcified cysts. These findings demonstrate the serious shortcomings of routine detection methods for porcine cysticercosis. While the specificity of tongue palpation and meat inspection was 100%, these tests failed to detect the infection in 83.9% and 61.3% of infected pigs, respectively.

Introduction

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Taenia solium cysticercosis, the pork tapeworm, is a serious livestock and public health problem in many communities in developing countries (Engels et al., 2003; Phiri et al., 2003). In man T. solium causes neurocysticercosis, the greatest cause of acquired epilepsy worldwide (Anon., 1994). Economic losses due to cysticercosis are mainly measured in terms of losses to farmers or families resulting from the loss of or depreciation in infected pig meat, and in terms of the impact of cysticercosis on pig productivity (Engels et al., 2003).

Tongue examination in live pigs and meat inspection of pig carcasses have been the main methods for identifying infected pigs. If carried out correctly (both palpation and visual inspection throughout the base) the specificity of
tongue palpation is close to 100% (Gonzalez et al., 1990; Dorny et al., 2004). The sensitivity of the technique, however, depends very much on the degree of infection in the pig. Although in heavily infected pigs tongue inspection might detect up to 70% of infected pigs, in lightly infected animals the sensitivity is much lower (Gonzalez et al., 1990). Several studies have shown that none of the pigs experimentally or naturally infected harbouring less than 100 cysts could be detected by tongue inspection (Nguekam et al., 2003; Dorny et al., 2004). Meat inspection at slaughterhouses to detect T. solium cysticerci depends largely on visual examination of different sites in the carcass, considered to be predilection sites for the parasite, such as the heart, masseter, tongue and shoulder muscles (Gracey, 1986). However, this selective inspection of muscles during meat inspection, although reported to be specific, is not very sensitive, especially the carcasses of pigs with low cyst burdens (Gonzalez et al., 1990; Scitto et al., 1998; Boa et al., 2002; Dorny et al., 2004).

Although it is accepted that a rather high and variable number of pigs infected with T. solium cysticercosis are not detected by tongue palpation and/or meat inspection, very few studies have been conducted in endemic countries to define the sensitivity and specificity of both methods. Therefore, a study was conducted to assess the presence of cysticercosis if cyst-like nodules were either seen or felt (Gonzalez et al., 1990; Boa et al., 2002; Dorny et al., 2004).

Results

Tongue examination

Tongue inspection was performed before slaughter. Each pig was placed in left recumbence and held by the neck and firmly restrained with the help of three people. The mouth of the pig was opened using a wooden rod and a mutton cloth. The tongue was gently pulled for examination and palpation on the ventral surface, especially the base. Pigs were considered positive for cysticercosis if cyst-like nodules were either seen or felt (Gonzalez et al., 1990).

Routine meat inspection

Immediately following slaughter and opening of the carcass, routine meat inspection was done by a member of the research team, to assess the presence of T. solium cysticerci in predilection sites (i.e. the masseter muscles, triceps brachial muscle, tongue, psoas muscles and heart), according to Boa et al. (2002). In the head two longitudinal incisions were made into the external masseter muscles and one incision into the internal masseter muscles on both sides of the lower jaw and the presence of the cysts noted. The tongue was detached from the head, the surface inspected and a deep longitudinal incision was made on the ventral surface, covering the entire length of the tongue, and examined. After visual inspection, the heart was incised into both ventricles and septum followed by visual inspection. Three deep incisions were made through the triceps muscles into the shoulder and the incised surface inspected. Both psoas muscles were incised longitudinally and examined for the presence of cysticerci.

