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Feasibility of scrotal colour Doppler and ultrasonography training during surgical residency

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Abstract
Introduction: The use of ultrasonography by non-radiologists is widely accepted worldwide and various training modules are available for training surgeons in office ultrasonography. Scrotal Colour Doppler and Ultrasonography (CDUS) for scrotal diseases is included in urology module. Office ultrasonography for scrotal diseases not only supports the clinical diagnosis but also helps in avoiding unnecessary surgeries. This study was undertaken to study the feasibility of training of surgery residents in Scrotal Colour Doppler and Ultrasonography.
Aim: This study aims to develop a training module for Scrotal Colour Doppler and Ultrasonography during surgical residency programme and validate it by comparing the competency of surgical resident with a radiologist resident
Materials and Methods: A training module for Colour Doppler and Ultrasonography was proposed after studying the modules available in literature and training schedule for radiology resident in our institution. A radiologist was nominated as co-guide. A surgical resident underwent training in three phase's i.e training phase, performing phase and evaluation phase. Initial training and evaluation was done by radiologist in radiology dept. The surgery resident and nominated radiology resident performed the CDUS on each patient in presence of co-guide/qualified ultrasonologist. Both reports were sealed and evaluated in evaluation phase.
Results: In the evaluation phase the reports of surgery resident and radiology resident were evaluated and compared with the reports of the ultrasonologist and also compared with final diagnosis. Results were statistically analysed.
Conclusions: The study concluded that training of surgery residents in Focused Scrotal Colour Doppler and Ultrasonography is feasible during residency with satisfactory results comparable to that of radiology resident

Keywords: Scrotal colour Doppler and ultrasonography, Training, Surgical Residency

Introduction
Role of Colour Doppler and Ultrasonography (CDUS) in acute scrotal conditions and trauma is well established. Even in chronic scrotal swelling CDUS plays an important role in diagnosing underlying diseases and associated pathologies [1]. Office Ultrasonography performed by the surgeon during initial examination results in improved diagnosis, prompt treatment and helps in reducing admissions and duration of hospital stay [2].
In India training of surgical residents in Ultrasonography is in initial stages [3]. Various training modules are available abroad for the training of non-radiologists in ultrasonography [4].
This study was undertaken to develop a training module for scrotal colour Doppler and ultrasonography during surgical residency programme and to validate it by comparing the competency of surgical resident with a radiology resident.

Materials and Methods
Institutional ethics committee approval was taken prior to the study. Informed consent was obtained from all the patients before inclusion in the study. Approval from the Head of Department of Radiology was taken and one professor from the Department of Radiology was assigned at a Co-Guide. The study included 200 patients with scrotal complains over a period of 20 months. All cases with open scrotal trauma, Inguino-scrotal hernias and undescended testis were excluded. The cases were divided into two groups, Group A: 50 cases (training phase), Group B: 150 (Performance Phase).

The training module was divided into three phases:
Phase I: Training Phase.
Phase II: Performing Phase.
Phase III: Evaluation of Results.
Phase I: (Training Phase) was further divided into three components
(a) Theory knowledge
(b) Practical knowledge
(c) Reciprocating the results.

Theory knowledge: Surgery resident underwent training in the basics of ultrasonography with special emphasis on Scrotal CDUS through 60 hour specially designed lesson plan shown in Table 1.

Practical knowledge: This component phase was designed to train the surgery resident with practical knowledge to perform a CDUS examination of the scrotal contents in different planes, recognise normal CDUS anatomy of the scrotal wall, testes, epididymis and spermatic cord and recognise the diagnoses of various pathologies. A total number of 100 scans were observed by the resident, while the radiologist was performing them.

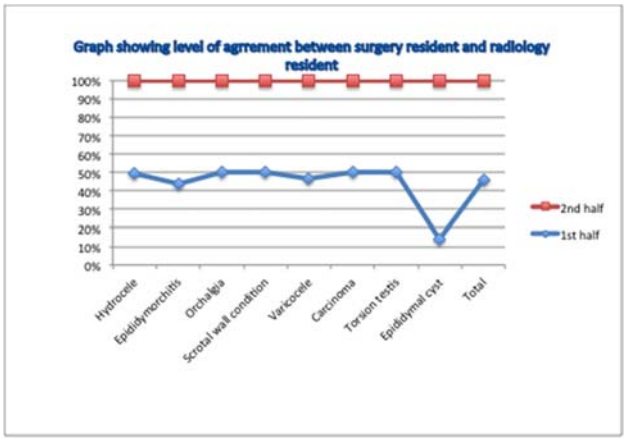
Reciprocating the results: A total of 50 Patients with scrotal complains coming to the OPD and patients referred to radiology department for scrotal CDUS were identified. The radiologist (co-guide) did CDUS while the surgery resident was observing and the scan was reciprocated by the surgery resident after observing it.
Phase I of training module concluded with a theory assessment by a written test, viva-voice, which included identifying random CDUS pictures assessed by the co-guide and accuracy in reciprocating the 50 scans was also noted. To qualify to the next phase surgery resident had to score more than 50% marks in theory and practical examination.

