



## Effect Of Inguinal Hernia And Open Hernioplasty On Testicular Perfusion

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### Abstract

Inguinal hernia is common disorder that predominantly affects men, with an incidence of 5 % to 10 % in the general population. Inguinal hernias are classified in 2 types namely **direct** and **indirect**, according to their relationship to the inferior **epigastric artery**<sup>[1,2]</sup>. Possible effects of inguinal hernias on the gonads have not been studied despite the fact that they are in a close anatomic relationship with testicular blood vessels throughout the inguinal canal. With the advent of Colour Doppler ultrasound, we have a modality that is capable of reliably showing the normal testicular arterial anatomy and flow and detect minor changes in flow patterns<sup>[3]</sup>. Some studies have shown that the resistive index might increase after hernia surgery itself indicating an injury to the cord structure at the time of surgery or by the effect of mesh wrapped around the cord<sup>[4,5]</sup>. In this study, we aimed to investigate whether an inguinal hernia would have an impact on blood flow, which are closely associated with spermatogenesis, and whether it can be implicated as a putative factor for testicular vascular impairment. Such a proof of impairment of blood flow to the testis may provide another indication for early surgical intervention for inguinal hernias.

**Patient and methods:** A prospective study was conducted which included 50 Patients (with unilateral uncomplicated inguinal hernia who were willing to participate in the study. A detailed history, clinical examination, colour Doppler ultra sonography of involved side and contralateral side (Scrotum) was done. The spectral Doppler parameters were compared statistically. The first statistical analysis was done comparing the resistive index of the hernia side with the normal side (control) before surgery. Next a statistical analysis was done between the **Resistive Index** after surgery with the Resistive Index before surgery on the hernia (involved) side to determine whether the surgery reversed the effect on the Resistive Index if present.

**Results:** In the study conducted it was observed, the mean RI of the **Supra-Testicular arteries** was significantly higher over the Involved side (0.71) than the contra-lateral side (0.68) with a P value= 0.046 respectively. In the study conducted it was observed, the mean RI of the **Intra-Testicular arteries** was significantly higher over the Involved side (0.62) than the contra-lateral side (0.57) with a P value =0.00 respectively. In the study conducted it was also observed that, the mean RI of the **Capsular arteries** over the Involved side (0.627) was lower than the contra-lateral side (0.632) despite not being statistically significant with P value =0.557..

**Conclusion:** Inguinal hernia significantly affects testicular perfusion in involved side as compared to normal side, particularly in supra testicular and intra testicular artery. Pre operatively impaired testicular perfusion is improved post-operatively after surgery. Therefore correction of hernia by surgery leads to normalization of testicular flow.

**Keywords:** NIL

## Introduction

Inguinal hernia is common disorder that predominantly affects men, with an incidence of 5 % to 10 % in the general population. In men between 45 and 64 years, the rate of inguinal hernias is 0.7 %, whereas it increases to 1.5 % after 75 years. Inguinal hernias are classified in 2 types namely direct and indirect, according to their relationship to the inferior epigastric artery<sup>5,10</sup>. An indirect hernial sac is formed by a persistent processus vaginalis or peritoneum, travelling through the deep ring and then the entire inguinal canal inferomedially and exiting through the superficial inguinal ring, after which it commonly enters to the scrotum<sup>4,5,10</sup>. The direct hernia sac does not traverse the entire inguinal canal but instead emerges through the Hasselbachs triangle, below the conjoint tendon to reach the superficial inguinal ring.<sup>5,10</sup>

The spermatic cord is the main content of the inguinal canal. It is made up of the vas deferens, the testicular artery and vein, the ilioinguinal nerve, lymphatic vessels, and fatty tissue ensheathed in tissue layers derived from the abdominal wall. Possible effects of inguinal hernias on the gonads have not been studied despite the fact that they are in a close anatomic relationship with testicular blood vessels throughout the inguinal canal.

