CHAPTER 3: DIFFERENT ASPECTS OF CONGENITAL UNDESCENDED TESTIS

SYNOPSIS: In this chapter the surgical aspects of congenital undescended testis, as found at orchidopexy, are presented and the consequences of orchidopexy on the long-term testicular growth and position is investigated.
3.1 **CONGENITAL UNDESCENDED TESTIS: FINDINGS AT ORCHIDOPEXY**

Objective. The aim of this study was to retrospectively review the findings on orchidopexy in congenital undescended testis (UDT), since congenital and acquired UDT are separate entities.

Methods. During an 18-year period (1986-2004), 220 orchidopexies were performed for congenital UDT in 206 boys. Intraoperative data were collected from the operative notes on the age at operation, testis position and volume, persistence of patent processus vaginalis (PV), attachment of the gubernaculum and associated anomalies (epididymis). Also, testis position postoperatively was evaluated.

Results. Age at operation ranged from 8 months to 14 years. Average age at operation was 4.6 years, 13 out of 206 (6%) had been operated on before the age of 2 years. In 203 of the 220 cases (92%), testis position was documented intraoperative; in 126 of these cases (62%), the testis was located canalicularly. In 167 of the cases a note was made regarding the presence or absence of a hernial sac: 151 (90%) were associated with an (wide) open PV. In 75 of the 220 cases (34%), the gubernacular attachment was assessed; in 15 of these (20%) an abnormal attachment was noted.

Conclusion. Congenital UDT is mainly characterised by canalicular position and (wide) open PV. Abnormal attachment of the gubernaculum and epididymal abnormalities are less frequent.
INTRODUCTION
Although an undescended testis (UDT) is one of the most common clinical entities in boys, its pathogenesis is still unclear. Therefore, anatomic findings in UDT may be important for understanding the mechanism of testicular descent.
At present, UDT is divided into congenital and acquired forms (1-3). A diagnosis of congenital UDT is made if the testis has never been descended from birth in contrast to an acquired UDT which has previously been scrotal.
Several studies have examined anatomical findings during orchidopexy. However, in the majority of these studies congenital and acquired UDT were not identified separately. In this retrospective study the surgical findings of congenital UDT are presented in order to identify any disturbances of the anatomical proportions that may have contributed to congenital UDT.

METHODS
The records of boys operated on for congenital UDT in our hospital between 1986-2004 were collected. A congenital UDT was defined as an UDT in which a scrotal location had never been documented since birth.
Reports were analysed retrospectively for the following aspects: age at operation, side affected, type of surgical approach, initial and postoperative testicular position, open or closed processus vaginalis (PV), attachment of the gubernaculum, epididymal abnormalities and testicular size. The principal epididymal abnormalities include anomalies of epididymal fusion that consisted of loss of continuity between the testis and the epididymis and long looping epididymis. The testicular sizes were compared with reference curves of mean testicular volume in Dutch boys according to Mul et al. (4) for ages < 8 years, the curves were extrapolated. Finally, they were classified as normal, small (for age) or atrophic.
Perioperative testis position was classified as absent (no gonad found), abdominal (testis proximal to the internal ring), canalicular (testis between the internal and external inguinal rings), in the superficial inguinal pouch (SIP) (testis beyond the external ring and deviated, mainly superior of the external aponeurosis) and ectopic (testis outside the usual anatomic path of testicular descent having passed the inguinal canal).
The appearance of the PV was defined as follows: open, if there was an open communication between the peritoneal cavity and tunica vaginalis. Closed, if the PV had been obliterated and instead of an open communication between peritoneal cavity and tunica vaginalis, there was merely a fibrous band alongside the funiculus.
We accepted a white fibrous connective tissue structure attached to the lower pole of the testis as representative of the postnatal gubernaculum.
Standard orchiopexy was performed, it involved an inguinal incision, exploration of the groin with mobilization of the testis, separation of the processus vaginalis or hernial sac, mobilisation of the cord structures and separation and ligation of the cremaster muscles. Finally the testis was fixed scrotally by suture in a subdartos pouch.

RESULTS
Between 1986 and 2004, 206 boys underwent 220 orchidopexies for congenital UDT:
88 (42.7%) operations were on the left side, 104 (50.5%) on the right side, and 14 (6.8%) were bilateral (Table 1).

**Table 1** Laterality of undescended testis in 220 orchidopexies.

<table>
<thead>
<tr>
<th>Laterality</th>
<th>No. of cases in which a note was made (N = 220) (%)</th>
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</thead>
<tbody>
<tr>
<td>Unilateral Left</td>
<td>88 (42.7)</td>
</tr>
<tr>
<td>Unilateral Right</td>
<td>104 (50.5)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>14 (6.8)</td>
</tr>
<tr>
<td>Total</td>
<td>220 (100)</td>
</tr>
</tbody>
</table>

Age at the time of the operation varied from 8 months to 14.2 years. Average patient age at the time of the operation was 4.6 years. Of the 206 boys included in this study, 22 (10.7%) were aged 10 years or over at the time of operation, 40 (19.4%) were aged 6 to 10 years, 131 (63.6%) were aged 2 to 6 years and the remaining 13 (6.3%) were less than 2 years of age.