PHASE II: (Performing Phase): The co-guide selected a radiology resident of the same year as the surgery resident, who was constant throughout the study. A total number of 150 cases with scrotal complains were identified. The surgery resident and radiology resident performed the CDUS on each patient individually, in presence of the Co-Guide or any other Faculty from Department of radiology. The reports prepared by both residents were sealed and submitted to the co guide which were evaluated in phase III.

PHASE III: (Evaluation of Results): The collected data was organized, tabulated and statistically analyzed. Open Epi (Version 3) and Primer statistical analysis software was used for statistical evaluation. The scan reports of the surgery resident and radiology resident were evaluated using Z test for comparison between two proportions. For interpretation of results, p value $p<0.05$ was considered significant. Kappa coefficient as statistical test was used for level of agreement of CDUS reports between surgery resident and radiology resident.

Results

The comparison of Clinical diagnosis and Final diagnosis is given in Table 2.The distribution of cases, intervention and final outcome of the cases are listed in table 3. Comparison of CDUS diagnosis by surgery and radiology resident in study group are listed in table 4.The improvement shown by the surgery resident in the second half of the study is depicted by this graph.



Graph 1: Graph showing level of agreement between surgery resident and radiology resident

96 cases were diagnosed as hydrocele on CDUS, 88 were diagnosed clinically. When compared to the final diagnosis CDUS showed a positive predictive value of 98.94% and sensitivity and specificity of 94.9% and 99.02% respectively. Of 8 cases that showed change in the diagnosis or had additional findings mostly were due the fact that swelling made the other appendages inaccessible to the examining fingers. Albino *et al.* [5] reported many cases ranging from simple impalpable epididymal cysts (7 out of 8 cases in our study) to impalpable malignant tumors.
23(11%) cases presented with vague pain in the testes without any signs of swelling or tenderness and were termed as Orchialgia clinically. 12 cases on CDUS showed an impalpable pathology thus changing the diagnosis and the management. Out of the 12 cases, 5 had epididymal cyst, 4 had varicocele, 2 had hydrocele and 1case had epididymorchitis. The clinical diagnosis had positive predictive value of only 47.87% and sensitivity and specificity of 100% and 93.65% respectively when compared to the final diagnosis. A study conducted by Laurence Levine [6], emphasize all these etiologies to be considered while managing a case of orchialgia.
Among the infectious causes 25 cases (12.5%) had epididymitis, 23 cases (11.5%) had epididymorchitis and 12 cases (6%) had funiculitis. All 48 cases of epididymorchitis were treated medically.
3 cases were clinically diagnosed to have torsion testes. One case was misdiagnosed clinically but proven to be epididymorchitis on CDUS thus avoiding unnecessary exploration, showing a positive predictive value of 66.67% and sensitivity and specificity of 100% and 99.49% respectively when compared to final diagnosis. A retrospective study reported by Sergiy Tadtayev *et al.* [7]. In 117 cases of emergency scrotal exploration for testicular torsion concluded that vast majority of unnecessary surgeries and their complications could be prevented by timely and accurate CDUS.
14 cases of varicocele were diagnosed on CDUS. Only 10 cases had clinical symptoms showing a sensitivity of only 71.43%, 4 cases which showed no signs clinically were diagnosed on CDUS. Thus showing the importance of CDUS in diagnosis of varicocele also emphasized by Michael K Wolver son, Monica L Leung *et al.* [8, 9].
3 cases of carcinoma underwent orchidectomy and seminoma was the histopathological report in all 3 cases, remaining 2 cases were referred for chemotherapy and radiation as they were advanced cases of carcinoma

