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Ultrasound and color Doppler in assessment of acute scrotal lesions

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Abstract
Background: The clinical features of acute scrotum are usually pain with or without scrotal swelling. In maximum cases, conservative or non-surgical approach can be followed but if there is spermatic cord torsion, immediate surgical intervention has to be done so that testis can be preserved.
Methods: This prospective study was conducted on 50 patients who were referred to our Department of Radiodiagnosis at Tanta university Hospitals presenting with acute scrotal pain between February 2021 and February 2022. Scrotal ultrasound was performed with a linear 7 to 12-MHz transducer with abundant acoustic gel. Imaging was done in longitudinal and transverse planes with Power Doppler and Color Doppler. The testes, epididymis, spermatic cord, scrotal wall and inguinal region were evaluated. Additional techniques such as the Valsalva maneuver or upright positioning was used for evaluating varicocele. Both testes were examined for size, echotexture and internal vascularity. B-mode parameters such as gain, depth, focus number and position as well as dynamic range were adjusted for better assessment. Both epidydmi were evaluated and compared to each other regarding size, echotexture and internal vascularity. Both spermatic cords were examined for thickness and vascularity as well as deep inguinal rings were examined in supine and erect position for exclusion of inguinal henria.
Results: All the 50 patients (100%) of our study were presented by scrotal pain, 18 patients (36%) presented by scrotal swelling while 14 patients (28%) presented by scrotal erythema. Only 6 cases (16.7%) with epididymo-orchitis, 4 cases (80%) with testicular torsion, 2 cases (100%) with incarcerated inguinal hernia, 6 cases (85.7%) with varicocele were presented with scrotal swelling, also erythema was presented in 13 cases with epididymo-orchitis and in only 1 case (20%) with testicular torsion.
Out of 50 patients of our study; 36 patients were diagnosed as epididymo-orchitis (72%), 7 patients as varicocele (14%), 5 patients as testicular torsion (10%) and only 2 patients as incarcerated inguinal hernia (4%).
Conclusion: In our study, from diagnostic point of view, whirlpool sign with absence of vascularity in distal spermatic cord and testis was the key finding for torsion cases. For epididymo-orchitis, increased vascularity in epididymis & testis were the indicative parameters. For incarcerated hernia, the diagnostic point was akinetic bowel loop in the inguino scrotal region with absent or minimal vascularity of that bowel loop.
For varicocele, dilated venous channels with reflux on Valsalva maneuver was considered. So, to conclude, ultrasound with color Doppler is very useful modality for diagnosing acute scrotum.

Keywords: Scrotal pain, color Doppler, varicocele, scrotal region, incarcerated hernia, epididymo-orchitis, whirlpool sign

1. Introduction
The clinical features of acute scrotum are usually pain with or without scrotal swelling. In maximum cases, conservative or non-surgical approach can be followed but if there is spermatic cord torsion, immediate surgical intervention has to be done so that testis can be preserved. So, here ultrasound with color Doppler provides an important modality option to differentiate between these causes & help in proper management [1].
The frequent etiological factors for causing pain in scrotum are epididymo-orchitis and spermatic cord torsion. It is very difficult to differentiate these conditions solely based on physical examination or laboratory tests and results may not be accurate in 50% of patients. [2].
Other modalities for evaluation of acute scrotum have limitations like MRI is expensive, not

easily available, and less tolerable to irritable patient due to longer duration of examination and CT scan causes radiation to gonads. However, sonography is cost effective & widely available. There is no radiation exposure, and the process is relatively of shorter duration. Scrotum is superficial structure so it can be easily examined by high resolution sonography. Utilization of gray scale sonography with color Doppler provides relevant and required anatomical details along with vascularity, thereby providing the diagnosis [3].

2 Methods

2.1 Study design, setting and time

This prospective study was conducted on 50 patients who were referred to our Department of Radio diagnosis at Tanta university Hospitals presenting with acute scrotal pain between February 2021 and February 2022. After reviewing the requisition and obtaining informed consent.

2.2 Inclusion criteria

Patients referred to Department of Radiodiagnosis at Tanta university hospitals presenting with acute scrotal pain.

