Observational Study

Medicine®

OPEN

The role of ultrasound in the management of undescended testes before and after orchidopexy – an update

Grzegorz Jedrzejewski, MD[a,*], Andrzej Pawel Wieczorek[a], Pawel Osemlak, MD[b], Pawel Nachulewicz[b]

Abstract

The aim of this study was to evaluate the testicular volume and structure using ultrasound (US) before and up to 3 years after orchidopexy in children with different age.

A total of 128 patients underwent orchidopexy for undescended testes. Afterwards, patients were invited for annual follow-up and control scrotal US. The total number of analyzed testes after orchidopexy was 184. Patients were divided according to age at the time of surgery: group I (2–4 years old), group II (5–7), and group III (8–10). In all patients, the testicular volume ratio was calculated as the operated testes volume versus the control testes mean volume.

There was an increase in the median ratio in all age groups, from 0.86 to 0.95 in group I, 0.82 to 0.92 in group II and 0.78 to 0.90 in group III. In group of the patients 2 to 4 years old the growth of the ratio 3 years after surgery was statistically significant.

Abnormalities in the structure of the testes, which may indicate severe damage to the testis, were seen in approximately 20% of patients on initial exams. On follow-up exams, this type of structure remained in 7% of patients. Testes with an initial ratio <0.25 and inhomogeneous structure did not show any significant growth.

Scrotal US can be used for an accurate comparative assessment of the structure and growth of the testes before and after orchidopexy.

Abnormalities in the structure of the testes may identify testes requiring more advanced methods of evaluation.

Abbreviation: US = ultrasound.

Keywords: cryptorchidisms, orchidopexy, ultrasound, undescended testes

1. Introduction

The management of undescended testes is one of the most controversial aspects in pediatric urology. The problem is not, in principle, the time to bring the testis down to the scrotum, but whether and when to perform imaging studies such as ultrasound (US) and why we still get the patients with undescended testis at a later age than global recommendations for orchidopexy.

Cryptorchidism is the most common congenital anomaly in boys and occurs in 3% to 9% of all full-term male neonates.[1–7] The incidence of cryptorchidism decreases, due to spontaneous descent, to 1% to 2% by 6 months of age.[1,2] Although the recommended age for orchidopexy is around 6 months to 1 year of age,[3–7] later orchidopexies have been reported in many studies. Cryptorchidism can result in infertility or even malignancy in adulthood.[8] After the age of 2 years, the degenerative process in an undescended testis can be observed histologically.[9,10] The undescended testis is often smaller in size than the intrascrotal one. It may also have internal structure changed, but such findings, their incidences and methods of evaluation have not yet been described.

Some practitioners agree that to evaluate undescended testes, precise physical examination complemented with appropriate imaging studies is advised.[5] In fact, we need such a diagnostic tool that would allow the evaluation of the testis before or after surgery, informing the physicians, as well as the parents and patients about testis development and changes that may suggest deterioration or even malignancy. The wide availability, high repeatability, low costs, and noninvasive nature of US have made it the imaging modality of choice for examining the scrotum. In many cases, it can be used to reveal lesions inaccessible to physical examination. Recent advances in US have improved the resolution of gray scale images of pediatric testis, which is especially important in the evaluation of the internal structure of undescended and mobile testis.

The aim of this study was to evaluate the testicular volume and structure using US before and up to 3 years after orchidopexy in children with different age.

2. Material

From January 2007 to December 2012, 128 patients between the ages of 2 and 10 years (mean 6.3 years) underwent orchidopexy for undescended testes. An undescended testis was diagnosed if the testis stayed constantly in the inguinal canal. The patients in whom undescended testis was not visible during preoperative US and patients with retractile and abdominal testis were not included to the study. Afterwards, patients were invited for

Editor: Yong Eun Chung.

The authors have no funding and conflicts of interest to disclose.

[a] Department of Pediatric Radiology, [b] Department of Pediatric Surgery, Medical University of Lublin, Lublin, Poland.

[*] Correspondence: Grzegorz Jedrzejewski, Department of Pediatric Radiology, Medical University of Lublin, Gebali 6, 20-093 Lublin, Poland (e-mail: gjedrzejewski@wp.pl).

