Testing the undescended testis

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Long-term testicular position and growth of acquired undescended testis after prepubertal orchidopexy

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ABSTRACT

Purpose
To determine long-term testicular position and growth of acquired undescended testes after prepubertal orchidopexy.

Methods
Patients who had undergone prepubertal orchidopexy for acquired undescended testis at our hospital between 1986 and 1999 were recruited to assess long-term testicular position and volume. Testis position was assessed by physical examination. Testis volume was measured with Prader orchidometry and ultrasound, and was compared with normative values reported in the literature.

Results
A total of 105 patients (aged 14.0 - 31.6 years) were included with 137 acquired UDT (32 bilateral, 33 left-sided, 40 right-sided). All but one of the orchidopexied testes (99.3%) were in low scrotal position. The mean volume of the orchidopexied testes in unilateral UDT (n=73; 10.57 ± 3.74 ml) differed significantly from the size of the testes at the contralateral side (14.11 ± 4.23 ml) (p = 0.000). The operated testes (10.28 ± 3.45 ml) were smaller than the mean adult testis volume reported in the literature (13.4 - 13.6 ml; cut-off 13.2 ml).

Conclusion
Testis position after prepubertal orchidopexy for acquired undescended testis was nearly always low scrotal. The volume of the orchidopexied testes was smaller than both the volume of the contralateral testes and the normative values reported in the literature.
INTRODUCTION

Undescended testis (UDT) is a common genital abnormality in boys, which is categorized into congenital and acquired forms.1,2 For congenital UDT, orchidopexy is advised between 6 and 12 months of age.3 By contrast, it is still under debate as to what the best management of acquired UDT is. Some authors recommend surgery at diagnosis, as this would reduce the risk of subsequent infertility.2,4 Still, no long-term follow-up data regarding acquired UDT after prepubertal orchidopexy have yet been published. Acquired UDT may also be managed with a conservative attitude; recently, long-term follow-up data regarding this policy have become available.5-8 In this study, we assessed long-term testicular position and growth for acquired UDT after prepubertal orchidopexy. These data may be helpful in determining the best treatment for a boy with acquired UDT.

METHODS

Population

In this study, 335 boys were included who had undergone orchidopexy for acquired UDT at our hospital (1986 – 1999) as detailed in an earlier publication.9 Each patient was requested by post to participate in the long-term evaluation. If no reaction followed, a second letter was sent and if still no reaction occurred, the patient was contacted by telephone. Written informed consent was obtained from the patient and/or his parents.

Patients were included if they had undergone an orchidopexy for acquired UDT in the Medical Centre Alkmaar between 1986 and 1999 before the age of 15 and if written informed consent had been obtained for participation in this study. Therefore, practically all included boys underwent the orchidopexy prepubertal.

Patients were excluded if one or more of the following criteria was present in their medical history: epidydimitis, chromosomal or hormonal abnormalities, hormonal medication, earlier orchidopexy or other inguinal surgery, congenital UDT, presence of a testicular germ cell tumor.
Definitions
A UDT was defined as a testis which could not be manipulated into a stable scrotal position in its most caudal position and further traction on cord structures was painful. It included high scrotal, inguinal or impalpable forms.
An acquired UDT was defined as a UDT for which a previous scrotal position had been documented at least twice.
All orchidopexies were performed in boys under general anesthesia as an outpatient procedure. Orchidopexy was started with an inguinal incision. Subsequently, exploration of the groin took place and, if present, the open processus vaginalis was separated from the cord structures and ligated. Retroperitoneal funiculolysis and separation of the cremaster muscle was performed to mobilize the cord. Finally, the testis was fixated scrotally by a scrotal incision in a created dartos pouch. Surgical findings in these boys have been published previously.10

Design of the study and follow up data
All patients were seen at the outpatient clinic. Their medical history was taken, and physical and ultrasound examination were performed. All patients were examined by the same physician (JG).

History
A special questionnaire was used to determine the patients’ medical history, including previous groin surgery and use of medication. Furthermore, the questionnaire included questions regarding fatherhood or the desire to father a child, as well as how long it took to conceive a child.

