Original Article

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Radiology Section

Comparison of Testicular Volume and Blood Flow in Children Before and After Surgery for Inguinoscrotal Diseases- A Prospective Cohort Study

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ABSTRACT

Introduction: Testicular diseases in children include hernia, hydrocele, undescended testis, epididymal cyst or torsion testis. Some of these like hernia and undescended testis will have affect on the testicular volume and blood flow. These are predictors for the future function of the testis. Manipulations during surgery can also affect blood flow to the testis.

Aim: To compare testicular volume and blood flow in children undergoing surgery for inguinoscrotal diseases in both normal and diseased sides, before and after surgery.

Materials and Methods: A prospective cohort study was conducted from March 2019 to December 2019 in which 30 children were selected from Surgery Outpatient Department (OPD), Department of Paediatrics, Gian Sagar Medical College, Rajpura, Punjab, India. For patients having inguinoscrotal disease, ultrasonography (US) and colour doppler was done preoperatively on all cases by an experienced radiologist, using the same machine settings on the seventh day and three months postsurgery. Preoperative and postoperative testicular volume and blood flow was recorded in all the patients. The Statistical Package for Social Sciences (SPSS) software was used to statistically analyse the data arising, $p<0.05$ was accepted as statistically significant.

Results: Total of 30 children (10 months to 10 years of age) formed the total sample of the study. Pathology was found in 18 patients on the right side and 12 patients on the left side. When the right and left side pathology were compared, it was found that right testicular volume was less as compared to left side. This difference was statistically significant with the p-value 0.006. There was a significant difference in blood flow between the right and left testis, both before (p-value 0.007) and after surgery (p-value=0.004). Testicular volume increased three months postsurgery in all the patients. This difference was more evident in left side pathology ($p<0.05$) as compared to right side ($p>0.05$). The increase in mean blood flow of diseased testis was significant after seven days of surgery (p-value <0.05). But change in mean testicular volume and blood flow after three months of follow-up was found to be non-significant.

Conclusion: Inguinal surgery does not affect the testicular volume and blood flow. But long term follow-up for children of inguinal surgery for its effect on fertility should be evaluated.

Keywords: Colour doppler, Inguinal surgery, Testicular diseases, Ultrasonography

INTRODUCTION

Diseases involving the testes and epididymis may have a variety of aetiologies including developmental, genetic, endocrinal, inflammatory, infective, obstructive, traumatic or neoplastic. These include hernia, hydrocele, undescended testis, epididymal cyst or torsion testis [1]. The testicular function has a direct correlation with testicular volume since seminiferous tubules and germinal elements comprise approximately 98% of the testicular mass [2]. Reduction in testicular size is mainly caused by reduction of these histological elements due to primary dysplasia in the undescended testis or secondary damage due to hernia or torsion and can therefore result in disturbed spermatogenesis [3,4].

Inguinal hernia or hydrocele can affect testicular blood flow. Testicular atrophy is a reported complication of inguinal hernia repair [5,6]. We could find only one study which compared the testicular volume and blood flow of diseased testis and non diseased in inguinoscrotal pathologies [1]. Testicular volume is an important indicator for testicular function. A decrease in testicular size can disturb spermatogenesis [2]. Testicular volume can be measured by USG. With colour doppler along with USG, testicular perfusion can also be measured [7,8]. The present study was conducted to compare the testicular volume and blood flow in testis on side of inguinal hernia, hydrocele, undescended testis and epididymal cyst vs testis on the normal healthy side. This study thus also compared the testicular volume and blood flow in diseased testis before and after surgical manipulations.

MATERIALS AND METHODS

A prospective cohort study was conducted at Department of Paediatrics, Gian Sagar Medical College, Rajpura, Punjab, India from March 2019 to December 2019. Approval of the ethical committee was taken before the study (MMMCH/IEC/19/275).

Inclusion criteria: Children, aged less than 14 years having a unilateral hernia, hydrocele, undescended testis and epididymal cyst were included in the study.

Exclusion criteria: Those children with bilateral disease, those with unilateral disease who had undergone previous surgery on the same side or opposite side or non palpable testis, ones with suspicion of torsion testis or incarcerated hernia in which testicular blood supply is already compromised were excluded from the study.

Sample size calculation: This study used a two-sample means test to calculate the sample size. An estimate was made that to assess the difference between preoperative blood flow of 7.4 mL and a post-operative blood flow of 8.8 mL with a common standard deviation between the two groups, 20 subjects, 10 in each group are required.