2.3 Exclusion Criteria

1. Patients with history of scrotal trauma.
2. Patients with history of scrotal mass.

2.4 Imaging procedure

Scrotal ultrasound was performed with a linear 7 to 12-MHz transducer with abundant acoustic gel. Imaging was done in longitudinal and transverse planes with Power Doppler and Color Doppler. The testes, epididymis, spermatic cord, scrotal wall and inguinal region were evaluated. Additional techniques such as the Valsalva maneuver or upright positioning was used for evaluating varicocele.

Both testes were examined for size, echotexture and internal vascularity. B-mode parameters such as gain, depth, focus number and position as well as dynamic range were adjusted for better assessment.

Both epidydmi were evaluated and compared to each other regarding size, echotexture and internal vascularity.

Both spermatic cords were examined for thickness and vascularity as well as deep inguinal rings were examined in supine and erect position for exclusion of inguinal hernia Using Color Doppler, testicular and epididymal vascularity was evaluated. Color Doppler parameters such as color scale, color gain and color box were adjusted to obtain optimized findings. If internal testicular vascularity was not obtained, color scale was reduced and color gain was increased to confirm the complete absence of vascularity.

In cases of testicular torsion, spectral doppler was used to assess the vascularity findings proximal and distal to the twisted pedicle to confirm the color Doppler findings. Spectral doppler parameters such as sample volume, spectral gain, scale, baseline, angle steer and wall filter were adjusted, and spectral data such as RI and PI were evaluated.

2.5 Statistical analysis of data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Significance was adopted at $p<0.05$ for interpretation of results of tests of significance.

3. Results

Table 1: Distribution of cases of acute scrotal pain according to age

Age (Yrs)	N	%
- Up to 10	4	8
>10 -20	7	14
>20 -30	17	34
>30 -40	8	16
>40 -50	5	10
>50 -60	5	10
>60 – 70	3	6
> 70 – 80	1	2
Total	50	100

We found that the most affected age group >20 – 30 years (3rd decade) 34% followed by 16% in the 4th decade while the least affected group was the eighth decade (2%)

Table 2: Association of Diagnosis and clinical presentation

Clinical presentation	Epididymo-Orchitis		Incarcerated Hernia		Torsion		Varicocel E		Total		p value
	N	%	N	%	N	%	N	%	N	%	
Pain	36	100.0	2	100.0	5	100.0	7	100.0	50	100	<0.001
Swelling	6	16.7	2	100.0	4	80.0	6	85.7	18	36	
Erythema	13	36.1	0	0.0	1	20.0	0	0.0	14	28	

All the 50 patients (100%) of our study were presented by scrotal pain, 18 patients (36%) presented by scrotal swelling while 14 patients (28%) presented by scrotal erythema as shown in table (4)

Only 6 cases (16.7%) with epididymo-orchitis, 4 cases (80%) with testicular torsion, 2 cases (100%) with incarcerated inguinal hernia, 6 cases (85.7%) with varicocele were presented with scrotal swelling, also erythema was presented in 13 cases with epididymo-orchitis and in only 1 case (20%) with testicular torsion.

Table 3: Distribution of cases of acute scrotal pain according to diagnosis

Diagnosis	N	%
Epididymo-orchitis	36	72
Incarcerated inguinal hernia	2	4
Testicular torsion	5	10
Varicocele	7	14
Total	50	100

Out of 50 patients of our study; 36 patients were diagnosed as epididymo-orchitis (72%), 7 patients as varicocele (14%), 5 patients as testicular torsion (10%) and only 2 patients as incarcerated inguinal hernia (4%).

Table 4: Association of diagnosis and affected testis size in age <20 yrs

Affected testis volume (In ml)	Epididymo-Orchitis		Incarcerated Hernia		Torsion		Varicocele		P value
	N	%	N	%	N	%	N	%	
<12	3	37.5	0	0.0	1	33.3	0	0.0	0.709
12-20	2	25.0	0	0.0	2	66.7	0	0.0	
>20	3	37.5	0	0.0	0	0.0	0	0.0	
Total	8	100.0	0	0.0	3	100.0	0	0.0	

In age group less than 20 years old, only 4 cases (In childhood period) presented with testis size less than 12 ml, 3 of them were positive for epididymo-orchitis and 1 positive for testicular torsion.