Medicine (2016) 95:51(e5731)

Received: 25 May 2016 / Received in final form: 11 November 2016 / Accepted: 29 November 2016

http://dx.doi.org/10.1097/MD.0000000000005731

annual follow-up and control scrotal US. Among these patients, 72 had unilaterally undescended testes, while 56 had bilaterally undescended testes. The total number of analyzed testes was 184 after orchidopexy and 72 scrotal testes in patients with unilateral cryptorchidisms. Because of the broad age distribution, patients were divided according to age at the time of surgery into 3 groups: group I (2–4 years old, n = 56 testes), group II (5–7 years old, n = 67), and group III (8–10 years old, n = 61).

The reference group was composed of 185 patients (n = 370 testes) between the ages of 2 and 13 years with normally descended testes with normal and homogeneous echogenicity of the testes.[11] This group was recruited from volunteer boys treated from other reasons than urological ones.

The Institutional Ethical Committee approved our protocol and informed consent was received from all patients in this study.

3. Methods

A Phillips iU22 US scanner with an L17-5 MHz linear probe was used for the determination of testicular structure and volume. Volume was calculated using the approximation for a prolate ellipsoid: $V = 0.523 \times \text{length} \times \text{thickness} \times \text{width}$.[7]

The testicular volume ratio was calculated by the equation of the operated testis volume to the scrotal (control) testis mean volume. The scrotal testis mean volume was calculated according to the results of reference group.

The structure of the testis was assessed in gray scale with the same settings of the gain, focus, and depth. Echogenicity was scored in 2 grades, normal (homogeneous) and abnormal (inhomogeneous). Microlithiasis was defined as 5 or more echogenic foci per view in the testis. All US scans were performed by 1 radiologist with 15 years' experience in the field of clinical US.

SPSS statistical software version 14.0 was used, with Wilcoxon signed ranks test for the analysis of differences between ratios.

4. Results

The mean testicular volumes of operated and scrotal testes measured by US in various age groups before and 1, 2, and 3 years after surgery are shown in Fig. 1 and Table 1. The testicular

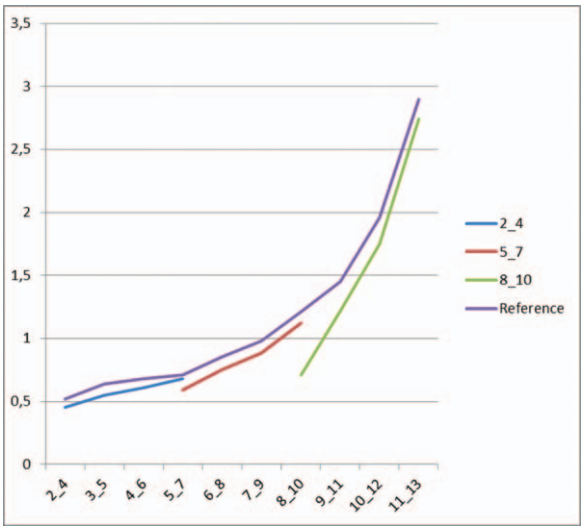

Figure 1. Testicular volume, in milliliters, of the undescended testes in various age groups, before and 1, 2, 3 years after orchidopexy and mean volume of the scrotal and reference testes.

Table 1

Patient age at treatment, number of testes (n), and mean testicular volume measured by ultrasound of the undescended and scrotal testes in various age groups, before and 1, 2, 3 years after orchidopexy.

	Undescended						Scrotal (in patients with unilateral cryptorchidisms)						Scrotal (reference)							
Age groups	n	Vol., mL	Before orch.	1 year after	2 years after	3 years after	n	Vol., mL	Before orch.	1 year after	2 years after	3 years after	n	Vol., mL	Age vol., mL	n	Age vol., mL	n	Age vol., mL	Age vol., mL
I (2–4)	56	Mean	0.45	0.55	0.61	0.68	24	Mean	0.46	0.61	0.68	0.70	88		2–4	92	3–5	91	4–6	5–7
														Mean	0.52		0.64		0.68	0.71
		Min	0.13	0.19	0.19	0.24		Min	0.16	0.18	0.2	0.26		Min	0.25		0.28		0.28	0.33
		Max	1.07	1.3	1.36	1.44		Max	0.8	1.09	1.19	1.29		Max	0.98		1.28		1.28	1.32
II (5–7)	67	Mean	0.59	0.75	0.88	1.12	23	Mean	0.64	0.78	0.99	1.20	90		5–7	88	6–8	89	7–9	8–10
		Min	0.27	0.3	0.33	0.33		Min	0.44	0.55	0.59	0.64		Mean	0.71		0.85		0.98	1.21
		Max	1.57	1.77	2.17	3.46		Max	1.22	1.36	2.09	3.88		Min	0.33		0.38		0.44	0.44
														Max	1.32		1.45		1.67	3.26
III (8–10)	61	Mean	0.78	1.22	1.75	2.74	25	Mean	1.02	1.41	1.87	3.06	94		8–10	96	9–11	98	10–12	11–13
		Min	0.3	0.46	0.55	0.59		Min	0.4	0.53	0.64	1.1		Mean	1.21		1.45		1.96	2.90
		Max	1.73	3.05	4.65	6.56		Max	1.98	3.26	5.02	8.45		Min	0.44		0.44		0.45	0.65
														Max	3.26		6.59		8.65	10.67