Physical examination
Physical examination included assessment of testis position and volume. Testis position was classified as low scrotal, high scrotal, inguinal or non-palpable. Testicular volume was measured with a Prader orchidometer. The orchidometer consists of a chain of 13 numbered beads of increasing size from 1 to 30 ml (1 to 6, 8, 10, 12, 15, 20, 25, 30 ml). The beads are compared with the testicles of the patient and the volume is read off the bead which matches most closely in size. If testes were larger than 30 ml, 35 ml was noted as testicular size.
Testicular ultrasound
After the physical examination, testicular volume was measured ultrasonographically. All ultrasound examinations were performed with the same equipment (Falco Auto Image, Falco Software Co, Tomsk, Russia) with a 12 MHz linear array transducer. To measure the testicular volume, the scanner was placed on the scrotum while exerting light pressure to avoid distorting the testicular shape. Grey-scale images of the testes were obtained in the transverse and longitudinal planes. Three separate transverse and longitudinal images were recorded for each testis. The epididymis was not included in the images. After maximum length, width and height were obtained in the ultrasonogram, these were measured and the volume was calculated with the formula for an ellipsoid = \( \pi/6 \times \text{length} \times \text{width} \times \text{height} \). For each testis, the highest value of the three testicular volumes was taken as volume measurement. Additional findings, such as hydrocele, varicocele and microlithiasis, were recorded. If necessary, the patient was referred for further follow-up.

Statistical analysis
All data were collected and analyzed with SPSS, version 14.0. The independent t-test was used to calculate the differences in age and volume. A p-value of less than 0.05 was considered statistically significant.

Comparison with normal values of testicular volume in adult men
To enable comparison of our testicular volume measurements with normal values of adult testicular volume known in the literature, we performed a PubMed search. The terms we used were ‘normal testicular volume’, with limitations for ‘humans’ and ‘adults’. We scored the abstracts of all results and related citations on country, publication year, selection and size of study cohort, age of population, method of volume measurement and calculation of the testicular volume.

Ethical approval
This study was approved by the Ethical Committee of the Hospital (reference number: NH 02-099).
RESULTS

Study population

From 1986 until 1999, 335 boys underwent prepubertal orchidopexy for acquired undescended testis in our hospital; when requested, 122 of these boys (36.4 %) gave informed consent to participate in this study. Of these 122 boys, 17 were excluded due to recurrent epididymitis (n=1), pubertas tarda and mental retardation (n=1), inguinal hernia surgery (n=10), previous orchidopexy (n=2) and congenital UDT (n=2). One patient (aged 26 years) was diagnosed at follow-up with a testicular germ cell tumor and underwent an operation within one week. Pathological research of the tumor showed a radical resected immature teratoma.

Consequently, 105 patients were included in this study (age at examination 14.0 to 31.6 years, mean 25.7). Of these 105 patients, 32 (30.5%) had undergone bilateral orchidopexy, and the other 73 had undergone unilateral orchidopexy (69.5%; 33 left-, and 40 right-sided). A total of 137 testes were eventually included (Figure 1).

Figure 1  Flowchart of patients (n=335) in whom prepubertal orchidopexy was performed for acquired undescended testis in the period of 1986 - 1999.

ORP = orchidopexy
UDT = undescended testis
Age at orchidopexy

The age range at orchidopexy was 2.4 – 13.9 years (mean ± SD; 9.2 ± 2.8); see Figure 2. 3 of the boys reached the age of 14. It is possible puberty had already set in at the time of orchidopexy in those boys. Of the boys with bilateral UDT (n=32), the age range at orchidopexy was 4.9 – 13.7 years (mean 9.9 ± 2.5) and of the boys with unilateral UDT the age ranged from 2.5 – 13.9 years (mean 8.9 ± 2.9; p = 0.108).

![Figure 2](image.png)

**Figure 2** Age (years) at prepubertal orchidopexy for acquired undescended testis (period 1986 – 1999) of patients (n=105) who were seen for long-term follow-up.
**Age at follow-up**

At follow-up, the age of the patients (n=105) ranged from 14.0 to 31.6 years (mean 25.7 ± 3.3); see Figure 3.