Table 5: Association of Diagnosis and Affected Testis Size in Age >20yrs

Affected Testis Volume (in ml)	Epididymo-Orchitis		Incarcerated Hernia		Torsion		Varicocele		p value
	N	%	N	%	N	%	N	%	
<12	1	3.6	0	0.0	0	0.0	2	28.6	0.018
12-20	7	25.0	2	100.0	2	40.0	2	28.6	
>20	20	71.4	0	0.0	0	0.0	3	42.8	
Total	28	100.0	2	100.0	2	100.0	7	100.0	

In age group more than 20 years old, about 3 cases presented with testis size less than 12 ml, one of them were positive for epididymo-orchitis, 2 were positive for for varicocele.

Table 6: Association of Diagnosis and Testis Echotexture

Testis Echotexture	Epididymo-Orchitis		Incarcerated Hernia		Torsion		Varicocele		P value
	N	%	N	%	N	%	N	%	
Heterogenous	12	33.3	0	0.0	5	100.0	0	0.0	<0.001
Homogenous	24	66.7	2	100.0	0	0.0	7	100.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Testes echotexture was heterogenous in 12 cases (33.3%) of epididymo-orchitis and in 5 cases (100%) of testicular torsion.Regarding incarcerated hernia and varicocele, testes echtexture was not affected (Homogenous)

Table 7: Association of Diagnosis and Testis Vascularity

Testis Vascularity	Epididymo-Orchitis		Obstructed Hernia		Torsion		Varicocele		p value
	N	%	N	%	N	%	N	%	
Increased	32	88.9	0	0.0	0	0.0	0	0.0	<0.001
Normal	4	11.1	2	100.0	0	0.0	7	100.0	
Nil	0	0.0	0	0.0	5	100.0	0	0.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Regarding epididymo-orchitis, testis vascularity increased in 32 cases (88.9%) and was normal in 4 cases (11.1%).In testicular torsion, testis vascularity was absent in all 5 cases (100%). Concerning to varicoclele and incarcerated inguinal hernia, testes vascularity was not affected (normal vascularity)

Table 8: Association of Diagnosis and Epididymis Echotexture

\Epididymis Echotexture	Epididymo-Orchitis		Obstructed Hernia		Torsion		Varicocele		p value
	N	%	N	%	N	%	N	%	
Heterogenous	29	80.6	0	0.0	5	100.0	0	0.0	<0.001
Homogenous	7	19.4	2	100.0	0	0.0	7	100.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Epididymis echotexture was heterogenous in 29 cases (80.6%) of epididymo-orchitis and in 5 cases (100%) of testicular torsion.Regarding incarcerated hernia and varicocele, epididymis echtexture was not affected (Homogenous)

Table 9: Association of Diagnosis and Epididymis Vascularity

Epididymis Vascularity	Epididymo-Orchitis		Obstructed Hernia		Torsion		Varicocele		p value
	N	%	N	%	N	%	N	%	
Increased	36	100.0	0	0.0	0	0.0	0	0.0	<0.001
Normal	0	0.0	2	100.0	0	0.0	2	28.6	

Prominent Venous Channels	0	0.0	0	0.0	0	0.0	5	71.4	
Whirlpool Sign	0	0.0	0	0.0	5	100.0	0	0.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Regarding epididymo-orchitis, epididymis vascularity increased in 36 cases (100%).In testicular torsion, epididymis vascularity was absent in all 5 cases (100%). Concerning to varicoclele and incarcerated inguinal hernia, epdididymis vascularity was not affected (normal vascularity)

Table 10: Association of Diagnosis and Affected epididymis Size

Affected epididymis Size	Epididymo-Orchitis		Incarcerated Hernia		Torsion		Varicocele		p value
	N	%	N	%	N	%	N	%	
Increased	31	86.1	0	0.0	5	100.0	0	0.0	0.018
Normal	5	13.9	2	100.0	0	0.0	7	100.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Epididymis enlarged in 31 cases (80.6%) of epididymo-orchitis and in 5 cases (100%) of testicular torsion.Regarding incarcerated hernia and varicocele, epididymis size was not affected

Table 11: Ultrasound Findings in the 5 Patient with Testicular Torsion

Examination mode	Ultrasound finding			NO	%
B mode	Testicular size	Enlarged		4	80
		Normal		1	20
	Testicular Echotexture	Heterogenous		5	100
		Homogenous		0	0
	Epididymis size	Enlarged		5	100
		Normal		0	0
	Epididymis Echotexture	Heterogenous		5	100
		Homogenous		0	0
Color Doppler US	Intra-testicular vascularity	Present		0	0
		absent		5	100
	RI	Intratesticular		-	-
		Proximal to the twisted pedicle	<0.75	0	0
			>0.75- 0.85	3	60
			>0.85	2	40
	PI	Intratesticular		-	-
		Proximal to the twisted pedicle	<1.2	0	0
			>1.2-1.5	3	60
			>1.5	2	40