Table 2

Testicular volume ratio of undescended testes and scrotal testes in patients with unilateral cryptorchidisms, at various age groups before and 1, 2, 3 years after orchidopexy and statistical significance of the ratios' growth in relation to the ratio before orchidopexy (*P*), 2 to 1 year after orchidopexy and 3 to 2 years after orchidopexy (*P) – $P < 0.05$ statistically significant.**

	Ratio							
	Undescended				Scrotal			
Age group	Before orch.	1 year after	2 years after	3 years after	Before orch.	1 year after	2 years after	3 years after
I (2–4)								
Mean	0.86	0.86	0.89	0.95	0.88	0.95	0.99	0.98
min	0.25	0.29	0.28	0.33	0.27	0.27	0.29	0.35
max	2.07	2.02	2.11	1.88	1.37	1.62	1.74	1.76
P		0.454	0.335	0.045		0.445	0.231	0.274
*P**			0.189	0.007			0.668	0.046
II (5–7)								
Mean	0.82	0.87	0.88	0.92	0.9	0.92	1.01	0.99
min	0.38	0.35	0.33	0.27	0.62	0.59	0.59	0.53
max	2.22	2.06	2.17	2.86	1.67	1.41	2.09	3.02
P		0.466	0.720	0.767		0.998	0.714	0.794
*P**			0.241	0.09			0.932	0.022
III (8–10)								
Mean	0.78	0.86	0.84	0.90	0.84	0.97	0.96	1.05
min	0.29	0.33	0.26	0.19	0.38	0.37	0.29	0.38
max	1.7	2.17	2.22	2.82	1.90	2.32	2.28	2.96
P		0.324	0.511	0.575		0.896	0.617	0.621
*P**			0.380	0.637			0.904	0.690

volume ratios are shown in Table 2. The age groups of patients from the reference group with normal testes are adjusted according to the increasing age of observed patients after orchidopexy. In patients with undescended testes from groups I–III, the testicular volume ratio of the operated testes on preoperative examination was 0.86 for group I, 0.82 for group II, and 0.78 for group III. On follow-up examination after 1 year of observation, the ratio in group I was still 0.86 and in groups II and III this increased to 0.87 and 0.86. After 2 years the ratios changed to 0.89, 0.88, and 0.84, respectively, and after 3 years of observation, the ratios showed an increase to 0.95, 0.92, and 0.90.

The testicular volume ratio was also calculated in scrotal testes in patients with unilateral cryptorchidisms. In most cases, the ratio was close to one, except for the preoperative examination in all groups and 1 year after orchidopexy in group II (Table 1).

The structure of the testis upon preoperative examination was inhomogeneous in 38 patients (21.7%) (group I n = 17, group II n = 15, and group III n = 6). On follow-up exams, this type of structure remained in 13 (7.1%) patients (group I-9, II-3, and III-1) (Table 3). New cases of inhomogeneous pattern after surgery were not observed. The cryptorchid patients with inhomogeneous echo in the testis displayed a significant lower volume as compared to the testis with homogeneous echo (Table 3). Six testes (3.3%; group I-3, II-2, III-1) with an initial ratio <0.25 and inhomogeneous structure did not show any significant growth.

Table 3

The number and volume of testes with normal and abnormal testicular structure at various age groups before and 3 years after orchidopexy.

		Structure of undescended testes			
		Before orchidopexy		3 years after	
Age groups	n vol., mL	Normal	Abnormal	Normal	Abnormal
I (2–4)	n	39	17	47	9
	Mean	0.48	0.37	0.72	0.45
	min	0.18	0.12	0.32	0.23
	max	1.06	0.69	1.35	0.78
II (5–7)	n	53	15	65	3
	Mean	0.60	0.52	1.14	0.51
	min	0.27	0.29	0.51	0.32
	max	1.57	0.82	3.45	0.65
III (8–10)	n	54	6	59	1
	Mean	0.80	0.72	2.77	1.42
	min	0.30	0.46	0.58	0 0
	max	1.72	0.96	8.87	
Total		146 (79.3%)	38 (21.7%)	171 (92.9%)	13 (7.1%)

Microlithiasis was found in 9 patients with cryptorchidisms (4.9%), in 6 patients with inhomogeneous testis structure, and in 3 patients with homogeneous testis structure.