With the advent of Colour Doppler ultrasound, we have a modality that is capable of reliably showing the normal testicular arterial anatomy and flow and detect minor changes in flow patterns.<sup>14</sup>

Previous studies have shown that inguinal hernia is associated with increase in resistive index indicating impairment in testicular blood flow, also the correction of hernia by hernioplasty have shown restoration of resistive index to normal levels there by normalizing the testicular flow. However, some studies have shown that the resistive index might increase after hernia surgery itself indicating an injury to the cord structure at the time of surgery or by the effect of mesh wrapped around the cord<sup>16</sup>. Therefore the study was done to determine whether a) Inguinal hernia is associated with any changes in testicular blood flow. b) Correction of hernia by surgery leads to normalization of any changes in testicular flow if present, the study aimed to investigate whether an inguinal hernia would have an impact on blood flow, which are closely associated

with spermatogenesis, and whether it can be implicated as a putative factor for testicular vascular impairment. Such a proof of impairment of blood flow to the testis may provide another indication for early surgical intervention for inguinal hernias.

## Patients And Methods

This prospective study was designed to evaluate the effect of inguinal hernia and subsequent open hernioplasty on testicular perfusion. The study was conducted in all the patients who presented with unilateral uncomplicated inguinal hernia. All men in the age group of 18-65 years with unilateral uncomplicated inguinal hernia were enrolled in the study. The involved side with hernia was measured with the opposite normal side acting as control.

A thorough history was taken and symptoms expressed by the patients, such as a feeling of pressure, discomfort or pain and history of a bulge, as well as the duration of the symptoms and the side of hernia noted. Nature of hernia whether direct/Indirect noted and the level of the inguinal hernia was assessed.

All the individuals included in the study were subjected to Ultrasonographic Evaluation:- Gray scale Ultrasonography and Color Doppler Ultrasonography. The Duplex assessment was done prior to surgery, at the time of discharge, at one week, at one month, post-operatively. The patients were examined in supine and Erect position. Spectral wave form analysis was performed on each side for the supra testicular, sub capsular, and intra-testicular arteries as soon as consistent and reproducible waveforms were obtained by sampling.

The arteries were identified as follows:- At suprastesticular level- the testicular artery is identified at 1cm superior to pole of testis within the spermatic cord. Capsular arteries- Identified along the outer margins of testis. Intra -testicular arteries- Identified as straight structures within the testicular parenchyma

The following parameters were used to determine testicular perfusion: i) Peak Systolic velocity (PSV), ii) End Diastolic Velocity (EDV), iii) Resistive Index (RI). With the help of PSV, EDV, Resistive Index (RI) is calculated using the formula,  $RI = (PSV - EDV)/PSV$ . When the resistive index increase-

testicular perfusion decreases, When the resistive index decreases- testicular perfusion increases. Resistive Index is one of the best markers for assessment of testicular blood flow. Normal mean RI is 0.6, ranging from 0.5 to 0.7. An increasing RI implied an increase in vascular impedance. A decrease in diastolic blood flow with an increase in RI identified testicular ischaemia.

To reduce any error, the mean values of 3 consecutive measurements were taken as the final reading for each of the indices at the suprastesticular, subcapsular, and intratesticular levels. The resistive index measured on the hernia ( affected ) side was compared with the opposite side ( control)

All patients enrolled in the study were taken up for hernioplasty under spinal anesthesia. At the time of the surgery, the nature of the hernia, whether direct or indirect were noted. All patients received a mesh repair by Lichtensteins tension free technique. Special

care was taken to ensure the cord structures were not injured during surgery. Post-operatively all patients underwent repeat Colour Doppler ultrasound to determine the RI on the operated side at 1 week and 1 month after surgery. The post op Resistive index was compared with the pre op values to determine whether it reverted back to normal.

### Results

Total 50 patients were enrolled in the study for analysis.