Standard orchidopexy (or better, funicolysis followed by orchidopexy) was performed as the type of surgical approach for all 220 UDT.

**Peroperative testis position**

Table 2 gives the testicular position found during the operation. In 203 cases (92.3%), the position of the testis was recorded: in 15 (7.4%) cases the testis was situated abdominally, 126 (62.1%) were canalicular, 50 (24.6%) were in the SIP, 1 (0.5%) was ectopic and 8 (3.9%) testes were not found during the operation. In 3 (1.5%) cases the position could not be determined.

**Peroperative size of the undescended testis**

This was recorded in 121 (55.0%) cases: the size was normal in 76 (62.8%), small in 32 (26.5%) and atrophic in 13 (10.7%) cases. Patients with bilaterally undescended testes were not compared (Table 3).

**Anatomical findings**

Processus vaginalis. In 167 (75.9%) testes a PV was observed: in 151 (90.4%) an (wide) open PV was present and in 16 (9.6%) cases a patent PV was absent.
Attachment of the gubernaculum. This was recorded in 75 (34.1%) cases: the gubernaculum was attached to a site other than the lower scrotum in 15 (20.0%) cases, (6 left and 8 right sided). The most frequent attachment was cranial to the scrotum. In 60 gonads (80.0%), a normal attachment, i.e., reaching the bottom of the scrotum, was found.
Epididymal abnormalities. Five testes (2.3%) had abnormalities of the epididymis (one was completely absent), 3 out of 5 (60%) testes with epididymal abnormalities had an associated patent PV (Table 4).

Postoperative testis position
In 216 of the 220 cases (98.2%), the position of the testis at the end of the operation was recorded. 64.4% (139/216) of the testes were successfully pexed into the low scrotum. Of the 216 testes 58 (26.8%) were high scrotal, 8 (3.7%) were in the groin region and 11 were either absent (8 cases) or removed (3 cases) (Table 5).

Table 4 Anatomical findings at orchidopexy.

<table>
<thead>
<tr>
<th>Presence or absence of patent processus vaginalis</th>
<th>No. of cases in which a note was made (N = 220) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>151 (90.4)</td>
</tr>
<tr>
<td>Absent</td>
<td>16 (9.6)</td>
</tr>
<tr>
<td>Total</td>
<td>167 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attachment of gubernaculum</th>
<th>No. of cases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>60 (80)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>15 (20)</td>
</tr>
<tr>
<td>Total</td>
<td>75 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Epididymal abnormalities</th>
<th>No. of cases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>220 (97.7)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Total</td>
<td>225 (100)</td>
</tr>
</tbody>
</table>

Miscellaneous
During the period under review all orchidopexies were performed in one stage. Seven of the 206 boys had a second operation performed, one of the 8 testes with postoperative position in the groin region was atrophic and it was decided not to perform staged orchidopexy.
DISCUSSION

The results of this study show that congenital UDT in 126 out of 203 cases (62.1%) is situated canalicularly and in 151 out of 167 cases (90.4%) associated with (wide) open PV. In 76 out of 121 cases (62.8%) the gonads are of a normal size.

At present, UDT is divided into a congenital and acquired condition (1-3). Congenital UDT describes the condition in which a testis has never been fully descended since birth, whereas an acquired UDT had previously been fully descended. Acquired UDT was observed in 1.2% of 6-year olds, in 2.2% of 9-year olds and in 1.1% of 13-year olds (5).

As shown in Table 2, congenital forms are mainly situated proximal to the external ring, especially canalicularly, and are associated with (wide) open PV. In contrast, acquired UDT is mainly situated in the SIP and in half of the cases associated with a closed or small open PV (6). These findings are consistent with other observations (7), that testicular maldescent is rarely congenital in the absence of a complete hernial sac. Both phenomena (canalicular position and (wide) open PV) in congenital UDT can be explained by the incomplete migration of the gonad to the scrotum. Whereas mechanisms for the development of acquired UDT may include failure of the spermatic cord to elongate due to a fibrous PV remnant (8) and cremaster muscle spasticity (9).

Many theories have been proposed to explain failure of testicular descent. The current evidence suggests that testicular descent occurs in two basic stages, the trans-abdominal and the inguinoscrotal phase (8). In these phases anatomical factors as well as hormonal influences play a role. The cause of congenital UDT is presumed to be a defect in the complex anatomical migration rather than in hormone regulation. This might explain the failure of hormone treatment in congenital UDT. It appears that acquired forms seem to respond well to hormonal treatment (10), since these gonads had previously been fully descended and anatomical abnormalities are supposed to be absent.