Study Procedure

The authors in the present study, utilised the contralateral healthy testis to establish the normative values of testicular growth and investigated the volume of testis on the diseased side. We also

evaluated the effect of manipulations performed in the inguinal hernia, hydrocele, undescended testis and epididymal cyst surgery on testicular blood flow using Colour Doppler Ultrasonography (CDUSG) by repeating Doppler ultrasound at seven days and three months postsurgery.

Technique: Ultrasonography and colour doppler was done preoperatively on all cases by the single radiologist (having 10 years experience) in the same settings. Scrotal US were performed with the patient in the supine position and the scrotum supported by a towel placed between the thighs.

High-frequency linear-array transducers: 15-8 MHz for neonates and infants and 8-5 MHz for prepubertal and pubertal boys. This study used the fundamental mode and scanned each hemi-scrotum in the transverse and longitudinal planes. The cord was identified in the inguinal canal, and its course was followed-up to the posterosuperior border of the testis. The testicular size was determined by measuring the anteroposterior diameter on comparable transverse images of the left and right sides or by calculating testicular volume with the formula for an ellipsoid by machine: Volume=Longitudinal×Anterop osterior×Transverse diameter×0.523.

Colour doppler imaging was performed in all cases to investigate extratesticular vascularisation and testicular perfusion, with parameters optimised to display low flow velocities {low wall filter (100 kHz), low pulse repetition frequency (1-2 Hz), and 70%-90% colour gain output settings}. The velocity waveforms of the normal intratesticular arteries showed high level of antegrade diastolic flow throughout the cardiac cycle, reflecting the low vascular resistance of the testis.

Colour doppler: The values were recorded from the diseased site as well as the normal side. The USG and Colour Doppler Ultrasonography (CDUSG) were repeated seven days and three months postsurgery and were compared with preoperative findings.

Primary Outcome Measures

- Change of testicular volume from preoperative to postoperative three months

Radiological evaluation was performed by the radiologist preoperatively and on days seven and three months postsurgery. Longitudinal, anteroposterior, and transverse diameters of the testis were measured, and the testicular volume was calculated using the CDUSG device. Formula used was volume=0.523×D1×D2×D3 in cm^3, (where D1, D2, and D3 are the maximal longitudinal, anteroposterior, and transverse diameters in cm) for both testicles in each patient. [Table/Fig-1] is showing volume of testis being measured.

- Change of blood flow (Change of blood flow from preoperative to postoperative three months)

Radiological evaluation was performed by the radiologist using CDUSG preoperatively and on day seventh and three months postsurgery. Peak Systolic Velocity (PSV) was calculated using the CDUSG system (in cm/s) for both testicles in each patient. [Table/Fig-2] is showing measurement of testicular blood flow is being done. The PSV is calculated from characteristic wave pattern with measurement of the peak of the wave. [Table/Fig-3] is showing the blood flow of epididymis having low flow and high resistance.

STATISTICAL ANALYSIS

Statistical analysis was done by Statistical Package for Social Sciences (SPSS) version 21.0. Testicular volume and blood flow were analysed as mean and p-value was calculated to check the statistically significant difference between preoperative, early postoperative and late postoperative testicular volume and blood flow by Friedman Test between normal side and diseased side. Testicular volume and blood were also compared on operated side before and after surgery and the p-value was calculated and $p<0.05$ was accepted as statistically significant.

RESULTS

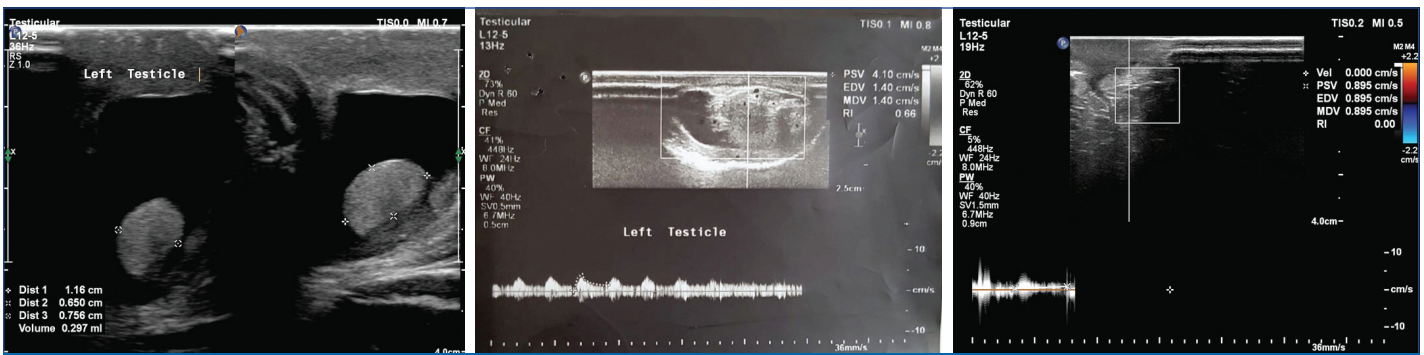
Thirty boys coming to surgical outdoor for the inguinoscrotal disease were included in the study. The age group ranges from 10 months to 10 years. Inguinoscrotal pathology was found in the right side in 18 patients and the left side in 12 patients. Pathology was inguinal hernia in 11 patients, undescended testis in 10 patients, hydrocele in eight patients and epididymal cyst in one patient. [Table/Fig-4] shows the details of surgical pathology found in patients of this study and surgical procedure was done.

