The value of ultrasonography in boys with a non-palpable testis

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ABSTRACT

Background
In patients with a non-palpable testis (NPT) on physical examination the testis is assumed to be either situated intra-abdominally, or to be hypoplastic or absent. Diagnostic laparoscopy in these boys is considered the preferable first step. In this study the diagnostic value of pre-operative ultrasound for NPT is assessed in comparison with laparoscopy.

Methods
All boys aged under the age of 17 years who were diagnosed with a NPT by a pediatric surgeon from 2000 till 2012, were evaluated. All patients of whom clinical, ultrasonographic and operative findings were available were included.

Results
Ninety-six boys with 117 NPT were included. With ultrasound 67 testes were detected in the inguinal canal, which was confirmed peroperatively for 61 testes. Of the 15 testes with an intra-abdominal position on ultrasound 10 were found intra-abdominally during surgery. The positive predictive value of the ultrasonography for inguinal located testes is 91% and for intra-abdominal located testes 67%.

Conclusion
Ultrasonography shows to have a high positive predictive value for inguinal located testes. When ultrasound finds a testis to be in an inguinal location, a primary inguinal exploration could be considered, preventing an unnecessary diagnostic laparoscopy.
INTRODUCTION

At the age of 1 year, 1% of full-term boys are diagnosed with non-scrotal testis.\textsuperscript{1,2} Twenty per cent of the non-scrotal testes is not palpable.\textsuperscript{3} A non-palpable testis (NPT) can be either situated in the abdomen or inguinal canal or it can be atrophic or absent due to vascular defects or incidents during testicular descent.\textsuperscript{2} The need of operative exploration of NPT is well-accepted \textsuperscript{4}, but whether a laparoscopy or inguinal exploration is the best approach is a matter of debate.\textsuperscript{5,6,7} Some authors describe the great diagnostic value of physical examination by a pediatric surgeon and recommend a laparoscopy as the first choice of management.\textsuperscript{8,9} However, studies show that although an NPT was diagnosed by a pediatric surgeon an inguinal testis was found in 21 - 85% of the patients during operation.\textsuperscript{3} Previous studies have shown that of many available imaging methods, ultrasound seems to be the best suited to localize non-palpable testes as it is non-invasive, harmless and it has an excellent spatial resolution for superficial organs such as testes.\textsuperscript{1,3,10} This study aims to evaluate the value of ultrasonography in children with NPT to localize the testis.

METHODS

Study population

All boys under the age of 17 years who were diagnosed with an NPT by a pediatric surgeon from January 2000 till May 2012, were evaluated. Patients of whom clinical, ultrasonographic and operative findings were available, were included. Patients were excluded when repeated physical examination at the outpatients clinic or physical examination under anesthesia revealed a palpable testis.

Testicular ultrasound

Ultrasound of the scrotum, inguinal region and/or abdomen was performed by a (pediatric) radiologist or by a radiology resident under supervision of a pediatric radiologist using either an Acuson Sequoia, Aloka Alpha-10 or F75, Siemens Elegra, Philips IU22 or Philips HD15. Testis position was described as being abdominal, inguinal, scrotal, ectopic or not visualized.
Chapter one

Operation
During laparoscopy or inguinal exploration the testis was identified and considered normal, a nubbin (residual testicular tissue due to vascular accident during embryologic development) or absent. In further analysis nubbins were considered as normal testes as they share the same possible locations. Testis position was asserted as being abdominal, inguinal or scrotal.

Statistical analysis
All data were managed and analyzed using IBM SPSS 19.0 (Armonk, NY: IBM Corp.). Operative testis position was compared with ultrasound findings using crosstabs. Ultrasonography outcome was considered true-positive (TP) if the testis was present and ultrasonographic result matched peroperative finding. Ultrasonography outcome was considered true-negative (TN) if both ultrasound and surgery did not localize a testis.
A false-positive (FP) ultrasound was concluded if a testis was detected during ultrasonography, but was situated elsewhere during surgery. Ultrasound outcome was considered false-negative (FN) if a testis was not detected during ultrasonography, but was found during surgery. Positive and negative predictive values (PPV, NPV), sensitivity and specificity were calculated per possible finding on ultrasound.

RESULTS

Study population
Ninety-six boys with 75 unilateral and 21 bilateral NPT, in total 117 NPT, were included. The mean age at ultrasound was 3.5 ± 3.7 years (range 0 months to 14.8 years) and at surgery 4.0 ± 3.8 years (range 1 month to 14.9 years). 44/96 (45.8%) boys had only an inguinal exploration whereas 52/96 (54.2%) of the boys underwent a laparoscopy first.

Ultrasonographical findings
Testicular ultrasounds were performed by a pediatric radiologist in 101 cases. In 6 cases, a resident performed the ultrasound under supervision of a pediatric radiologist. In 10 cases, a general radiologist performed the ultrasound. Ultrasonography was able to locate 85/117 (73%) of the NPT. 15 (13%) NPT were found intra-abdominally, 67
(57%) inguinally and one was found in the scrotum. In two cases (2%) the NPT was found outside of the normal descending tract (ectopic).

**Operative findings**

During operation, 21/117 (18%) of the testes were located in the abdomen, while 78 (67%) were situated in the inguinal canal. Three (3%) NPT appeared to be scrotal. 15 (13%) NPT were absent.