The abnormal cranial attachments of the gubernaculum, as was found in 20% in these

<table>
<thead>
<tr>
<th>Testicular position postoperatively</th>
<th>No. of cases in which a note was made (N = 220)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom scrotum</td>
<td>139</td>
<td>(64,4)</td>
</tr>
<tr>
<td>High scrotal</td>
<td>58</td>
<td>(26,8)</td>
</tr>
<tr>
<td>Groin region</td>
<td>8</td>
<td>(3,7)</td>
</tr>
<tr>
<td>Absent</td>
<td>8</td>
<td>(3,7)</td>
</tr>
<tr>
<td>Removed</td>
<td>3</td>
<td>(1,4)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>216</strong></td>
<td><strong>(100)</strong></td>
</tr>
</tbody>
</table>

Table 5 Location of the testis postoperatively.
Chapter 3

series suggests that the gubernaculum is mostly normally anchored in patients with congenital testicular maldescent. However these findings are not consistent with earlier observations (11-13), which showed that the gubernaculum testis is abnormally anchored in patients with UDT. In addition, epididymal abnormalities were found in only 2.3% of patients whereas other series have shown a much higher incidence of epididymal abnormalities associated with congenital UDT (14-16). For example, Favorito et al (17) showed that epididymal abnormalities were more frequent when the PV was patent. Our study shows that a patent PV is more frequent (90.4%) in congenital UDT compared to acquired UDT (54.6%) (6). A normal epididymis and gubernaculum is needed to complete the process of descent (13,15,18-20). Therefore, abnormalities in these structures are likely to result in congenital maldescent.

At present, the age of election for operation of congenital UDT is between 6-12 months of age (21), because deterioration of the cryptorchid testis begins around one year of age (22). However, the mean age in the present study is higher (4.6 years), despite recommendations for early treatment. This might be due to the fact that not too many years ago, the recommended age for ORP was 8 to 10 years. The older age for orchidopexy may also be accounted for by the operations for acquired UDT in the past. Nevertheless, the age of choice for an operation for acquired UDT is still under debate. It has been shown that three out of four acquired forms descend spontaneously in the peripubertal period with testicular volumes appropriate for age (23).

Postoperative findings in congenital UDT reveal that the position of the testis at the end of the operation in 26.8% was high scrotal, probably due to shortness of the spermatic cord. This might offer an explanation for the observation in previous studies that the failure rate after orchidopexy is higher in more proximal testes as compared to more distal testes (24,25). This might also indicate that the prognosis is less favourable for boys with congenital UDT as compared to boys with acquired UDT.

The limitations of this study need to be addressed. This was a retrospective and observational study and therefore potential errors such as incomplete data acquisition and selection bias may have been introduced. In addition, the results were based on visual observations and palpation during surgery.

In conclusion, congenital UDT is characterised by the position of the testis proximal to the external ring, especially canalicularly and (wide) open PV. Abnormal attachment of the gubernaculum and epididymal abnormalities were found less frequently. To get better information regarding surgical findings, a prospective evaluation is essential.

REFERENCES
3.2 LONG TERM TESTICULAR GROWTH AND POSITION AFTER ORCHIDOPEXY FOR CONGENITAL UNDESCENDED TESTIS

K. Sijstermans, W.W.M. Hack, L.M. van der Voort-Doedens, R.W. Meijer
ABSTRACT

Objective. We aimed to investigate long-term testicular growth and position of congenital undescended testes (UDT) after orchidopexy (ORP), because nowadays UDT has to be divided into congenital and acquired forms.

Methods. This study included 181 patients with 199 congenital UDT (91 right-sided, 72 left-sided, 18 bilateral), in whom ORP had been carried out (1986-2006). Long term testicular position and growth were assessed by clinical examination and ultrasound (US). Medical records and operative notes were also reviewed. The mean age at ORP was 3.4 years (range 0.0-11.1) and the mean age at follow-up was 12.5 years (range 2.6-28.6).

Results. In 44.5% (65/146), testicular volume of the unilaterally operated congenital UDT was > the 50th centile for age. In 55.5% (81/146) the volume was ≤ the 50th centile of which 13.0% (19/146) were ≤ the 10th centile. In 17 instances testicular volume could not be measured by orchidometer. In 7 of 34 (20.6%) bilaterally operated congenital UDT testicular volume was ≤ the 10th centile. In 2 instances testicular volume could not be measured by orchidometer. The difference in size between the operated congenital UDT and the contralateral non-operated testes measured by both Prader orchidometer (p=0.00) and US (p=0.00) was statistically significant. There was a strong correlation between orchidometer and US. In 138 out of 199 (69.3%) congenital UDT the pre-operative position was canalicular. On examination, 87.9% (175/199) of the operated testes were located in the lower scrotum.

Conclusion. The findings of this study suggest that ORP, for congenital UDT, is probably not disadvantageous, in terms of long-term testicular growth and position. Longer follow-up is necessary to conclude whether early operation might be more beneficial.
INTRODUCTION
An undescended testis (UDT) is one of the most common urogenital anomalies in boys and is associated with decreased fertility and increased risk of testicular cancer. The overall risk of later infertility in unilateral UDT after orchidopexy (ORP) is approximately 33% and the overall relative risk of developing testicular cancer in patients with a history of UDT appears to be 4.8 (1). These figures, however, apply to UDT as a whole since studies on fertility and testicular cancer do not distinguish between congenital and acquired UDT. At present, UDT has to be divided into congenital and acquired forms (2,3) which are probably different entities. Therefore, the prognosis might also be different for each form. Surgery is currently recommended for congenital UDT at 6-12 months of age, mostly based on recent knowledge on germ cell development. Nevertheless, evidence regarding the effectiveness of early treatment has not been presented yet. Treatment of acquired UDT, on the other hand, might be postponed until mid or late puberty, since this form has a high tendency of spontaneous peripubertal descent (4,5).
In this study, we report on long term testicular growth and position after ORP for congenital UDT.