Carcass dissection and cyst counts and viability assessment

The muscle groups were excised from the half carcasses together with the complete heart, tongue, head and neck muscles, psoas muscles, diaphragm, lungs, kidneys, liver, brains and eyes. Slicing was done in such a way that all fully developed cysts could be revealed and enumerated (i.e. each slice was less than 0.5 cm thick). The total number of cysticerci for those muscle groups where cysts were only counted in half of the carcasses was calculated by multiplying the detected unilateral number by two. Additionally, cysticerci were macroscopically classified as either viable or calcified according to their macroscopic appearance. Viable cysticerci had well-limited thin-walled cystic structures containing clear vesicular fluid and a visible whitish protoscolex. Calcified cysticerci were non-cystic but rather had semi-solid caseous masses with no discernible parasite structures. All doubtful cases were considered negative.

Statistical analysis

The Pearson’s chi-square (Fisher’s exact test and Yates corrected chi-square test) was used to determine the associations of origin of pigs on the prevalence of cysticercosis. Cysticerci medians of viable and calcified cysts from the Southern and Eastern provinces were compared using the Mann-Whitney U test. The SPSS (Version 11) and Epi-info 2002 software were used for statistical analyses.

Results

Number of infected animals according to the parasitological tests

Taenia solium cysticerci were found in 5 (7.7%) pigs at tongue examination, in 12 (18.5%) pigs after routine meat inspection and in 31 (45.7%) pigs after total carcass dissection of the 65 pigs examined (table 1). Tongue examination was unable to detect any infected pigs in the

Materials and methods

The study was conducted between April 2002 and March 2003. Pigs were randomly purchased from the Chibolya small livestock association market in Lusaka (n = 30) where mostly pigs from the Southern province are sold, and from villages in the Katete and Petauke districts in the Eastern Province (n = 35). The estimated ages of pigs ranged from one to five years covering both sexes. All the pigs from the Lusaka market were crosses of Large white and Landrace breeds. Pigs from the Eastern province were all of a smaller local breed.

Tongue examination

Tongue inspection was performed before slaughter. Each pig was placed in left recumbence and held by the neck and firmly restrained with the help of three people. The mouth of the pig was opened using a wooden rod and a mutton cloth. The tongue was gently pulled for examination and palpation on the ventral surface, especially the base. Pigs were considered positive for cysticercosis if cyst-like nodules were either seen or felt (Gonzalez et al., 1990).
Table 1. The prevalence (%) of cysticercosis in 65 pigs from the Southern (n = 30) and Eastern (n = 35) provinces of Zambia assessed by tongue examination, meat inspection and carcass dissection.

<table>
<thead>
<tr>
<th>Province</th>
<th>Tongue palpation (%)</th>
<th>Meat inspection (%)</th>
<th>Dissection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>0 (0)</td>
<td>2 (5.7)</td>
<td>17 (48.6)</td>
</tr>
<tr>
<td>Southern</td>
<td>5 (16.7)</td>
<td>10 (33.3)</td>
<td>14 (46.7)</td>
</tr>
<tr>
<td>Total</td>
<td>5 (7.7)</td>
<td>12 (18.5)</td>
<td>31 (47.7)</td>
</tr>
</tbody>
</table>

Eastern province but detected 16.7% of infected pigs from the Southern province (table 1). The prevalence of *T. solium* cysticerci in pigs from the Southern province was significantly higher than that in the Eastern province after tongue examination ($\chi^2 = 6.22$, $P = 0.01$) and meat inspection ($\chi^2 = 6.45$, $P = 0.01$), but there was no difference when the infection was measured by carcass dissection (table 1). After carcass dissection, cysticerci were found distributed throughout the carcass. The numbers of cysts were highly variable among the organs and muscle groups. Cysts were found in shoulder muscles (20 pigs), the tongue (18 pigs), heart (16 pigs), psoas muscles (16 pigs) and masseter muscles (14 pigs). Recovery of cysts from the so-called predilection sites was not different when compared to their presence in non- (routinely) inspected muscles and organs.