In our study the most frequent findings in testicular torsion were heterogenous testicular echotexture, enlarged heterogenous epididymis and absent testicular vascularity. Regarding doppler indices, RI more than 0.75 and PI more than 1.2 were the most frequent findings

Table 12: Ultrasound Findings in the 36 Patient with Epididymorchitis

Examination mode	Ultrasound finding		NO	%
B mode	Testicular size	Enlarged	32	88.9
		Normal	3	8.3
		Small sized	1	2.8
	Testicular Echotexture	Heterogenous	12	33.3
		Homogenous	24	66.7
	Epididymis size	Enlarged	31	86.1
		Normal	5	13.9
	Epididymis Echotexture	Heterogenous	29	80.6
		Homogenous	7	19.4
Color Doppler US	Testicular vascularity	Increased	32	88.9
		Normal	4	11.1
	Epididymal vascularity	Increased	36	100
		Normal	0	0
	RI	<0.5	28	77.8
		>0.5-0.75	8	22.2
		>0.75	0	0
	PI	<0.67	28	77.8
		>0.67-1.2	8	22.2
		>1.2	0	0

In our study the most frequent findings in epididymitis or epididymo-orchitis were heterogenous hypervascular epididymis regarding doppler indices RI <0.5 and PI <0.67 were the most frequent indices.

Table 13: Ultrasound Findings in the 7 Patient with Varicocele

	Ultrasound finding		NO	%
Examination mode	Pampiniform plexus of veins diameter	<2.5 mm	0	0
		2.5-<3 mm	1	14.3
		3-<4 mm	4	57.1
		>4 mm	2	28.6
	Level of dilated veins	Only groin level	0	80.6
		Down to proximal segment of venous plexus	2	28.6
		Down to distal segment of venous plexus	5	71.4
Color Doppler US	Change of velocity with Valsalva maneuver	2-5 cm/sec	0	0
		>5-10 cm/sec	3	42.9
		>10 cm/sec	4	57.1

In our study the most frequent findings in varicocele were dilated pampinform plexus of veins; maximum vein diameter more than 3 mm at the distal portion of venous plexus with change of velocity more than 5 cm

Case No (1)
Clinical history
Male patient 26 year old presented by acute right sided scrotal pain.

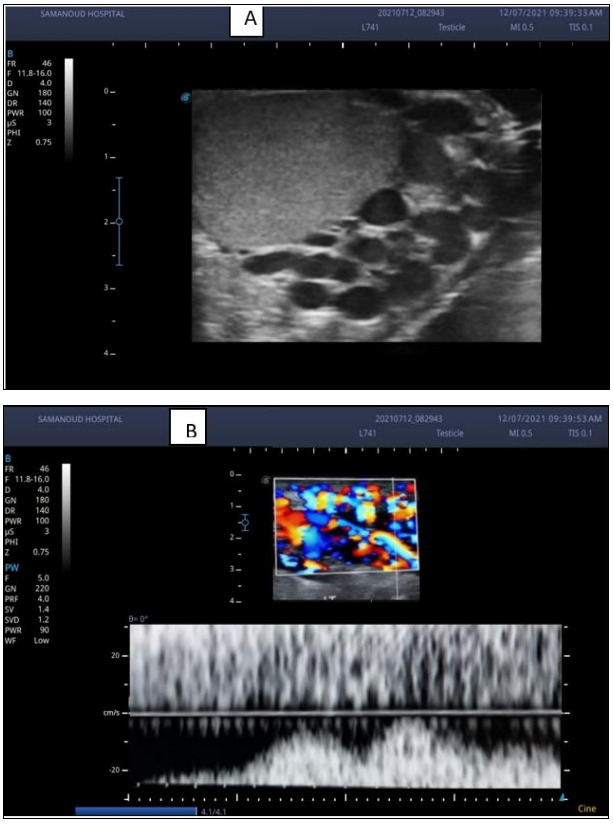

Fig 1: A & B: scrotal ultrasound revealed

Male patient 26 year old presented by acute right sided scrotal pain, had performed ultrasound (B mode and color Doppler). (A) HRUS TS of lower portion of left hemiscrotum showing marked dilated pampiniform plexus maximum diameter reaches 3.8 mm. (B) HRUS LS of the aforementioned dilated pampiniform plexus while patient standing and performing Valsalva maneuver. The color and spectral Doppler shows marked venous reflux in the distal vessels at level of lower scrotum, Final diagnosis: marked grade III varicocele.