METHODS
Study design
Records were collected of boys treated for UDT between 1986 and 2006 at the Medical Centre Alkmaar. Only the records of boys in whom ORP had been carried out for congenital UDT were reviewed. Congenital UDT was defined as an UDT in which a scrotal position had never been documented since birth. The previous testicular positions were ascertained from the national register of testicular position at birth (6), respectively the Youth Health Care medical records, the hospital medical records and/or microfilm. In all boys, standard orchidopexy was performed by a specialised surgeon or urologist in the field of paediatrics. (It involved an inguinal incision, exploration of the groin with mobilization of the testis, separation of the processus vaginalis or hernial sac, mobilisation of the cord structures and ligation of the cremaster muscles. Finally the testis was fixed scrotally by suture in a subdartos pouch). A letter offering participation in the study was sent to 386 boys operated on for congenital UDT. Written informed consent was obtained from the boy and/or his parents. At the outpatient clinic, a physical and ultrasound examination was performed by one and the same physician (KS) determining testis position and volume and pubertal stage. If consent was not given, the reason was recorded with a special information leaflet elucidating why participation was declined. Follow-up occurred if abnormalities were detected during examination.

Definitions
Descent was defined as attainment of a spontaneously stable scrotal position of the testis at the bottom of the scrotum. A retractile testis was defined as a normally developed testis which could be brought into a low scrotal position where it remained until the cremasteric reflex was elicited. Traction on cord structures was not painful. An undescended testis was defined as a testis which could not be manipulated into a stable scrotal position and further tension on cord structures was painful. A high scrotal testis
was defined as an UDT which could be manipulated through the scrotal entrance into a high, but unstable, scrotal position, while further traction on cord structures was painful. An acquired undescended testis was defined as an UDT for which a previous scrotal position was documented on at least one occasion.

**Physical examination**

Testicular examination was performed with a two-handed technique in the supine and cross-legged positions. Testis position was classified either as low scrotal, high scrotal, inguinal or not palpable and finally diagnosed as descended, retractile, undescended or absent. Pubertal development was assessed by visual inspection using Tanner’s criteria.

**Testicular volume**

Testicular volumes were measured using a Prader orchidometer and ultrasound (US). All examinations were performed by the same physician (KS).

Testicular volume was determined by comparative palpation with the testis models of a Prader orchidometer, which consists of 12 solid ellipsoid models ranging in volume from 1 to 25 cm³ (1 to 6,8,10,12,15,20 and 25 cm³). A value in between was taken as well. These volumes were compared with reference curves of mean testicular volume in Dutch boys according to Mul et al. (7) For ages < 8 and > 21 years, the curves were extrapolated.

All US examinations were performed with the same equipment (model Pie Medical Picus-scanner, Pie Medical Benelux B.V., Maastricht, The Netherlands) using a 12 MHz linear array transducer with subjects in the supine position. In each case, grey-scale images of the testes were obtained in the transverse and longitudinal planes. Three separate transverse and longitudinal images of each testis were recorded, and the length, width, and depth were measured using electronic callipers. The epididymis was not included. The testicular volumes were calculated using the approximation for a prolapsed ellipsoid: \( V = L \times W \times D \times \pi/6 \text{ ml} \). The largest value of the three calculated testicular volumes was determined and used as volume measurement. When evaluating the conventional grey-scale examinations, both sides were compared regarding testicular position and size. Additional US findings were also noted, such as hydrocele, ascending testis and testicular microlithiasis. Other aspects of pathological morphological alterations, however, were not studied and colour Doppler sonography to assess testicular blood flow was not utilised.

**Data extraction**

Variables selected for evaluation were obtained by way of a separate questionnaire completed by the physician during the visit at the outpatient clinic. The questionnaire included the following items; birth weight, gestational age, medical problems, medications, major surgery, prior groin surgery and ethnic background of the parents. Adenotonsillectomy and/ or middle ear drainage were not taken into account.

Medical records and operative notes of all boys were analysed retrospectively for pre-operative testicular position (categorised as abdominal, canalicular, superficial inguinal pouch (SIP), ectopic, absent or unknown), age at operation, post-operative position and re-ORP.
Statistical methods
Correlation coefficients, the Wilcoxon signed ranks test or the paired T-test were used to compare the volumes of the operated testes with the contralateral testes and to compare the testicular volumes measured using a Prader orchidometer with the testicular volumes measured using ultrasonography.

Ethical approval
The study was approved by the Ethical Committee of the Hospital (ref. number: M05-029).