**Diagnostic performance of ultrasound**

Table 1 shows the relation between the testicular position found by ultrasound and the peroperative testicular position. On ultrasound 67 testes were detected in the inguinal canal. Peroperatively, this was confirmed for 61 testes. Of the 6 testes wrongly localised in the inguinal canal by ultrasound, 3 were actually situated in the scrotum and 3 in the abdomen. Ultrasound localized 15 testes in the abdomen. Of these, 10 were found intra-abdominally and 5 were found in the inguinal canal during surgery.

Table 2 shows the PPV, NPV, sensitivity and specificity per ultrasonographic finding. The positive predictive value for an abdominal-localized testis is 66%, and its sensitivity was 48%. For the inguinal-localized testis, a positive predictive value of 91% was found and its sensitivity was 78%.

Table 1  Ultrasonographical versus peroperative testis position in a cohort of 117 NPT.

<table>
<thead>
<tr>
<th>Position at ultrasound</th>
<th>Abdominal</th>
<th>Inguinal</th>
<th>Scrotal</th>
<th>No testis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Inguinal</td>
<td>3</td>
<td>61</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Scrotal</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ectopic</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Not visualized</td>
<td>8</td>
<td>9</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

| Total                  | 21        | 78       | 3       | 15        | 117 |
**Table 2** The positive predictive value (PPV), negative predictive value (NPV), sensitivity and specificity of ultrasound in localizing the NPT, measured per ultrasonographic finding.

<table>
<thead>
<tr>
<th></th>
<th>PPV</th>
<th>NPV</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal Testis</td>
<td>67%</td>
<td>89%</td>
<td>48%</td>
<td>95%</td>
</tr>
<tr>
<td>Inguinal Testis</td>
<td>91%</td>
<td>66%</td>
<td>78%</td>
<td>85%</td>
</tr>
<tr>
<td>Not visualized</td>
<td>47%</td>
<td>100%</td>
<td>100%</td>
<td>83%</td>
</tr>
</tbody>
</table>

PPV: TP/ (TP + FP), NPV: TN/ (TN + FN), sensitivity: TP/ (TP + FN), specificity: TN/ (TN + FP)

**DISCUSSION**

In this study we found that 61 of the 67 NPT that were located inguinally on ultrasound were indeed situated in the inguinal canal, corresponding with a PPV of 91%. The PPV of the not visualized testis on ultrasound was 47%.

Our findings are comparable with the results of Nijs et al. They report respectively a PPV of 97% and 67% when a testis was located inguinally and not visualized on ultrasound. In addition, they found an equal sensitivity of the abdominally located NPT of 48%.

Tasian et al reviewed all literature of diagnostic performance of ultrasound in NPT and calculated the composite sensitivity (45%) and specificity (78%) of the ultrasound. Then they focused on the pretest probability (55%) and posttest probability that an NPT was within the abdomen, which was 64 and 49% after a positive and negative ultrasound respectively. With this, they concluded that whatever the results of the ultrasound is, a surgical exploration of the NPT is needed and so, the ultrasound does not contribute to the preoperative workup of the NPT. A conclusion which we can agree with, on the basis of a PPV of 48% of the not visualized NPT we found.

However, Tasian et al also found a 97% ultrasound detection (sensitivity) of the inguinal NPT. As mentioned, we found a PPV of 91% of this inguinal located NPT and we believe a pre-operative ultrasound can be of value in assessing this NPT in the inguinal canal. In clinical practice, we propose to perform an inguinal exploration, not a laparoscopy when the pre-operative ultrasound localizes the NPT in the inguinal canal. This means that boys may be spared an unnecessary laparoscopy of which the complication rate is 1.2 - 4.7% and which harbours the risk of long-term intra-abdominal adhesions.
The limitations of this study need to be addressed. We analysed nubbins as normal testes. However, nubbins are more difficult to localise with physical examination and ultrasonography than normal testes. This might have resulted in more false-negative ultrasounds in our study population. Furthermore, although our guideline recommends a laparoscopy for non-palpable testes, in our study population, all with NPT, some patients underwent an inguinal exploration primarily. It is not unthinkable that the surgeon’s approach was influenced by the ultrasonographic results. However, the chosen surgical approach has not been of any influence on the results of our study, being the value of the pre-operative ultrasound of NPT. At last, it is important to mention that the position of the testis can be dynamic. This is seen in the so-called “peeping testis” in which the position may change from inguinal to low-abdominal. A retractile testis can also change position. A dynamic position may result in different ultrasonography and operative outcomes.

The standard approach in NPT is considered diagnostic laparoscopy. Our study shows that ultrasonography can confirm an inguinally situated testis with a positive predictive value of 91%. When the standard approach in these patients would be inguinal exploration, unnecessary laparoscopy can be avoided in 9 out of 10 cases.

CONCLUSION

The results of our study show that ultrasound can reliably confirm an inguinal testis in boys with NPT. We therefore advise ultrasonography for all boys with NPT. If ultrasound establishes an inguinal testis, an inguinal exploration should be performed. When ultrasound does not show an inguinal testis, diagnostic laparoscopy should be the preferential first step during the surgical procedure. Our suggested work-up in boys referred with NPT is visualized in Figure 1.
**Figure 1** Algorithm for boys referred with non-palpable testes.
References

1 Christensen JD, Dogra VS. The undescended testis. Semin Ultrasound CT MR. 2007;28:307-16.