Case No (2)
Clinical history
Male patient 22 year old presented by acute right side scrotal pain and mild swelling.

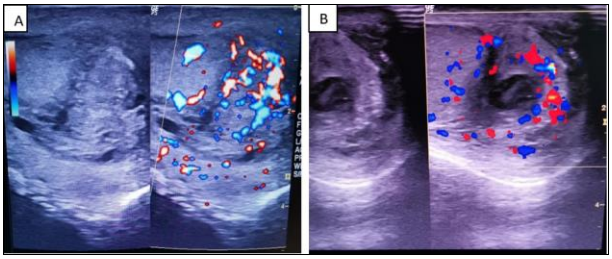

Fig 2: A and B: scrotal ultrasound revealed

Male patient 22 year old presented by acute right side scrotal pain and mild swelling, had performed ultrasound (B mode and color Doppler). (A) HRUS LS of the right epididymis revealed; enlarged edematous epididymis with heterogeneous echotexture associated with increased internal vascularity. (B) HRUS LS of epididymal tail revealed a fairly defined hypoechoic lesion 6 x 4 mm with multiple internal echoes without detectable internal vascularity exhibiting inflammatory collection, Final diagnosis: acute epididymitis

Case No (3)
Male patient 50 year old presented by acute left sided scrotal pain and inguinal swelling.

Fig 3: A & B: scrotal ultrasound revealed

Male patient 50 year old presented by acute left sided scrotal pain and inguinal swelling, had performed ultrasound (B mode and color Doppler). (A) HRUS LS of the proximal portion of left inguinal canal showing herniated small bowel loops through left deep inguinal ring being irreducible by patient nor gentle probe pressure exhibiting mushroom sign. (B) Complementary abdominal examination revealed dilated small bowel loops proximal to the herniated loops with to and fro intestinal motion i.e U/S findings are consistent with incarcerated indirect inguinal hernia

Case No (4)
Male patient 25 year old presented by acute left side scrotal pain and swelling.

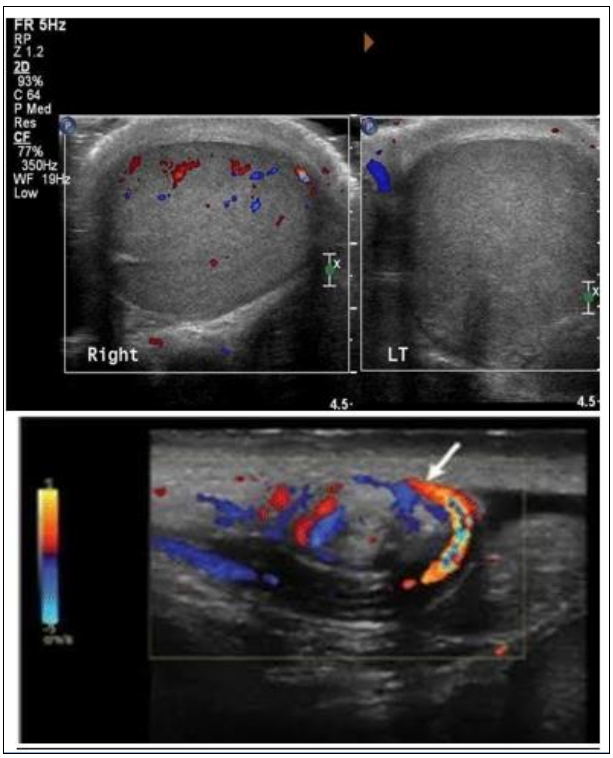

Fig 4: A, B&C: scrotal ultrasound revealed

Male patient 25 year old presented by acute left side scrotal pain and swelling, had performed ultrasound (B mode and color Doppler). (A) HRUS TS of right hemiscrotum revealed normal orientation of right testis with preserved internal vascularity. (B) HRUS TS of left hemiscrotum revealed abnormal orientation of left testis being horizontally oriented displaying subtle heterogenous echopattern without detectable internal vascularity on color doppler ultrasound (C) HRUS TS of spermatic cord revealed characteristic whirlpool sign, Final diagnsos: Left testicular torsion.