RESULTS
Of the 386 persons contacted by post, 233 responded to our letter and 181 boys consented to take part in the study. Fifty-two of the 233 persons did not take part in the study, mainly because of embarrassment. For the other 153 persons follow up was not possible, because they changed addresses (N=22) or simply did not answer our letter (N=131).
At the time of examination, the age of the 181 patients ranged from 2,6 to 28,6 years (mean 12,6 years). The mean age at orchidopexy was 3,4 years (range 0,0 to 11,1) see Figure 1. Time between surgery and study was 1,3 years to 20,8 years (mean 9,2 years). Of the patients that responded, 163 (90,1%) had been treated for unilateral (91 right sided, 72 left sided) and 18 (9,9%) for bilateral congenital UDT. Counting testes, a total of 199 congenital UDT were included in the study.

Figure 1 Age at orchidopexy in 181 boys with 199 congenital undescended testes.
BILATERAL CRYPTORCHIDISM GROUP
The age of the 18 patients operated on for bilateral UDT ranged from 3.2 to 28.6 years at the time of examination (mean 14.3 years). The mean age at orchidopexy was 4.1 years (range 1.3 to 11.1). Time between surgery and study ranged from 1.8 to 20.8 years (mean 10.1 years).

Testis position
On examination, 32 of the 36 (88.9%) bilateral testes were located low scrotal, 2 high scrotal, 1 in the inguinal region and 1 was not palpable. 32 of the bilateral testes were diagnosed as descended, 3 as undescended and 1 was absent. The boys with the three testes (2 high scrotal and 1 inguinal) in which a diagnosis of (acquired) UDT was made, were referred for follow-up.

Testicular volume
Testicular volumes could be measured by Prader orchidometer in 34 of the 36 testes (1 absent, 1 inguinal). These volumes ranged from 1.0 to 27.5 ml with a mean value of 10.6 ml. Testicular volumes measured by Prader orchidometer, according to reference curves, after ORP for bilateral congenital UDT are shown in Figure 2. As shown 11 out of 34 testes (32.4%) were > the 50th centile for age and 23 (67.6%) ≤ the 50th centile and 7 (20.6%) ≤ the 10th centile.
Testicular volumes could be measured by ultrasound in 35 testes (1 absent). These volumes ranged from 0.32 to 13.74 ml with a mean value of 4.68 ml. The testicular volumes measurements obtained using the Prader orchidometer showed a strong correlation with the US measurements r=0.966 (p=0.00).

Figure 2 Long term testicular volumes in 17 bilateral congenital undescended testes after orchidopexy measured by Prader orchidometer. Reference curves of mean testicular volume in Dutch boys according to Mul et al. (2001).
UNILATERAL CRYPTORCHIDISM GROUP
At the time of examination, the ages of the 163 patients operated on for unilateral UDT ranged from 2.6 to 27.9 years (mean 12.4 years). The mean age at orchidopexy was 3.4 years (range 0.0 to 10.4). Time between surgery and study was 1.3 years to 20.8 years (mean 9.0 years).

Testis position
On examination, 143 of the 163 (87.7%) unilaterally operated testes were located low scrotal, 3 high scrotal, 6 in the inguinal region and 11 were not palpable.
After examination, 142 testes were diagnosed as descended, 1 as retractile, 9 as undescended and 11 were absent. The 9 testes (3 high scrotal and 6 inguinal) for which a diagnosis of UDT was made, were referred for follow-up.
On examination, 155 of the 163 (95.1%) contralateral non-operated testes were located low scrotal, 3 high scrotal and 5 in the inguinal region. After examination, 150 contralateral testes were diagnosed as descended, 5 as retractile and 8 as undescended. The 8 testes (3 high scrotal and 5 inguinal) for which a diagnosis of (acquired) UDT was made, were referred for follow-up.

Testicular volume
Testicular volumes could be measured by Prader orchidometer in 146 of the 163 unilaterally operated testes (11 absent and 6 inguinal). Testicular volumes of these testes ranged from 1.0 to 30.0 ml with a mean value of 10.2 ml. Testicular volumes of the 163 contralateral non-operated testes could be measured in 156 testes (2 hydroceles and 5 inguinal), these volumes ranged from 0.8 to 30.0 with a mean value of 11.4 ml. Testicular volumes measured by Prader orchidometer, according to reference curves, after ORP for unilateral congenital UDT are shown in Figure 3. As shown 65 out of 146 testes (44.5%) were > the 50th centile for age and 81 (55.5%) ≤ the 50th centile and 19 (13.0%) ≤ the 10th centile.
Testicular volumes measured by Prader orchidometer, according to reference curves, of the contralateral non-operative testes are shown in Figure 4. As shown, 95 out of 156 testes (60.9%) were > the 50th centile for age, 61 (39.1%) ≤ the 50th centile and 14 (8.9%) ≤ the 10th centile. The difference in size between the operated testes and the contralateral non-operative testes measured by Prader orchidometer was statistically significant (p=0.00).
Testicular volumes could be measured by US in 152 (11 absent) of the 163 unilaterally operated testes. These volumes ranged from 0.28 to 19.81 ml with a mean value of 4.29 ml. Testicular volumes of the 163 contralateral non-operated testes ranged from 0.19 to 24.73 with a mean value of 5.81 ml. The difference in size between the operated testes and the contralateral non-operative testes measured by US was statistically significant (p=0.00). The patient age at treatment and the mean testicular volume (measured by US) of the UDT in various age groups is shown in Table 1. Table 2 shows the patient age at treatment and the mean testicular volume (measured by US) of the contralateral non-operated testes in various age groups. However, because of the small numbers in especially the older age groups no statistical test can be applied to compare the age at treatment (≤ 2 yrs or > 2 yrs of age) with testicular size. Furthermore, US revealed additional findings, see Table 3. In the majority of these cases, follow-up US was advised.
The testicular volume measurements obtained using the Prader orchidometer showed a strong correlation with the US measurements for the unilaterally operated testes and for the contralateral non-operated testes ($r=0.958$, $p=0.00$, respectively $r=0.946$, $p=0.00$). The difference in testicular volume of the unilaterally operated testes using Prader orchidometry and US is statistically significant ($p=0.00$), with a mean difference of 5.7 ml. The difference in testicular volume of the contralateral non-operated testes using Prader orchidometry and US is also statistically significant ($p=0.00$), with a mean difference of 5.3 ml. The mean orchidometric testicular volume was larger than ultrasonographic testicular volume.