5. Discussion

There is a common consensus that cryptorchid testes should be brought down to the scrotum in early childhood to preserve function and mitigate cancer risk.[1,7] However, in some pediatric centers, many of these procedures are performed later in life, even up to 10 years of age. This could be due to either lack of screening methods or unclear procedures in the case of undescended testes, as well as delayed diagnosis by medical practitioners. Also, parental inattention and their unawareness of the necessity of this operation may affect the decision.[5] Other factors associated with the timing of orchidopexy include insurance status, and the hospital at which the surgery is performed.[6] Some authors suggest that US has no role in case of undescended testes, and a delayed urology consultation could be due to "unnecessary" US.[4]

Although the possible consequences of cryptorchidism are well-known, there have been problems with the assessment of the influence of orchidopexy on the future function of the testis, as this requires a very long follow-up period from diagnosis and treatment in childhood until full testicular function in adulthood.[12] To monitor testicular function, invasive testicular biopsies would be required, but such an invasive procedure in young boys would not be ethically acceptable. It has also been thought that repeated measurements of testicular volume could be translated to testicular function.[1] Another method of monitoring can be assessment of the serum hormone levels, like follicle-stimulating hormone, because of its role in spermatogenesis,[13] but it does not give information about testis size and structure. In this study the use of US is emphasized, and indeed, abnormalities in the echostructure were seen in approximately 20% of patients in the present study (Table 3). These findings have not been previously described. Ultrasonography is known to be a reliable tool for the measurement of testicular volume with high reproducibility and is used to determine the volume of the cryptorchid testis before and after testis repositioning (Fig. 2).[14] In the case of unilaterally undescended testes, to compare the growth of the undescended testis to the scrotal testis, the testicular volume ratio can be calculated by using the operated to scrotal testis volume. This is an index of the degree of growth deficit of the cryptorchid testis and has been used in several studies concerning the growth of the undescended testis after surgery, as well as in this group of patients. In a study by Kollin et al,[7] there was an increase in the median ratio from 0.68 at 6 months to 0.81 at 4 years ($P < 0.001$) in the early treatment group operated on at 9 months of age. In contrast, a decrease in the median ratio was noted in the late treatment group (surgery at 3 years) from 0.68 at 6 months to 0.56 at 4 years ($P < 0.001$). At ages 2, 3, and 4 years,