### Age Distribution

Out of the 50 patients with inguinal hernia, the maximum number of patients were in the age group of 41-50 (34%), 20% each were in the age group of 31-40 yrs and 51-60 yrs, while 14 % were in the age group of <30, and > 60 yrs were only 12%. The mean age of the patients was 45 years with a range of 22-65 years.

**Table 1: AGE DISTRIBUTION**

Age group	Frequency	Percentage
≤ 30	7	14.0%
31 - 40	10	20.0%
41 - 50	17	34.0%
51 - 60	10	20.0%
> 60	6	12.0%
Total	50	100%

### Side Wise Distribution

In the study, 29 (58%) patients had a right sided Inguinal hernia and 21 (42%) patients had left sided Inguinal hernia.

**Table 2: SIDE WISE DISTRIBUTION**

Side of Hernia	Frequency	Percentage
LEFT	21	42.0%
RIGHT	29	58.0%

### Duration Of Symptoms

The average duration of symptoms in patients with inguinal hernia was 17.44 months, (range 1 month – 60 months). 32% had a duration of less than 6 months, 46% had a duration between 6 to 24 months and 22% were had duration more than 24 months.

**Table 3: DURATION OF SYMPTOMS**

Duration of symptoms	Frequency	Percentage
≤ 6 Months	16	32.0%
6 - 24 Months	23	46.0%
> 24 Months	11	22.0%

### Type Of Hernia Distribution

In the study, the total number of Indirect Inguinal hernias was 24/50 (48%), Direct Inguinal hernias was 20/50 (40%) and Pantaloon hernia (both Direct and Indirect) was 6/50 (12%).

**Table 4: TYPE OF HERNIA DISTRIBUTION**

Type of Hernia	Frequency	Percentage
DIRECT	20	40.0%
DIRECT & INDIRECT	6	12.0%
INDIRECT	24	48.0%

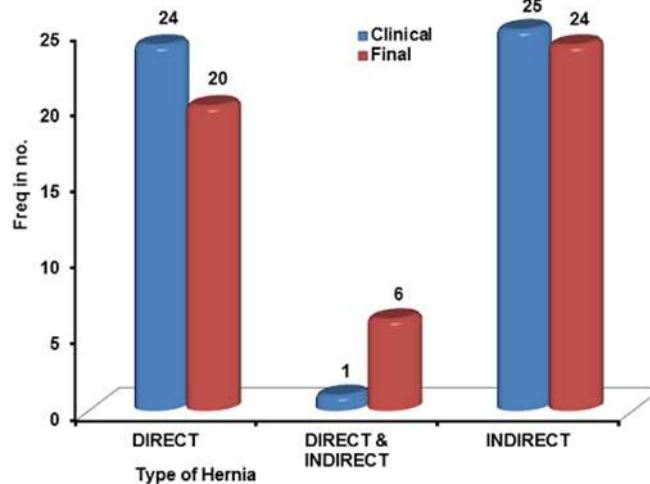
### Clinical Vs Intra-Op (Diagnosis) Wise Distribution

The diagnosis of the type of hernia whether indirect or direct made by clinical examination was compared with the intra-op findings. The findings differed from the initial clinical diagnosis in 8 patients. The error in clinical diagnosis in establishing the type of hernia was therefore 16%. Direct hernias were more likely to be diagnosed incorrectly on clinical examination (30%).