Case No (5)
Male patient 20 year old presented by acute right side scrotal pain.

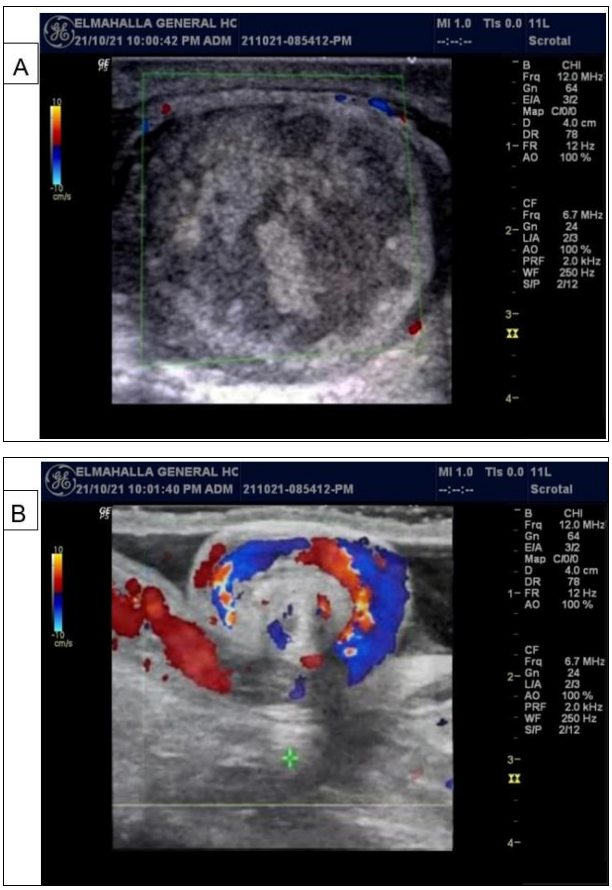

Fig 5: A&B: scrotal ultrasound revealed

Male patient 20 year old presented by acute right side scrotal pain performed ultrasound (B mode and color Doppler). (A) HRUS LS of right testes revealed swollen heterogenous testis showing multiple hyperechoic area represent hemorrhagic infarctions without detectable internal vascularity on color Doppler. (B) HRUS TS of spermatic cord revealed characteristic whirlpool sign, Final diagnosis: Right testicular torsion.

4 Discussion
A study involving fifty patients of acute scrotum was done. Out of 50 patients of our study; 36 patients were diagnosed as epididymo-orchitis (72%), 7 patients as varicocele (14%), 5 patients as testicular torsion (10%) and only 2 patients as incarcerated inguinal hernia (4%). The most common cause of pain and swelling in the scrotum is seem to be epididymo-orchitis which occurs due to retrograde infection from the bladder or the prostate gland. The epididymal head is the region most commonly affected [4]. The incidence of these scrotal pathologies varies from study to study. Melekos *et al.* [5] and Jefferson *et al.* [6] referred spermatic cord torsion, while McAndrew *et al.* [7] referred torsion of

the appendages as the most common etiology of acute scrotum in. In accordance with other series, [7, 8] the present study showed that the most common cause was epididymo orchitis. Epididymo orchitis was also found to be the leading cause of acute scrotum in studies conducted by other authors [9, 10]. The most affected age group in our study were >20 – 30 years (3rd decade) representing 34% followed by 16% in the 4th decade while the least affected group was the eighth decade (2%).

The greatest number of cases in our study were 17 and belonged to the age group of 21 to 30 years, which is similar to the findings of Arger *et al* who mentioned that 64% of cases in his study were of age group 21-40 years [11, 12]. Also similar to our study another prospective and observational study which was carried out in the Radiology Department of S.S.G. Hospital & Medical College, Baroda, Gujarat showed that, out of 46 cases largest number of patients fall in age group of 21-40 years, which is 69.4% of all cases. 3 cases were in age group of ≤ 20 years (8%) and rest 20% (11 cases) were in age group of 40-60 years [13]. Real-time grayscale imaging is most helpful to identify a spermatic cord "twist" as seen in 199 of 208 patients (sensitivity 96%), whereas a normal linear cord was found in patients without torsion (705 of 711 patients, 99% specificity) [14]. This twisted cord finding is known as the "whirlpool sign" and can be seen above the testis, external to the inguinal ring [15]. In our study of 50 patients, 5 cases (10%) were diagnosed positive for torsion. Pain was present in all the 5 cases. Swelling was present in 4 cases while only one case had erythema. The echotexture of testis was heterogeneous in all 5 cases as compared to opposite side. There was absent vascularity in affected testis in all the cases. In all the five cases there was heterogeneous echogenicity of the epididymis. Also, whirlpool sign was noted in all the cases, in which there was snail shaped or whorled appearance of spermatic cord affecting the epididymis as well. The part proximal to this whorled appearance was showing vascularity, while distal to it there was absence of vascularity. This was the typical feature present in our study & also the most characteristic one as well. On surgical confirmation, all the five cases were found out to be torsion.