Figure 3 Long term testicular volumes in 146 unilateral congenital undescended testes after orchidopexy measured by Prader orchidometer. Reference curves of mean testicular volume in Dutch boys according to Mul et al. (2001).

Figure 4 Long term testicular volumes in 156 contralateral normally descended testes measured by Prader orchidometer. Reference curves of mean testicular volume in Dutch boys according to Mul et al. (2001).
Table 1 Patient age at treatment and mean testicular volumes of the undescended testes (measured by ultrasound) in various age groups on examination.

<table>
<thead>
<tr>
<th>Age at treatment 0-2 years:</th>
<th></th>
<th>Mean vol. (ml.)</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12</td>
<td>36</td>
<td>0,91</td>
<td>0,81</td>
</tr>
<tr>
<td>13-17</td>
<td>8</td>
<td>6,40</td>
<td>3,38</td>
</tr>
<tr>
<td>&gt;18</td>
<td>3</td>
<td>11,19</td>
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<th>Age at treatment &gt; 2 years:</th>
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<td></td>
</tr>
<tr>
<td>0-12</td>
<td>56</td>
<td>1,26</td>
<td>1,07</td>
</tr>
<tr>
<td>13-17</td>
<td>16</td>
<td>8,94</td>
<td>3,01</td>
</tr>
<tr>
<td>&gt;18</td>
<td>33</td>
<td>9,73</td>
<td>4,00</td>
</tr>
</tbody>
</table>

Table 2 Patient age at treatment and mean testicular volumes of the contralateral testes (measured by ultrasound) in various age groups on examination.

<table>
<thead>
<tr>
<th>Age at treatment 0-2 years:</th>
<th></th>
<th>Mean vol. (ml.)</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12</td>
<td>43</td>
<td>0,97</td>
<td>0,55</td>
</tr>
<tr>
<td>13-17</td>
<td>8</td>
<td>7,27</td>
<td>3,18</td>
</tr>
<tr>
<td>&gt;18</td>
<td>3</td>
<td>13,97</td>
<td>2,32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age at treatment &gt; 2 years:</th>
<th></th>
<th>Mean vol. (ml.)</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12</td>
<td>57</td>
<td>1,36</td>
<td>1,04</td>
</tr>
<tr>
<td>13-17</td>
<td>17</td>
<td>12,52</td>
<td>5,37</td>
</tr>
<tr>
<td>&gt;18</td>
<td>35</td>
<td>14,69</td>
<td>5,02</td>
</tr>
</tbody>
</table>

Table 3 Additional ultrasound findings (1=operated side/2=non-operated side).

<table>
<thead>
<tr>
<th>Hydrocele</th>
<th>1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending testis</td>
<td>5/5</td>
</tr>
<tr>
<td>Testicular microlithiasis</td>
<td>4/3</td>
</tr>
<tr>
<td>Epididymal cyst</td>
<td>1/2</td>
</tr>
</tbody>
</table>
Data extraction
For 140 of the 181 operated boys a birth weight was known. Fifteen of the 140 (11,4%) had a birth weight of < 2.5 kg. For 171 of the 181 operated boys the gestational age was known. Thirteen of the 171 (7,6%) were premature (< 37 weeks).
Associated anomalies: 5/181 (2,8%) suffered from asthma, 9/181 (5,0%) had an allergy and 4/181 (2,2%) were diagnosed with a syndrome (Marfan, Down, Noonan, Beckwith Wiedemann).
Thirty seven of the 181 (20,4%) boys had had groin surgery for inguinal hernia on the same side as the UDT and at the same time as the ORP. Two of the 181 (1,1%) boys had had groin surgery for inguinal hernia before the ORP was performed. 170 Of the 181 (93,9%) boys were Caucasian and 11/181(6,1%) had another ethnic background.

Pre-operative testis position
Thirteen of the 199 (6,5%) testes were situated abdominally, 138 (69,3%) were canalicular, 27(13,6%) were in the SIP, 2 (1,0%) were ectopic and 6 (3,0%) were not found during the operation. In 13 (6,5%) cases the pre-operative testis position was unknown (not described in the operation record).