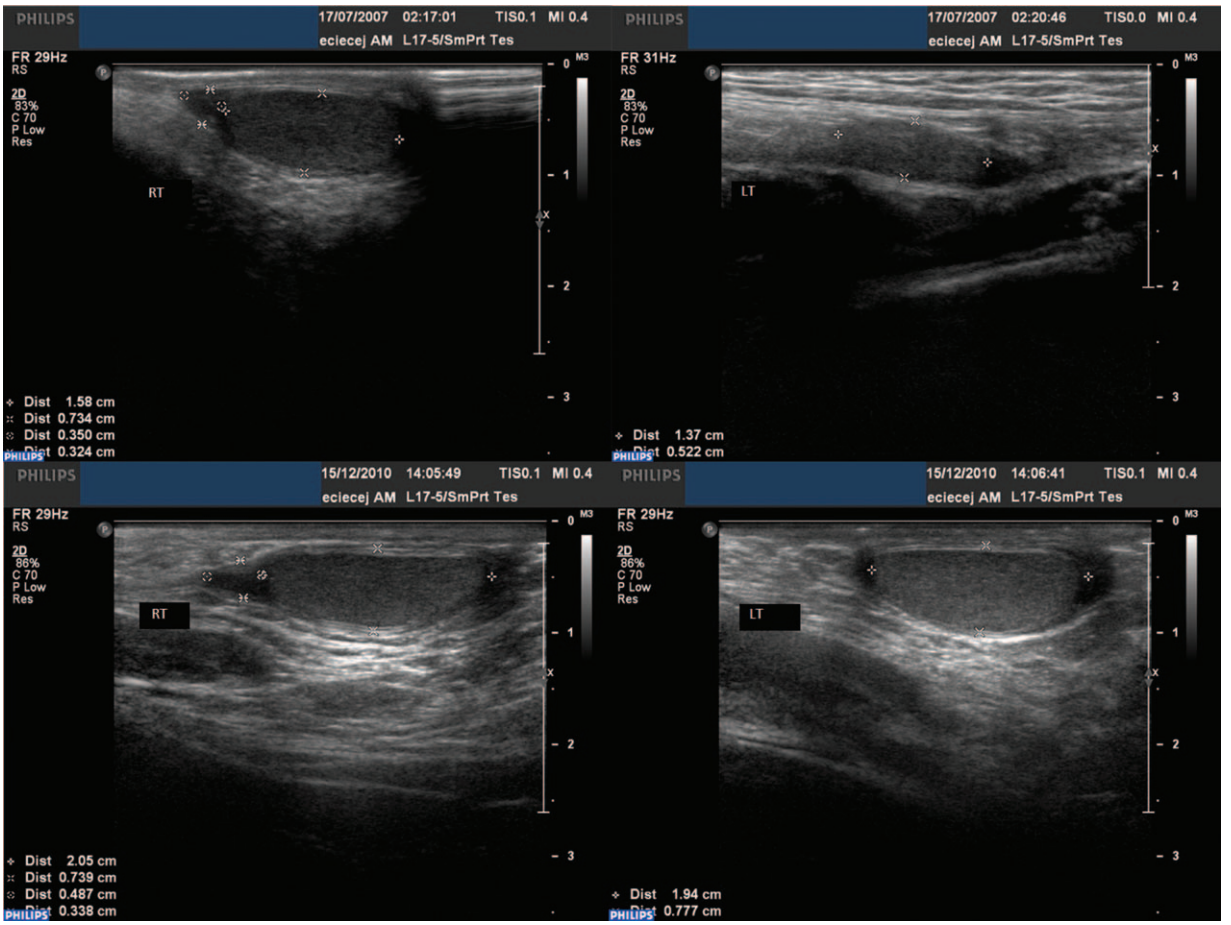

Figure 2. The measurements of the scrotal testis (RT) and undescended one (LT) before orchidopexy (upper images) and 3 years after orchidopexy (bottom images). See the "catch up" growth of the left testis. LT = left testis, RT = right testis.

there were significant differences in this ratio between the early and late treatment groups, again demonstrating the partial catch-up growth of testes that are treated early ($P < 0.001$). This means that only an early orchidopexy is likely to result in significant recovery of testicular size and appearance. Also, in a study by Kim et al[1] at the follow-up examination 2 years after orchidopexy, the testicular volume percentage (the ratio multiplied by 100) showed an increase: in the group of patients operated on before the 2nd year of life (I) from 46.6 to 90; in the group of patients operated between 2 and 5 years of life (II), from 68.1 to 78.2; and in the group operated after the 5th year of life (III), from 65.7 to 77.6. Only group I, which received orchidopexy within 2 years of birth, showed a significant recovery of testicular volume at follow-up compared with groups II and III.[1] However, unilateral cryptorchidism may have some effect on scrotal testis, thus contralateral testis should not be assumed as a reference (Table 2). That is why independent control group was introduced giving possibility to the combined assessment of the unilateral and bilateral undescended testes.

In this study, there was an increase in the median ratio in all age groups (Table 2), but the increase in the median ratio 3 years after surgery in group I (from 0.86 to 0.95) was statistically significant ($P < 0.05$). That is way these or earlier age should be addressed for orchidopexy. Significant growth occurred mostly in the 3rd year of observation, which confirms the need for long-term follow-up after orchidopexy. Despite quite good "catch up" growth, some of the testes had significantly changed volume at the time of diagnosis. The possibility of identifying of these testes is the main advantage of scrotal US. A large difference in testis volume could be recommendation for early orchidopexy as well as finding that testicular volume ratio in undescended testes decreased with age if the testes were left untreated (from 0.86 in group I to 0.78 in group III).

This study also included patients who were elder at the time of orchidopexy than what is currently recommended (group III). Those children and children from the eldest reference group could enter into puberty during observation, which restrict the value of the results of this group and suggest its exclusion from future research.