**Table 5: CLINICAL VS INTRA-OP (DIAGNOSIS) WISE DISTRIBUTION**

Type of Hernia	Clinical Diagnosis	Final Diagnosis
DIRECT	24	20
DIRECT & INDIRECT	1	6
INDIRECT	25	24

**Graph 1: CLINICAL VS INTRA-OP (DIAGNOSIS) WISE DISTRIBUTION**

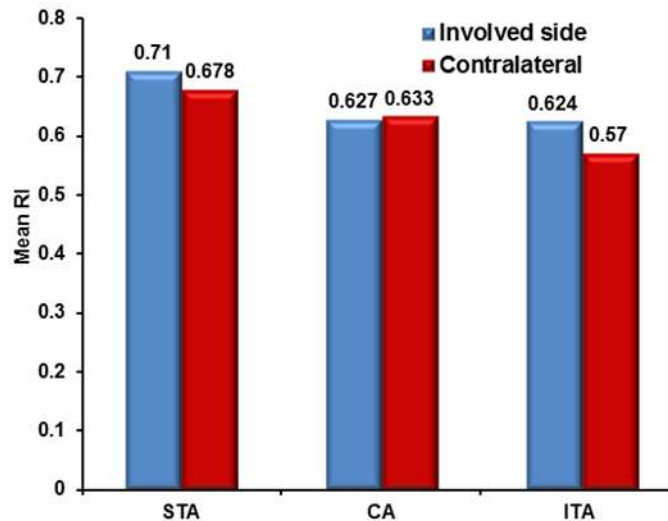


**Distribution Of Mean Resistive Index Values Of Sta, Ca, Ita (Involved Vs Contra-Lateral Side)**

Mean RI of Supra testicular artery (STA) was significantly higher in involved side RI- 0.71 as compared to contra lateral(control) side, RI-0.68(  $p=0.046$ ). Mean RI of capsular artery (CA) in involved side (RI-0.627) was lower than contra lateral(control) side RI-0.632,  $p = 0.557$  ( $>0.05$  and did not reach statistical significance). Mean RI of Intra testicular arteries (ITA) in the involved side was RI-0.62. This was significantly higher than contra lateral (control) side, RI-0.57,  $p=0.00$  ( $<0.05$ ), hence considered significant.

The results showed a statistically significant increase in the mean RI in the supra testicular and intra testicular arteries in the involved side as compared to normal side indicating hernia affects testicular blood flow.

**Graph 2: MEAN RI VALUES OF STA, CA, ITA (INVOLVED VS CONTRA-LATERAL SIDE)**



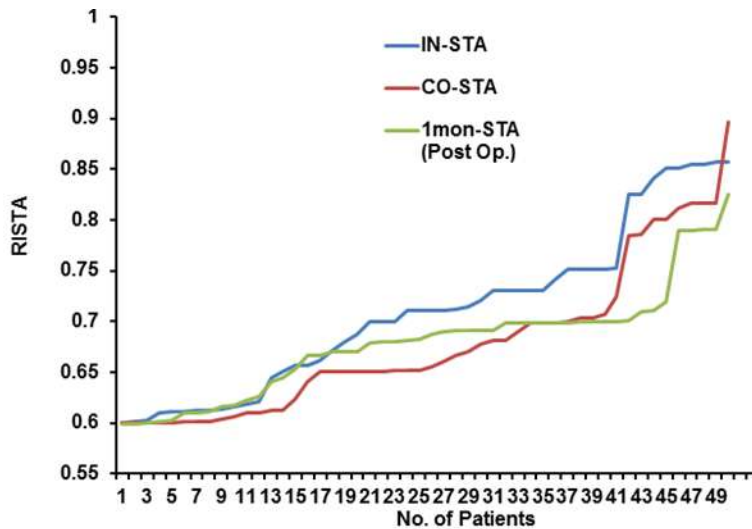
**Comparison Of Supra Testicular Artery (Resistive Index) Of 50 Patients Pre-Op (Involved Side), Contralateral (Control) Side With Post-Op After 1 Month**

The graph shows resistive index of supra testicular artery (STA) of involved side before surgery (Blue line) was more than the contra lateral normal side (Red line) in a majority of patients (40 out of 50, 80%). After surgery, the resistive index of the involved side (Blue line) before surgery shows a decrease at post-op 1 month after mesh repair (Green line) indicating the reversal of the initial resistance to flow which was there when the

hernia was present. Mean RI of Supratesticular artery was significantly higher in involved side, RI- 0.71 as compared to contralateral (normal) side, RI-0.68( p=0.046).