**Table 4** Pre-operative position of the testes and mean testicular volumes (measured by ultrasound) in various age groups on examination

<table>
<thead>
<tr>
<th>PRIMARY LOCATION:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canalicular</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td>Mean vol. (ml.)</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>0-12</td>
<td>81</td>
<td>1,12</td>
<td>1,00</td>
</tr>
<tr>
<td>13-17</td>
<td>22</td>
<td>7,12</td>
<td>3,56</td>
</tr>
<tr>
<td>&gt;18</td>
<td>30</td>
<td>10,46</td>
<td>2,63</td>
</tr>
<tr>
<td><strong>SIP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td>Mean vol. (ml.)</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>0-12</td>
<td>18</td>
<td>0,81</td>
<td>0,75</td>
</tr>
<tr>
<td>13-17</td>
<td>3</td>
<td>8,03</td>
<td>2,04</td>
</tr>
<tr>
<td>&gt;18</td>
<td>6</td>
<td>11,18</td>
<td>4,68</td>
</tr>
<tr>
<td><strong>Abdominal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age groups (yrs.)</td>
<td>No. testes</td>
<td>Mean vol. (ml.)</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>0-12</td>
<td>6</td>
<td>1,36</td>
<td>0,72</td>
</tr>
<tr>
<td>13-17</td>
<td>1</td>
<td>5,87</td>
<td>-</td>
</tr>
<tr>
<td>&gt;18</td>
<td>5</td>
<td>7,61</td>
<td>2,64</td>
</tr>
</tbody>
</table>

**BILATERAL AND UNILATERAL CRYPTORCHIDISM GROUP**

Data extraction
For 140 of the 181 operated boys a birth weight was known. Fifteen of the 140 (11,4%) had a birth weight of < 2.5 kg. For 171 of the 181 operated boys the gestational age was known. Thirteen of the 171 (7,6%) were premature (< 37 weeks).
Associated anomalies: 5/181 (2,8%) suffered from asthma, 9/181 (5,0%) had an allergy and 4/181 (2,2%) were diagnosed with a syndrome (Marfan, Down, Noonan, Beckwith Wiedemann).
Thirty seven of the 181 (20,4%) boys had had groin surgery for inguinal hernia on the same side as the UDT and at the same time as the ORP. Two of the 181 (1,1%) boys had had groin surgery for inguinal hernia before the ORP was performed. 170 Of the 181 (93,9%) boys were Caucasian and 11/181(6,1%) had another ethnic background.

Pre-operative testis position
Thirteen of the 199 (6,5%) testes were situated abdominally, 138 (69,3%) were canalicular, 27(13,6%) were in the SIP, 2 (1,0%) were ectopic and 6 (3,0%) were not found during the operation. In 13 (6,5%) cases the pre-operative testis position was unknown (not described in the operation record).
On examination, from the 13 testes situated abdominal, one testis could not be measured and from the 138 situated canalicular, five testes could not be measured. The pre-operative position of the testes and the mean testicular volume in various age groups is shown in Table 4. However, because of the small numbers in especially the older age groups no statistical tests can be applied to compare the volume with respect to pre-operative position.

Post-operative testis position
143 of the 199 (71.9%) testes were successfully pexed into the low scrotum. Of the 199 testes 27 (13.6%) were high scrotal, 6 (3.0%) were in the groin region, 3 (1.5%) had undergone orchidectomy as a result of testicular atrophy and in 20 (10.0%) cases the post-operative testis position was unknown (not described in the operation record). In none of the boys post-operative complications occurred. Seven of the 199 (2.0%) boys had a second operation (re-ORP) performed.

DISCUSSION
This study shows that in 44.5% of the cases the testicular volume, of the unilaterally operated congenital UDT, is > the 50th centile for age and 55.5% are ≤ the 50th centile for age, of which 13.0% ≤ the 10th centile. However, the operated congenital UDT is on average significantly smaller than the contralateral non-operated testis, measured by both Prader orchidometer and US. The preoperative location of the congenital UDT was canalicular in 138 of the 199 (69.3%) cases. On examination, 88.8% of the bilaterally operated testes and 87.7% of the unilaterally operated testes were in a low scrotal position. Currently, UDT is categorised as congenital or acquired. Congenital and acquired UDT are quite different entities, with most probably a quite different prognosis. To our knowledge, this is the first long term follow-up study which contains a homogenous group of operated congenital forms.

Over the years, the recommended age for surgical treatment of congenital UDT has gradually been reduced to 6-12 months (8), based on histopathological studies and on the high incidence of spontaneous testicular descent during the first months of life. Whether this is the optimal age for ORP remains to be seen, when the present generation of boys with early ORP reach adulthood. In our study, the mean volumes of the UDT of patients undergoing surgery at > 2 years of age were even slightly greater in the 0-12 year and 13-17 year age groups than of those patients treated at an age younger than 2 years, although no statistical test could be applied because of the small numbers. Kollin et al. (9), however, recently showed that early ORP seems to have a beneficial effect on testicular growth during the first 4 years after surgery. Nevertheless, the adult volumes of the gonad are the most important and because of the small numbers in our study, longer follow-up is needed.