US could also be helpful in monitoring testis structure. Some abnormalities, like hypoechoic and inhomogeneous patterns, were seen in 20% of patients with cryptorchidism. In 5% to 10% of undescended testes, changes persisted during the entire observation period, suggesting parenchymatous disorders. What is more microlithiasis can occur more frequently in testes with abnormal structure. However, the combination of assessing testis echostructure and its volume could have the strongest prognostic importance, especially in a group of testes with a very low volume ratio (<0.25) and a hypoechoic, inhomogeneous structure, which was observed in 6 (3.3%) patients. This is too small group of patients for statistical evaluation, but because these testes did not show any recovery during observation in these patients more advanced methods of evaluation should be considered, like hormones levels or even biopsy. The symptoms of deterioration of the testis structure may also appear in later age, but such findings were not observed in our patients. Some of abnormalities, which quickly resolved after orchidopexy, could be due to the inguinal position of the testis and the need for deeper penetration of a US and, consequently, a weaker signal. This could give some limitations for the initial exam, before the surgery, but only in the assessment of the testis echostructure. Other information, such as the location and the volume of the testis, could be still very valuable. In fact, undescended testis is a predisposing factor for malignancy, as well as microlithiasis. This also applies to the patients after orchidopexy. Since in the case of microlithiasis, US is an established method of observation, why cannot be used also in the case of undescended testes and testes after orchidopexy. Authors realize that the subjectivity of the evaluation of the echostructure could also be some disadvantage, but additional US tools can be used in the assessment of the testis condition, such as Color and Spectral Doppler. Also to monitor the stiffness or vascularity of the testes, beyond 2D US, modern US techniques could be applied, such as elastography or 3D US,[15] but this requires additional study. Potentially these are the tools we are looking for.

In summary, scrotal US can provide an accurate comparative assessment of the growth of testes before and after orchidopexy. In group of the patients 2 to 4 years old the growth of the ratio 3 years after surgery was statistically significant and these or earlier age should be recommended for orchidopexy. Abnormalities in the structure of the testes do not accurately reflect the testicular function, but can be used for identifying testes requiring more advanced methods of evaluation, like hormones levels or even biopsy.

References

[1] Kim S-O, Hwang EC, Hwang IS, et al. Testicular catch up growth: the impact of orchiopexy age. Urology 2011;78:886–90.

[2] Toma P, Rossi UG. Pediatric ultrasound. II. Other applications. Eur Radiol 2001;11:2369–98.

[3] Ritzen EM, Bergh A, Bjerknes R, et al. Nordic consensus on treatment of undescended testes. Acta Paediatr 2007;96:638–43.

[4] Aggarwal H, Rehfuss A, Hollowell JG. Management of undescended testis may be improved with educational updates for referring providers. J Ped Urol 2014;10:707–11.

[5] Moslemi MK. Evaluation of orchiopexy practice patterns in patients with cryptorchidism: a single centre study. J Ped Urol 2014;10:230–2.

[6] Kokorowski P, Routh J, Graham D, et al. Variations in timing of surgery among boys who underwent orchidopexy for cryptorchidism. Pediatrics 2010;126:576–82.

[7] Kollin C, Karpe B, Hesser U, et al. Surgical treatment of unilaterally undescended testes: testicular growth after randomization to orchiopexy at age 9 months or 3 years. J Urol 2007;178:1589–93.

[8] Murphy F, Paran T, Puri P. Orchidopexy and its impact on fertility. Pediatr Surg Int 2007;23:625–32.

[9] Hadziselimovic F. Cryptorchidisms, its impact on male fertility. Eur Urol 2002;41:121–3.

[10] Thong MK, Lim CT, Fatimah H. Undescended testes: incidence in 1,002 consecutive male infants and outcome at 1 year of age. Pediatr Surg Int 1998;13:37–41.

[11] Osemlak P. Size of testes and epididymes in boys up to 17 years of life assessed by ultrasound method and method of external linear measurements. Dev Period Med 2011;15:39–55.

[12] Jedrzejewski G, Wozniak MM, Madej T, et al. The differences in testicular volumes in boys 8-36 months old with undescended, retractile and hydrocele testis — Usefulness of scrotal screening ultrasound. Early Hum Dev 2012;88:185–9.

[13] Plant T, Marshall G. The functional significance of FSH in spermatogenesis and the control of its secretion in male primates. Endocr Rev 2001;22:764–86.

[14] Riebel T, Herrmann C, Wit J, et al. Ultrasonographic late results after surgically treated cryptorchidism. Pediatr Radiol 2000;30:151–5.

[15] Jedrzejewski G, Ben-Skowronek I, Wozniak MM, et al. Testicular adrenal rest tumors in boys with congenital adrenal hyperplasia-3D US and elastography – do we get more information in diagnosis and monitoring? J Ped Urol 2013;9:1032–7.