1. The involved hernial side(before surgery) is denoted with a blue line. (IN-STA)
2. The contra lateral (control or normal) side with a red line. (CO-STA)
3. The post- op (1 month) of the involved side(after mesh repair) with a green line.

**Graph 3: Mean resistive index (Supra testicular artery) Intra op, post op (1 month) & contralateral site (control/normal)**



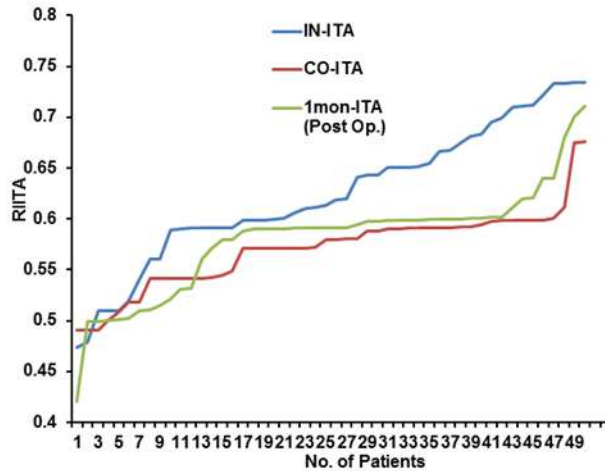
**Comparison Of Intra-Testicular Artery (Resistive Index) Of 50 Patients Pre-Op (Involved Side), Contralateral (Control) Side, Post-Op 1 Month**

The graph shows resistive index of involved side before surgery (blue line) was more than the contra lateral or normal side (red line) in majority of patients (45/50;90%). After surgery, resistive index of involved side (blue line) shows a decrease. The resistive index (testicular perfusion) improved after post-op 1 month of surgery (green line). The study shows , the mean RI of the Intra-Testicular arteries was significantly higher in Involved side(0.62) than contra-lateral side ( 0.57) with difference of 0.05 (P value =.000) , P<0.05, paired sample t test. The RI values of the intra-testicular arteries were higher on the side of the hernia in 45 out of 50 patients (45/50, 90%).

1. The involved hernial side (before surgery ) is denoted with a blue line.
2. (IN-ITA)
3. The contra lateral (control or normal) side with a red line. (CO-ITA )
4. The post- op (1 month) of the involved side(after mesh repair) with a green line.



**Graph 4: Mean resistive index (Intra testicular artery) Intra op, post op (1 month) & contralateral site (control/normal)**

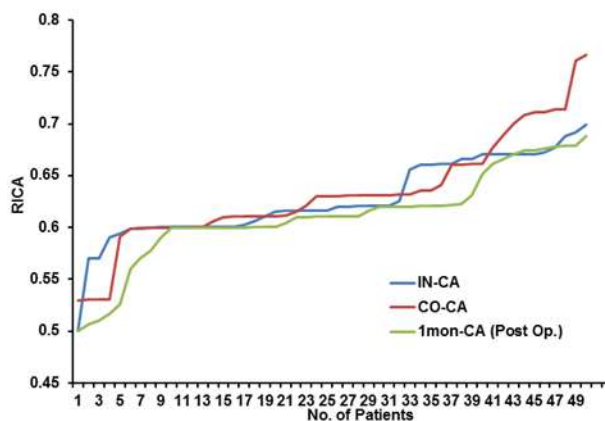


**Comparison Of Capsular Artery (Resistive Index) Of 50 Patients Pre-Op (Involved Side), Contralateral (Control) Side, Post-Op 1 Month**

Above graph shows resistive index of involved side was less than contra lateral side. Study showed, the mean RI of the Capsular arteries on Involved side (blue line) was lower than contra lateral side (red line) despite not being statistically significant {0.627 and 0.632} (P value = 0.557). The RI values of the capsular arteries were higher on the contra-lateral side in 34 patients out of 50 (68%).