![Figure 3](image)

**Figure 3** Age (years) at follow-up of patients (n=105) in whom prepubertal orchidopexy for acquired undescended testis was performed (period 1986 – 1999).

**History**

Medical history of the boys/adolescents included epilepsy (n=1), circumcision (n=7), psoriasis (n=1), asthma (n=2), bipolar disorder (n=1), appendectomy (n=5), perinatal asphyxia (n=1), eczema (n=2), brain tumor (n=1) and hypertension (n=1). Medication used included corticoids (n=3), inhalation medication for asthma (n=2), antidepressants (n=1), anti-hypertensive drugs (n=1) and depakine (n=1).

**Testis position**

At follow-up, in 136 cases (99.3%) testis position was low scrotal, whereas in 1 case (0.7%) it was inguinal.
Prepubertal orchidopexy for acquired undescended testes

Testis volume

Testicular volume measured by Prader orchidometry
Of the 137 testes, 1 was in inguinal position; as a result, only 136 could be measured by Prader orchidometry. The volume of these 136 testes ranged from 8 to 35 ml (mean 21.13 ± 5.34 ml). The mean volume of the unilateral UDT (n=72) was 21.58 ± 5.51 ml (range 8.0 – 35.0). The mean volume of the bilateral orchidopexied UDT (n=64) was 20.63 ± 5.15 ml (range 8.0 – 28.0). No significant difference in testicular volume was found between unilateral and bilateral orchidopexied acquired UDT (p = 0.298).

In unilateral UDT, the contralateral testis (n=73) had a mean volume of 25.60 ± 4.5 ml (range 12.0 – 35.0). This measurement presents a significant difference with the size of the orchidopexied testis (p < 0.001).

Testicular volume measured by ultrasonography
When measured by ultrasound, the volume of the 137 operated testes ranged from 2.75 to 20.4 ml (mean 10.28 ± 3.45). The mean volume of the unilateral UDT (n=73) was 10.57 ± 3.74 ml (range 3.67 – 19.95). The mean volume of the bilateral orchidopexied UDT (n=64) was 9.95 ± 3.08 ml (range 2.75 – 20.40). No significant difference was found in testicular volume between unilateral and bilateral orchidopexied acquired UDT (p = 0.290).

In unilateral UDT, after orchidopexy the volume of the left testes (n=33) ranged from 3.67 – 18.71 ml (9.83 ± 3.43) and of the right testes (n=40) from 5.19 – 19.95 ml (11.18 ± 3.91) (p = 0.124). There was a significant difference in volume between these orchidopexied testes (n=73) and their contralateral counterparts, which had a mean volume of 14.11 ± 4.23 ml (range 4.90 – 23.87; p < 0.001) (see Table 1).

In unilateral UDT, no correlation was found between the patient’s age at orchidopexy and the volume of the testicles at follow-up. If the age at orchidopexy was <10 years (n=39), the mean testicle volume at follow-up was 10.04 ml ± 3.72; if the age at orchidopexy was ≥10 years, the mean testicle volume at follow-up was 11.18 ± 3.71 (p = 0.195).
Table 1. Mean, standard deviation and range of testicular volume (ml) measured by ultrasound at follow-up per group of men after pre-pubertal orchidopexy for acquired undescended testis and in unilateral cases comparison with its counterpart.