Traditionally, the success rate in relation to operative treatment of UDT is defined as the percentage of testes that remain in the scrotum and do not atrophy (10). Consequently, a way of assessing the effect of ORP on congenital UDT during childhood would be to follow testicular growth and position (11). Testicular volume has a direct correlation with semen profiles (12) and therefore testicular volume might be considered a reliable
indicator of testicular function (13,14). Testicular volume can be measured by orchidometer and US. The latter is more accurate but the first is more practical. In addition, for Dutch boys, normal values are only available for measurement by orchidometer and not by US. In our study, the Prader orchidometer overestimated the ultrasonographic testicular volume, however, orchidometric measurements correlated strongly with US measurements.

In the current study we found a smaller testis, as compared to its counterpart, after congenital ORP. Kollin et al. (9) have reported a difference in volume between scrotal and retained testes from birth. Therefore, it seems that this difference is consistent and apparently might be explained by testicular damage due to the “primary condition” (prenatal dysgenesis) (15). Other probable explanations for the difference in volume between the UDT and the contralateral testis may include compensatory enlargement of the descended testis (due to an alteration in pituitary feedback) (16) or surgical trauma (17). Many studies have shown that in adulthood previously surgically treated UDT are significantly smaller than normal testes (17,18,19). These studies, however, may contain two different patient populations since no distinction was made between congenital and acquired UDT. In addition, Taqvi et al. (20) concluded that there was no difference in size of the UDT in comparison with that of normally descended testes in relation to age and location. In our study, most volumes of the operated congenital UDT were within normal limits, as compared to reference curves for testicular volume in Dutch boys. This may suggest that ORP might be equally advantageous with regard to the outcome of the congenital UDT when expressed in long term testicular growth. Whether this seemingly successful ORP will allow improved spermatogenesis and paternity in adulthood remains, however, unclear (21). An important factor in predicting fertility is whether the condition is unilateral or bilateral, as bilateral UDT has a much lower fertility rate. Our results show that in 20.6 % (7/34) of the bilaterally operated congenital UDT the testicular volumes were ≤ the 10th centile comparison to 13.0 % (19/146) of the unilaterally operated congenital UDT.

Congenital UDT was mainly situated canalicularly. After surgical treatment most operated testes were in a satisfactory (low scrotal) position. When we compared the mean testicular volume in various age groups at different positions, it seemed that the abdominally situated testes were of smaller final size. However, whether pre-operative position affects testicular volume is not yet clear, since the ages of the patients in our study ranged from 2.6 to 28.6 years (mean 12.5 years) at the time of examination and larger numbers are needed, especially in the older age groups, to make a well founded statement. However, the size of the UDT grew with the age as UDT of larger sizes were found in older age groups as compared to younger age groups.

UDT is also an established risk factor for developing testicular cancer in adulthood. It is hypothesised that this risk is largely determined in utero and is not reduced following ORP. Recent evidence, however, suggests that early surgery may decrease the risk of testicular cancer (22). However, the study contained a heterogeneous group of both congenital and acquired UDT. In unilateral UDT there is also an increased incidence of malignancy in the contralateral descended testis (23). In the present study, in 4 operated testes and 3 non-operated testes testicular microlithiasis (TM) was discovered. It has
been suggested that TM might be associated with testicular cancer (24). In these cases, long term annual US follow-up along with periodic self-examination, is recommended (25).

The limitations of this study need to be addressed. In this study, most ORPs were performed at quite an early age (mean age at surgical treatment was 3.4 years (SD 2.2 years). Nevertheless, the age range at treatment in our study is still higher than the current recommendations, due to the variable previous treatment regimens. Therefore, our results do not clarify whether an operation performed even earlier, between 6-12 months, might be more beneficial. In addition, in England, only 1 in 3 boys requiring ORP undergoes surgery before their second birthday and the reasons are likely to be multifactorial (26). One of their reasons is testicular secondary ascent. In our study, however, we make a distinction between congenital and acquired forms. Longer follow-up, until all boys operated on for congenital UDT have reached adulthood, is needed to see if the testes grow adequately during puberty.

Furthermore, it is uncertain whether those boys who responded were representative of the whole initial group, therefore the possibility of selection bias cannot be excluded. In addition, in this study testicular volume was the only parameter used to assess testicular function and reference curves were only available for the Prader orchidometer measurement and not for US, while US is more accurate. During the period in which surgical data was collected (1986-2006) different surgeons with different skills probably performed the surgeries, which could have lead to testicular atrophy (because of excessive traction, inappropriate and extensive dissection, vascular lesions etc). The examinations were performed by the same physician (KS), which can lead to examiner bias.

In conclusion, the findings of this study suggest that ORP for congenital UDT does not seem disadvantageous in terms of long-term testicular growth and position. However, the surgically treated unilateral congenital UDT shows a significant difference in volume with its counterpart. This might be due to the primary condition. Whether early operation, performed before the age of two, might be more beneficial can only be expressed in terms of adult volume, consequently, longer follow-up is necessary.

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Different aspects of congenital undescended testis