1. The involved hernial side (before surgery) is denoted with a blue line. (IN-CA)
2. The contra lateral (control or normal) side with a red line. (CO-CA)
3. The post-op (1 month) of the involved side (after mesh repair) with a green line

**Graph 5: Mean resistive index (Capsular artery) Intra op, post op (1 month) & contralateral site (control/normal)**



**Mean Ri Values Of Supra Testicular Artery, Capsular Artery, Intra- Testicular Artery (Pre-Op Vs Post-Op For 1 Week,1 Month)**

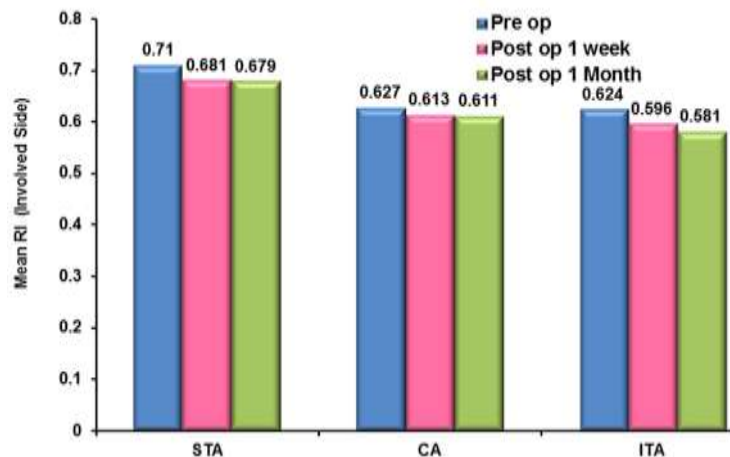
The graph shows that the increased pre-op RI value, decreases 1 week after surgery and is then maintained till 1 month. In all the arteries, the post op decrease in RI from pre-op levels was statistically significant (p<0.05).

This indicates that the surgery for inguinal hernia leads to reversal of the decreased testicular flow caused by the hernia.

(post op 1 wk P value, STA=.008,CA=.049,ITA=.001)

(post op 1 month P value, STA=.002,CA=.048,ITA=0.00)

**Graph 6: Mean RI at the 3 levels (STA, ITA and CA) preoperatively and at 1 week and 1 month after surgery**



**Comparison Of Mean Ri (Supra Testicular Artery, Capsular Artery, Intra- Testicular Artery) Over Involved Side And Contralateral Side In Patients With Symptoms <17months & >17 Months (Pre Op)**

Mean duration of symptoms was 17 months. In the subgroup < 17 months there were 28 patients and in sub group >17 months there were 22 patients. In both sub-groups, the mean RI values of STA and ITA for the involved side ,(and mean RI of CA for <17 months) were higher than those for the contra lateral side. Mean RI values of CA for (>17 months)the involved side were lower than those for the contra lateral side.

**Table 6: RI over involved side and contralateral side in patients with symptoms <17months & >17 months (pre op)**

VESSEL		STA		CA		ITA	
DURATION		< 17 Months	> 17 Months	< 17 Months	> 17 Months	< 17 Months	> 17 Months
RESISTIVE INDEX	Involved	0.680	0.748	0.658	0.639	0.618	0.647
	Contralateral	0.606	0.705	0.622	0.648	0.560	0.585

**Comparison Of Mean (Ri) Involved Side And Contralateral In Patients With Direct, Indirect, Direct & Indirect Hernia (Pre Op)**

The study population -50 patients was divided into 3 subgroups: Direct, Direct & Indirect and Indirect. The mean RI values for supra testicular and intra testicular artery were higher for involved side than contra lateral side in all sub groups of patients.. The mean RI values of capsular arteries for involved side was lower than contra lateral side in all sub groups of patients (direct, indirect, direct & indirect). Hence ,the duration of symptoms ,type of hernia had no correlation with changes in testicular flow or resistive index.