<table>
<thead>
<tr>
<th></th>
<th>n (testes)</th>
<th>testis volume (ml)</th>
<th>mean</th>
<th>SD</th>
<th>min</th>
<th>max</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>all</td>
<td>137</td>
<td>10.28</td>
<td>3.45</td>
<td>2.75</td>
<td>20.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDT unilateral</td>
<td>73</td>
<td>10.57</td>
<td>3.74</td>
<td>3.67</td>
<td>19.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDT bilateral</td>
<td>64</td>
<td>9.95</td>
<td>3.08</td>
<td>2.75</td>
<td>20.40</td>
<td>0.290</td>
<td></td>
</tr>
<tr>
<td>UDT unilateral left</td>
<td>33</td>
<td>9.83</td>
<td>3.43</td>
<td>3.67</td>
<td>18.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDT unilateral right</td>
<td>40</td>
<td>11.18</td>
<td>3.91</td>
<td>5.19</td>
<td>19.95</td>
<td>0.124</td>
<td></td>
</tr>
<tr>
<td>UDT bilateral left</td>
<td>32</td>
<td>9.61</td>
<td>2.57</td>
<td>4.34</td>
<td>14.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDT bilateral right</td>
<td>32</td>
<td>10.29</td>
<td>3.52</td>
<td>2.75</td>
<td>20.40</td>
<td>0.379</td>
<td></td>
</tr>
<tr>
<td>UDT unilateral contralateral testis</td>
<td>73</td>
<td>10.57</td>
<td>3.74</td>
<td>3.67</td>
<td>19.95</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>UDT unilateral left contralateral testis</td>
<td>33</td>
<td>9.83</td>
<td>3.43</td>
<td>3.67</td>
<td>18.71</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>UDT unilateral right contralateral testis</td>
<td>40</td>
<td>11.18</td>
<td>3.91</td>
<td>5.19</td>
<td>19.95</td>
<td>0.008</td>
<td></td>
</tr>
</tbody>
</table>

* independent t-test

UDT = undescended testis.
Correlation between Prader orchidometry and ultrasonography
There was a positive correlation between testicular volume measured by ultrasonography and Prader orchidometry (0.845; p < 0.001), as can be seen in Figure 4.

![Figure 4](image)

Figure 4 Correlation between testicular volume measurement by ultrasonography (ml) and Prader orchidometry (ml) in all testicles (n=209) measured at follow-up.

Testicular volume measured by ultrasound compared with normal testicular volume measured by ultrasound in adult men as recorded in the literature
The Pubmed search for “normal testicular volume” yielded 683 hits. Limitation to ‘humans’ and ‘adults’ resulted in 299 hits. Table 2 shows the results of the scores on the nine most relevant publications. Lenz 13 and Bahk 19 published the only two studies with a cohort of more than 100 healthy men with ultrasonographical measurement.
Table 2  Review of nine articles reporting normal testicular volume in healthy adults.