**Discussion**

An important issue raised by this work is the failure of long-established and considered reliable parasitological diagnostic procedures for pig cysticercosis. While the specificity of tongue palpation and meat inspection in this study was 100%, these tests were unable to exclude *T. solium* infected pork from the food chain since they failed to detect infections in 83.9% and 61.3% of infected animals, respectively. Thus, the two commonly used methods are unsuitable for use in epidemiological surveys and cannot be applied to monitor control programmes of *T. solium*. The low sensitivity of these parasitological tests was also demonstrated using a Bayesian analysis on a dataset of Zambian village pigs (Dorny *et al.*, 2004), which estimated the sensitivity of tongue inspection and routine meat inspection at 21% and 22%, respectively. Light infections especially were not detected by tongue palpation and carcass inspection.

The number of parasites harvested by each of the 17 infected pigs from the Eastern province indicated that most animals (82%) harboured less than ten parasites. In six pigs only calcified cysts were found. In contrast, 11 (76.6%) of the 14 infected pigs from the Southern province had more than 100 cysts, and in all but one infected animal viable cysts were found. The number of pigs examined in the present study is too small to speculate on these differences, but it may be interesting to investigate whether pig breeds display different susceptibilities to cysticercosis. In the Eastern province a small local breed is reared while in the Southern province larger improved breeds are kept. Differences in intensity of infection may also reflect a distinct epidemiological situation: In the Eastern province villages are larger with more breeds are kept. Differences in intensity of infection may also reflect a distinct epidemiological situation: In the Eastern province villages are larger with more

Table 2. The number of cysts in 31 pigs from the Eastern (n = 17) and Southern (n = 14) provinces of Zambia assessed by carcass dissection.

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of cysts per carcass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1–50 (%)</td>
</tr>
<tr>
<td>Eastern</td>
<td>13 (76.47)</td>
</tr>
<tr>
<td>Southern</td>
<td>2 (14.28)</td>
</tr>
<tr>
<td>Total</td>
<td>15 (48.39)</td>
</tr>
</tbody>
</table>

Table 3. Viability of cysticerci found in pigs from the Eastern and Southern provinces of Zambia.

<table>
<thead>
<tr>
<th>Province</th>
<th>Status of cyst</th>
<th>Infected pigs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>Only viable</td>
<td>3 (8.6)</td>
</tr>
<tr>
<td></td>
<td>Viable and calcified</td>
<td>8 (25.8)</td>
</tr>
<tr>
<td></td>
<td>Only calcified</td>
<td>6 (17.1)</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>17 (48.6)</td>
</tr>
<tr>
<td>Southern</td>
<td>Only viable</td>
<td>7 (23.3)</td>
</tr>
<tr>
<td></td>
<td>Viable and calcified</td>
<td>6 (19.3)</td>
</tr>
<tr>
<td></td>
<td>Only calcified</td>
<td>1 (3.3)</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>14 (46.7)</td>
</tr>
<tr>
<td>Total positive</td>
<td>All</td>
<td>31 (47.7)</td>
</tr>
</tbody>
</table>

Discussion

From a total of 31 pigs found positive at carcass dissection, ten pigs harboured only viable cysticerci, 14 pigs had both viable and calcified cysticerci and seven pigs had only calcified cysts. Six of these seven pigs with only calcified cysts were from the Eastern province (table 3).
inhabitants and the number of pigs reared is much higher than in the Southern province.

Cysticerci were recovered from the heart, tongue, internal masseter, external masseter, triceps brachii, diaphragm, brain, head muscles, psoas and muscles of the forelimbs, hind limbs, head, oesophagus, trunk and abdomen. Cysts were not recovered from the kidneys, livers, spleen and lungs. Similar findings were reported from Nigeria by Onah & Chiejina (1995) and Boa et al. (2002) in Tanzania.

The existence of light infections in Zambian village pigs together with the low sensitivity of currently used parasitological techniques may result in a serious underestimation of the true prevalence of the infection. Therefore, to control the parasite effectively in endemic areas more sensitive and specific diagnostic methods should be used, such as immunodiagnostic tools (Dorny et al., 2004).

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References


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