[Table/Fig-5] shows the comparison of preoperative and postoperative testicular volume and blood flow on right and left sides in patients with right side pathology. Volume and blood flow of left testis were more as compared to right testis and this difference was statistically significant ($p<0.05$). This difference was also seen at the seventh day and three months postsurgery ($p<0.05$).

[Table/Fig-6] shows the comparison of preoperative and postoperative testicular volume and blood flow on right and left sides in patients with the left side pathology. Left testicular volume and blood flow were more as compared to the right side in the preoperative and early postoperative period ($p<0.05$). However, there was no difference in blood flow of both testis three months postsurgery.

Testicular blood flow increased in operated testis seven days after surgery ($p<0.05$) on left side only. However, no statistically significant change was observed in testicular volume and blood flow in diseased testis at the seventh postoperative day and three months postsurgery on right side ($p>0.05$) as shown in [Table/Fig-7].

When we compared the testicular volume and blood flow between right and left testis in all patients, we observed that mean testicular volume and blood flow was less in right side as compared to left side. This finding was seen at seventh day and three months also [Table/Fig-8].



[Table/Fig-1]: Colour doppler Ultrasonography (CDUSG) image with volume of testis being measured; **[Table/Fig-2]:** CDUSG image measurement of testicular blood flow is being done. **[Table/Fig-3]:** Measurement of testicular blood flow shown. (Images from left to right)

Surgical pathology	Number of patients	Age range (years)	Type of surgery	Any complication
Inguinal hernia right	6	2-10 (mean-4)	Right hernitomy	Nil
Inguinal hernia left	5	5-12 (mean-7)	Left herniotomy	Nil
Hydrocele right side	5	5-12 (mean-6)	Right herniotomy	Nil
Hydrocele left side	3	6-10 (mean-7)	Left herniotomy	Nil
Undescened testis right	6	2-5 (mean-4)	Right herniotomy and orchidopexy	Wound infection-2
Undescended testis left	4	3-7 (mean-6)	Left herniotomy and orchidopexy	Nil
Epididymal cyst right	1	4	Excision of cyst	Nil

[Table/Fig-4]: Surgical pathology in the patients and surgery done.

Parameters	Right (mean±SD) (n=18)	Left (Normal contralateral side) (mean±SD) (n=18)	p-value
Testicular volume (mean) (cm^3)			
Before surgery	0.17±0.02	0.197±0.019	**0.006**
7 days postsurgery	0.14±0.02	0.196±0.019	**0.003**
3 months postsurgery	0.18±0.018	0.21±0.02	**0.002**
Testicular blood flow (mean) (cm/s)			
Before surgery	2.83±0.174	3.38±0.173	**0.007**
7 days after surgery	2.87±0.178	3.46±0.173	**0.004**
3 months postsurgery	2.91±0.184	3.43±0.173	**0.004**

[Table/Fig-5]: Comparison of preoperative and postoperative testicular volume and blood flow in patients with the right side pathology.
SD is standard deviation; (paired t-test)

Parameters analysed	Right (Normal contralateral side) (Mean±SD) (n=12)	Left (Mean±SD) (n=12)	p-value
Testicular volume (mean) (cm^3)			
Before surgery	0.213±0.001	0.291±0.002	**0.005**
7 days after surgery	0.209±O.001	0.275±0.002	**0.004**
3 months postsurgery	0.214±0.001	0.289±0.002	**0.006**
Testicular blood flow (mean) (cm/s)			
Before surgery	3.12±0.023	3.68±0.016	**0.002**
7 days after surgery	3.36±0.023	3.96±0.016	**0.005**
3 months postsurgery	3.44±0.023	3.87±0.016	0.23

[Table/Fig-6]: Comparison of preoperative and postoperative testicular volume and blood flow in patients with the left side pathology.
SD is standard deviation; (paired t-test)