<table>
<thead>
<tr>
<th>author</th>
<th>year of publication</th>
<th>country</th>
<th>study cohort</th>
<th>number</th>
<th>age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handelsman¹¹</td>
<td>1984</td>
<td>Australia</td>
<td>Potential sperm donors</td>
<td>119</td>
<td>31.4 ± 0.7</td>
</tr>
<tr>
<td>Takihara¹²</td>
<td>1987</td>
<td>Japan</td>
<td>Men of infertile couple attending andrology clinic</td>
<td>305</td>
<td>24 – 50 (mean: 28.8)</td>
</tr>
<tr>
<td>Lenz¹³</td>
<td>1993</td>
<td>Denmark</td>
<td>Medical board before military service Employees from a larger industrial company</td>
<td>287 mili group 157 empl group</td>
<td>18 – 27 (med 18.8) 22 – 59 (med 35.6)</td>
</tr>
<tr>
<td>Arai¹⁴</td>
<td>1998</td>
<td>Japan</td>
<td>Infertile men seen at infertility clinic (excl: hydrocele, concomitant infections, cryptorchidism, chromosomal abnormalities, hypogonadotropic hypogonadism and ductal obstructions)</td>
<td>486 all: 444</td>
<td>23 – 52 (med 33)</td>
</tr>
<tr>
<td>Spyropoulos¹⁵</td>
<td>2002</td>
<td>Greece</td>
<td>White men of Hellenic nationality who presented to the clinics for reasons of minor severity or for routine annual examinations. No history of testicular pathologic features or surgery.</td>
<td>52</td>
<td>19 – 38 (mean 25.9 ± 4.4)</td>
</tr>
<tr>
<td>Jensen¹⁶</td>
<td>2007</td>
<td>Denmark</td>
<td>Danish men attending a compulsory military physical examination.</td>
<td>3457</td>
<td>19.4 ± 1.2</td>
</tr>
<tr>
<td>Sakamoto¹⁷</td>
<td>2008</td>
<td>Japan</td>
<td>Infertile men</td>
<td>397</td>
<td>35.6 ± 5.3</td>
</tr>
<tr>
<td>Sakamoto¹⁸</td>
<td>2008</td>
<td>Japan</td>
<td>Infertile men</td>
<td>408</td>
<td>35.8 ± 5.3</td>
</tr>
<tr>
<td>Bahk¹⁹</td>
<td>2010</td>
<td>Korea</td>
<td>Normal young adults in military service</td>
<td>1139</td>
<td>23.52 ± 2.74</td>
</tr>
<tr>
<td>aim of study</td>
<td>method of volume measurement and if US, calculation of volume</td>
<td>volume testis and reference for normal value of testis volume</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>To assess the ranges of a variety of testicular function parameters in healthy volunteers</td>
<td>&lt; 25 cc: Prader orchidometry&lt;br&gt; &gt;25 cc: visual estimation</td>
<td>24.9 ± 0.7 (SE)&lt;br&gt;95% CI: 17.1 - 32.7&lt;br&gt;(total sperm output was positively correlated with mean testicular volume)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>To determine the correlation of testicular size, with seminiferous tubular function and Leydig cell function in a large population of men.</td>
<td>Elliptical orchidometry</td>
<td>normal quantity, &gt; 20 ml&lt;br&gt;normal quality, &gt; 14 ml&lt;br&gt;normal LH/T, &gt; 12 ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To establish a normal reference for scrotal ultrasonography including texture and ultrasonic measured size of the testis</td>
<td>Ultrasonography; formula of an ellipsoid: 4/3 x π x A x B x C x 1/8&lt;br&gt;A = longest axis&lt;br&gt;B/C = 2 mutual perpendicular dimensions</td>
<td>right: 3.0 – 31.4 (med 14.1)&lt;br&gt;left: 3.5 35.2 (med 13.04)&lt;br&gt;post-crypt: 3.9 – 17.1 (med 10.5)</td>
<td></td>
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<tr>
<td>To investigate the relationship between testicular volume and function and determination of the critical testicular volume above testicular function was within normal range.</td>
<td>Prader orchidometry</td>
<td>normal descent:&lt;br&gt;6.0 – 31.8 (med 14.1)&lt;br&gt;all: 5 – 60 (32.1 ± 9.4)&lt;br&gt;“critical total testicular volume that indicates possibly normal function is 30 ml in Japanese males”</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>To estimate the sizes of the external genital organs in physically normal adult males.</td>
<td>Ultrasonography; length x width x anteroposterior depth x 0.52</td>
<td>6.1 – 26.9 (16.9 ± 4.7)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>To study the relationship between self-rates health and semen quality.</td>
<td>Prader orchidometry</td>
<td>19.9 ml (± 4.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To evaluate the relationship between testicular function and volume and determine the critical TTV for a normal testicular function.</td>
<td>Prader orchidometry&lt;br&gt;ultrasonography; 0.71 x length x width x height</td>
<td>Prader; TTV mean 36.8 ± 9.7 (5.5 – 60)&lt;br&gt;critical TTV &gt; 30 ml&lt;br&gt;US: TTV mean 26.3 ± 9.5&lt;br&gt;(3.0 – 71.9)&lt;br&gt;critical TTV &gt; 20 ml&lt;br&gt;“mean total sperm count was subnormal with a mean testicular volume &lt; 10 ml”&lt;br&gt;mean 18.25 ± 3.73&lt;br&gt;cut-off value of 18 ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To evaluate the relationship between testicular function and size</td>
<td>Ultrasonography; 0.71 x length x width x depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To establish a cut-off value for normal adult testicular volume.</td>
<td>Ultrasonography; 0.71 x length x width x thickness</td>
<td></td>
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</tbody>
</table>
of the testicles. Lenz et al \(^13\) performed scrotal ultrasonography in 888 testes of 444 healthy men: 287 military personnel (median age 18.8 years) and 157 employees of an industrial company (median age 35.6 years). Each testicle was measured using electronic callipers along the longest axis (A) and on a perpendicular section in two mutual perpendicular dimensions (B, C). The volume was calculated with the formula for the volume of an ellipsoid: \(\pi/6 \times A \times B \times C\). Lenz et al found a mean volume of the right testis of 14.05 ml (range 3.0 − 31.4) and a mean volume of the left testis of 13.04 ml (range 3.5 − 35.2).