Catalano *et al*., using similar technique with that of our study, Despite the large number of patients, only 11 out of the 126 cases investigated by the authors with the real-time contrast-specific U/S, concerned acute painful scrotum situations [16]. In the report by Paltiel *et al*., the U/S demonstrated that 9 of 11 were cases of torsion and 23 of 30 were cases of non-torsion with 1 false positive and there were 8 indeterminate cases [17]. In a study by Vijayaraghavan, whirlpool sign with no vascularity in distal part was present in torsion in the 61 out of 221 cases. This finding was consistent as we found whirlpool sign in all our cases. However, in other 4 cases, there was distal vascularity present. Such cases were diagnosed with incomplete torsion. In these 4 cases, there were focal areas of hypoechogenicity with absent vascularity. These were the regions of segmental infarction in the testis. In our study, there was no such case of partial presence of vascularity in the testis or in the distal part of spermatic cord. The reason may be lower sample size of 50 cases in our study [18]. Lukosiute-Urboniene A found 8 cases out of torsion out of 50 cases with similar findings of absent testicular flow. There was sensitivity and specificity of 100%. This was comparable with our study [19]. In our study of 50 patients, 36 cases (72%) were diagnosed for epididymo-orchitis & epididymitis. All the 36 cases presented with pain while swelling was present in 6 cases. There was erythema in 13 patients. There was homogenous normal echotexture of testis in 24 cases, & it was the finding in majority. Heterogeneous echogenicity was noted in 11 cases while 1 case showed hypoechoic heterogeneous echotexture. Testicular vascularity was characteristically increased in 32 cases while in remaining 4 cases it was normal. In these 4 cases the diagnosis was of epididymitis was provided. On contrary to testis echotexture, the epididymal echotexture was heterogeneous in majority 29 cases & homogenous in 7 cases. Increased epididymal vascularity was present in all 36 cases. So, in our study, vascularity of testis & epididymis were the major criteria for the diagnosis of epididymo-orchitis and epididymitis. Vijayaraghavan opined enlarged testis or epididymis or both and increased Vascularity as the main diagnostic feature [18]. D'Andrea *et al* and Thinyu *et al* also confirmed the same finding [20, 21]. In our study of 50 patients, there were 2 cases of incarcerated hernia of age 26 Years & 50 years. The feature of pain & swelling was present in both cases. Testicular Echotexture & vascularity were normal in both of the cases. Similarly, epididymis was Homogenous with maintained vascularity in both cases. Similar findings were in the previous studies. Ogata *et al* diagnosed obstructed hernia in 35 out of 39 patients with akinetic loop which was dilated [22].

Celestino *et al*. also indicated the same feature of dilated akinetic loop of intestine for obstructed hernia [23]. A M Agrawal *et al* found 1 case of obstructive inguino-scrotal hernia. Non-Peristaltic or akinetic bowel loop in the scrotum was the characteristic feature [24] In our study of 50 patients, there were 7 cases of varicocele. Additionally, there was positive history of infertility in 2 patients. Pain & swelling were present in 7 & 6 cases respectively. While erythema was not there in any case. Testicular echotexture & vascularity both were normal in all the 7 cases. Epididymis was homogenous in all the cases, but there were significant prominent Vascular channels which demonstrated venous flow. This characteristic feature of venous flow with reflux on Valsalva maneuver was the diagnostic feature in our study. Same feature was found in previous studies. R L Bree *et al* & E D Kim *et al* Described varicocele as tubular structures with anechoic echotexture on gray scale [25].

Conflict of Interest
Not available

Financial Support
Not available

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