Testicular parameters analysed	Mean	p-value
I Right side (n=18)		
a. Testicular volume (mean) (cm^3)		
Before surgery	0.17	-
7 days after surgery	0.14	0.15
3 months postsurgery	0.18	0.17
b. Testicular blood flow (mean) (cm/s)		
Before surgery	2.83	-
7 days after surgery	2.87	0.50
3 months postsurgery	2.91	0.19
II. Left Side (n=12)		
a. Testicular volume (mean) (cm^3)		
before surgery	0.197	-
7 days after surgery	0.196	0.21
3 months postsurgery	0.21	0.13
b. Testicular volume (mean) (cm^3) (cm/s)		
Before surgery	3.38	-
7 days after surgery	3.46	<0.05
3 months postsurgery	3.43	0.19

[Table/Fig-7]: Comparison of preoperative and postoperative testicular volume and blood flow in patients in diseased testis at seventh postoperative day and at three months later.
(paired t-test)

Parameters	Right side pathology	Left side pathology	p-value
Testicular volume (mean) (cm^3)			
Before surgery	0.187±0.026	0.234±0.048	**0.003**
7 days after surgery	0.168±0.037	0.227±0.041	**0.002**
3 months postsurgery	0.193±0.022	0.242±0.041	**0.009**
Testicular blood flow (mean) (cm/s)			
Before surgery	2.93±0.019	3.49±0.020	**0.001**
7 days after surgery	3.04±0.276	3.64±0.280	**0.005**
3 months postsurgery	2.99±0.181	3.59±0.255	**0.007**

[Table/Fig-8]: Comparison of preoperative and postoperative testicular volume and blood flow in patients between right and left testis.
(paired t-test)

DISCUSSION

In the present study, we used USG and CDUSG to assess the testicular volume and blood flow, respectively. We used a CDUSG device which is noninvasive to evaluate testicular volume. Since, measurement of diastolic blood flow was not possible only PSV was calculated, so resistive index could not be calculated [9].

Elective hernia surgery in children can have multiple complications like scrotal oedema, haematoma, wound infection [5,10]. Inguinal hernia itself can lead to impaired testicular blood flow probably due to the compression effect in adults [7,11]. Inguinal hernia also affects blood flow and thickness of spermatic cords in boys [12]. There are studies that have observed a decrease in testicular volume on the operated side as compared to the normal/non operated side [10,13,14]. Preserving testicular volume and blood flow is crucial in hernia surgery. The most important factor for testicular volume is testicular blood flow. So by measuring testicular blood flow before and after surgery, one can predict the change in testicular volume [15]. The study conducted by Suchllu I et al., showed no significant difference in testicular volume after hernia surgery. The study conducted by Niedzielski JK et al., showed an increase in testicular volume in patients with undescended testis on the operated side, six months after surgery [3,15]. Preoperative location of the testis, early surgery and preoperative Human Chorionic Gonadotropin (HCG) administration do not affect testicular volume [4]. Though preoperative volume of the undescended testis is smaller as compared to the normal side, there is an increase in volume after orchidopexy [16].

In the present study, we found a transient increase in testicular blood flow on the affected side after surgery. This returned to normal and was confirmed by three months postsurgery USG and CDUSG ($p>0.05$). The same findings were noted by Palabiyik FB et al., [6]. When we compared the right and left testis, it was found that the right testicular volume was less than the left side. Mean testicular volume on right side was 0.187 mL and on left side 0.234 mL [Table/Fig-8]. This was independent of the fact whether pathology was on the right side or left side and this finding was statistically significant (p-value<0.05). Preoperative testicular blood flow was also less in patients of right side pathology. Similar findings have been obtained by Tuncer AA et al., [1]. Testicular volume increased three months postsurgery. Surgery does not lead to a decrease in testicular volume.

Testicular blood flow increased immediately after surgery probably due to surgical insult but this returns to normal three months postsurgery as there was no statistically significant difference in testicular volume and blood flow from preoperative value (p>0.05).

Limitation(s)

The testicular volume and blood flow only upto three months which is a short period was measured. Long-term follow-up is a must for future prediction of fertility. Surgical insult if any to the vasculature of testis will be evident by one year though some changes can be seen in three months ultrasound.

CONCLUSION(S)

Inguinal surgery does not affect the testicular volume and blood flow. In some cases, there was a decrease in testicular volume immediately postsurgery. Though this difference is statically insignificant at three months postsurgery. But long term follow-up for children of inguinal surgery for its effect on fertility should be evaluated. Every child should undergo preoperative USG of testis for testicular volume and blood flow to document the changes occurring to testicular volume and blood flow after the surgery. This will help in the prediction of future testicular function or chances of fertility.

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