Bahk et al \(^19\) measured the testicles of 1,139 normal young men enrolled in military service (mean age 23.52 ± 2.74). Testicular volume was measured by ultrasonometry and calculated as \(0.71 \times \text{length} \times \text{width} \times \text{depth}\). Mean testicular volume was 18.37 ± 3.62 ml for the left testis, and 18.13 ± 3.85 ml for the right.

Goede et al \(^20\) recently published the normative values for testicular volume measured by ultrasound in healthy Dutch boys aged 0.5 − 18 years. The mean testicular volume they found for boys at the age of 18 years was 13.7 ± 3.51 ml.

The dotted reference lines in Figure 5 represent the mean values found by Lenz et al, Bahk et al and Goede et al. Since Bahk et al used a different formula to calculate the testicular volume, the mean volume they found has been converted: \(((18.37 + 18.13)/2)/0.71) \times \pi/6 = 13.4\). Similarly, the cut-off value of 18 ml has been converted to 13.2 (continuous line).

Figure 5 shows the mean ± 2 SE of the volumes of the unilateral UDT, the contralateral testis and the bilateral UDT with the reference lines as mentioned.

**Additional findings**

At follow-up, 2 patients had a mild hydrocele at the ipsilateral side, after orchidopexy for unilateral acquired UDT. Seven patients presented with an extratesticular varicocele; 6 of these also had an intratesticular varicocele. In another three boys, an isolated intratesticular varicocele was observed.

**Paternity**

At follow-up, 99 men were 21 years or older. In this subgroup, the paternity rate was 9.1% (n=9). In six of these men, the time taken to conceive had been less than one month, in one case between one and two months and in two cases between two and three months. Of the 90 boys older than 20 years without children, 3 wanted to have
children; this wish had been present for 2, 3 and 24 months (all three had presented with unilateral acquired UDT).

**Figure 5** Mean long-term volume of the testis (ml; ± 2 Standard Error) after pre-pubertal orchidopexy for acquired undescended testis for unilateral (n=73) and bilateral cases (n=64). For unilateral cases mean volume (ml; ± 2 SE) of its counterpart is shown. In addition, mean testicular volume of adults is shown as published in the literature. Reference lines indicate the mean (dotted line) and cut-off testicular volume published by Lenz et al (13), Balik et al (19) and Goede et al (20).

uni UDT = unilateral undescended testis
contralat UDT = contralateral testis of unilateral undescended testis
bi UDT = bilateral undescended testis

**DISCUSSION**

To the best of our knowledge this is the first study into the long-term results of prepubertal orchidopexy for acquired UDT. It became clear that at follow-up all but one orchidopexied UDT was situated scrotally. In addition, we found that the volume of the orchidopexied unilateral UDT (mean 10.57 ± 3.74 ml) was comparable with that of the orchidopexied bilateral UDT (mean 9.95 ± 3.08 ml); however, the volume of the orchidopexied unilateral UDT differed significantly from the volume of the contralateral testes (mean 14.11 ± 4.23 ml; p < 0.0001). Moreover, the volume of the unilateral
Chapter six

and bilateral orchidopexied UDT were smaller than the normative values given in the literature.
In our study, the testicular volume measured by Prader orchidometry (21.13 ± 5.34) varies greatly with the ultrasonic measurements (10.28 ± 3.45). The orchidometer is known to overestimate testicular volume as it measures the epididymis as well as the scrotal skin, ultrasonography is more precise.\textsuperscript{21,22} However, several studies comparing the orchidometer and ultrasound found that both methods correlated well.\textsuperscript{20,23} In addition, we found a positive correlation of $R^2 = 0.845; \ p < 0.001.$