**Table 7: RI over involved side and contralateral side in patients with direct, indirect, direct & indirect hernia (pre op)**

VESSEL		STA			CA			ITA		
TYPE		DIR ECT	DIRECT & INDIRECT	INDIRECT	DIR ECT	DIRECT & INDIRECT	INDIRECT	DIR ECT	DIRECT & INDIRECT	INDIRECT
RESISTIVE INDEX	Involved	0.75	0.70	0.68	0.64	0.64	0.62	0.65	0.66	0.60
	Contralateral	0.69	0.67	0.67	0.65	0.65	0.63	0.59	0.59	0.56

### Discussion

Inguinal hernia is common disorder that predominantly affects men, with an incidence of 5 % to 10 % in the general population. Inguinal hernias are classified as direct and indirect according to their relationship to the inferior epigastric artery.<sup>5,1</sup>

In clinical practice, the diagnosis of a hernia relies mainly on clinical assessment of the patient, including taking a history and performing a physical examination. Ultrasonography of the inguinoscrotal region is suggested for confirming the diagnosis, furthermore, Color Doppler Ultrasound has been suggested for differentiation of blood vessels. Sufficient attention has not been given to whether the close anatomic proximity of the hernia and the vascular pedicle in the inguinoscrotal region might cause impingement of blood vessels and resulting vascular impairment to the testis.

Many studies have been done to determine whether the presence of inguinal hernia affects testicular perfusion and determine whether surgery reverses the effect. In this study the mean age was 45 years and the total range of age group was 22-65 years. Out of the total 50 patients, 24 patients (48%) had Indirect Inguinal hernia , 20 patients (40%) had Direct Inguinal hernia ,6 patients (12%) had Pantaloon hernia (Direct and Indirect Inguinal hernia). Out of 50 patients , 29 patients (58%) were right sided inguinal hernia and 21 patients (42%) were left sided inguinal hernia.

In a study done by Ahmed T.Turgut, et al<sup>18</sup> and Beddy et al<sup>1</sup> showed that inguinal hernia was associated with increase in resistive index indicating

impairment in testicular perfusion. Similarly in this study, Mean RI of supra testicular and Intra testicular artery was higher in involved side as compared to control side . Mean RI of capsular artery in involved side were lower than those in control side, hence not statistically significant by paired sample t test. This data precludes that increase in the mean RI in the suprastesticular and intratesticular arteries in the involved side as compared to normal side indicating hernia affects testicular blood flow.

The study by Peter Beddy et al<sup>1</sup> showed Preoperatively there was a significant elevation in the sonographic resistive index (RI) in the affected (hernia) side compared with the normal side. Similarly our study showed that Mean RI of Suprastesticular and Intratesticular artery is significantly higher over Involved Side than Contralateral side for STA and ITA. Mean RI of Capsular artery was not statistically significant. This elevation of RI Pre-op (on involved side) reversed Post-operatively on (Involved Side). Mean Resistive Index decreased Post-op in all three arteries STA, CA, ITA and was statistically significant.

In the study by A-A-M Elkholy et al<sup>19</sup> Pre-operatively there was significantly higher Resistive Index (RI) on the hernia side compared with normal side, these elevations returned normal post-operatively which proved that impaired testicular perfusion on the side of hernia improved post-operatively. In our study, the Resistive Index was higher on involved side as compared to contralateral side which improved post-operatively at 1 week and 1 month follow up.

**Conclusion:**

Inguinal hernia significantly affects testicular perfusion in involved side as compared to normal side, particularly in suprastesticular and intra testicular artery. Pre operatively impaired testicular perfusion is improved post-operatively after surgery. Therefore correction of hernia by surgery leads to normalization of testicular flow.

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