Acquired UDT is defined as a testis previously situated in the scrotum which can no longer be manipulated into a stable scrotal position. It is seen in 1.5\% of prepubertal boys and early as well as late forms have been described.\textsuperscript{1,24-25} Its pathogenesis is unclear, but tethering of cord structures due to persistence or a fibrous remnant of the processus vaginalis is considered a main etiological factor.\textsuperscript{3,26-30}

For congenital UDT, surgery is recommended at between 6 – 12 months of age.\textsuperscript{8} However, there is still no consensus on the management of acquired UDT. Usually, surgery is recommended at diagnosis. This is mainly based on the supposedly negative influence of the thermal inguinal environment on testicular development and future spermatogenesis. However, so far no follow-up data have been published that justify this policy. Some authors have advocated a conservative attitude, thus restricting orchidopexy at puberty to cases of non-descent. Due to testosterone surges at puberty, spontaneous descent will occur in 3 out of 4 cases.\textsuperscript{8} Long-term follow-up data associated with a conservative attitude have recently become available. They show almost normal testicular growth after either spontaneous descent or pubertal orchidopexy.\textsuperscript{8}

The present study shows that after prepubertal orchidopexy, in unilateral cases, the growth of the operated testis seems to be retarded in comparison both with its contralateral counterpart and with the values reported in the literature. Several studies have shown that UDT which had been treated surgically in childhood are smaller in adulthood than normal testes.\textsuperscript{31-34} This may be caused by the primary condition of the testis (prenatal dysgenesis),\textsuperscript{34} the surgical trauma,\textsuperscript{31} or both.

Orchidopexy may result in vascular damage of the testis; in open surgery this has led to atrophy in 5.4\% of cases.\textsuperscript{35} Ultrasonographic studies suggest that vascular damage may be more extensive than previously suspected.\textsuperscript{36} In addition, the phenomenon of compensatory hypertrophy of the contralateral testis\textsuperscript{37-41} may contribute to the significant difference between the testicular volume of the unilateral acquired UDT and
its counterpart. Nevertheless, in this study we found no significant difference between the volume of the supposed compensatory enlarged testis and the normative values found in the literature (see Figure 4).

The limitations of this study also need to be addressed. Only 122 of the 335 (36.4%) patients approached gave informed consent to participate in this study. We asked most patients about their motives for not participating; in the great majority of cases, logistical reasons were mentioned. However, there may still have been selection bias. Furthermore, we can not exclude that in some boys puberty had already set in at the time of orchidopexy. Nonetheless, because only boys who underwent orchidopexy before the age of 15 were included, probably practically all boys were prepubertal at orchidopexy.

Moreover, the follow-up consisted of only one examination, and therefore it was impossible to analyze when the delay in testicular growth had occurred. According to the comparison of our results with the literature, testicular volumes vary in accordance with geographic area, ethnicity, environmental factors and nourishment conditions.

Although, Lenz et al 13 and Bahk et al 19 both described a large cohort of healthy adult men whom testicles were measured sonographically, they studied respectively the Japanese and American men. However, Goede et al 23 studied normative values of testicular volumes in healthy Dutch boys up to adolescence and founded at the age of 18 years a mean testicular volume of 13.7 ± SD 3.51 ml. The mean testicular volumes found by Lenz et al 13, Bahk et al 19 and Goede et al 23 are respectively 13.6, 13.4 and 13.7 ml and therefore comparison seems reliable. Furthermore, at follow-up hormone levels were not measured, and neither was semen analysis performed. Although testicular volume may serve as an indication of testicular function, since there is a good correlation between the spermatogenic activity of a testicle and its volume 12, 13, parameters such as hormone levels and semen analysis may have led to more specific results. Lastly, we did not analyze the individual surgical findings at orchidopexy which may have influenced testicular volume, such as the preoperative testicular position. No correlation was found between testis volume and age at surgery.
CONCLUSION

After prepubertal orchidopexy for acquired UDT, long-term testicular growth seems to be retarded. We believe that the data of this study underline the necessity for a randomized controlled trial of prepubertal orchidopexy comparing a conservative attitude. Until then, final recommendations for the proper management of acquired UDT cannot be given and it is up to the individual physician to decide which is best.
References