Table 1: Topics and Hours of training

S. No.	Topic	No. of Hours
1	Basic Physics	6
2	Instrumentation	6
3	Doppler And Color Flow Principles	8
4	Sonographic Scrotal Anatomy	10
5	Imaging Acute Scrotal Pain	6
6	Imaging Chronic Scrotal Pain	6
7	Imaging Scrotal Lumps 1	6
8	Imaging Scrotal Lumps 2	6
9	Incidental Scrotal Findings	6

Table 2: The comparison of Clinical diagnosis and CDUS diagnosis**.**

Diagnosis	Clinical diagnosis	CDUS diagnosis	PPV	NPV	Sensitivity	Specificity
Hydrocele	94(47%)	96(49%)	98.94%	94.28%	94.9%	99.02%
Epididymorchitis	47(23.5%)	48(24%)	97.87%	98.69%	95.83%	99.34%
Orchialgia	23(11.5%)	11(5.5%)	47.8%	100%	100%	93.65%
Scrotal wall condition	15(7.5%)	15(7.5%)	93.33%	99.46%	93.33%	99.46%
Varicocele	10(5%)	14(7%)	100%	97.89%	71.43%	100.00%
Carcinoma	4(2%)	5(2.5%)	100%	99.49%	80%	100.00%
Torsion testis	3(1.5%)	2(1%)	66.67%	100%	100%	99.49%
Atrophic testis	1(0.5%)	1(0.5%)	100%	100%	100%	100.00%
Haematocele	2(1%)	3(1.5%)	100%	99.49%	66.67%	100.00%
Epididymal cyst	1(1%)	15(7.5%)	100%	92.96%	6.66%	100.00%

Table 3: Distribution of cases, intervention and final outcome of the cases

Final Diagnosis	n	Intervention	n	HPE
Epididymorchitis	48	Medical/ conservative/supportive	48	NA
Hydrocele	96	Lords Plication	46	NA
		Jaboulay Procedure	48	NA
		Medical/ conservative/supportive	2	NA
Varicocele	14	Palomo Operation	10	NA
		Medical/ conservative/supportive	4	NA
Carcinoma	5	Referred for radiotherapy	2	NA
		High Orchidectomy	3	Seminoma(3)
Epididymal Cyst	6	Medical/ conservative/supportive	5	NA
		Excision	1	Epididymal cyst(1)
Orchialgia	11	Medical/ conservative/supportive	11	NA
Testicular torsion	2	Detorsion and orchiopexy	2	NA
Scrotal wall Abscess	10	Debridement/I&D	10	NA
Sebaceous cyst over scrotum	3	Excision	3	Sebaceous cyst(3)
Atrophic testis	1	Orchidectomy	1	Atrophic testis(1)

Table 4: Comparison of CDUS diagnosis by surgery and radiology

Diagnosis	N (%)	Surgery resident	Radiology resident	Z value	P Value
Hydrocele	75(100)	71(94%)	73(97%)	0.425	0.671
Epididymorchitis	31(100)	25(80%)	30(96%)	1.598	0.110
Orchialgia	6(100)	6(100%)	6(100%)	0	>0.05
Scrotal wall condition	12(100)	12(100%)	12(100%)	0	>0.05
Varicocele	12(100)	10(83%)	11(91%)	-0.002	0.998
Carcinoma	5(100)	5(100%)	5(100%)	0	>0.05
Torsion testis	2(100)	1(50%)	1(50%)	-1.000	0.317
Epididymal cyst	6(100)	1(16%)	6(100%)	2.344	0.019
Atrophic testis	1(100)	1(100%)	1(100%)	0	>0.05
Total	150(100)	132(88%)	144(96%)	2.341	0.019

Discussion

The use of ultrasound by non-radiologists is widely being accepted worldwide. Surgeons are using it as an aid in various therapeutic and diagnostic modalities. Grace S. Rozycki *et al.* [10]. And Christophe LM *et al.* [11]. Have described many courses most of which have a focused attention on one particular aspect like breast imaging, FAST protocol. Most of these courses include an instructor, theory classes, observing and reciprocating the scans and most important setting the goals to be achieved at the end of the training. The training module was designed, on the basis of guidelines according to Ultrasound Training Recommendations for medical and surgical specialties published by The Royal college of Radiologists in 2012 which recommends 250 cases and three to six months of training to reach Level I excellency in Urological module [12]. In our study training module (Phase I) with observing 100 cases and reciprocating 50 cases did show positive results. However it showed a significant difference in opinions with radiology resident in first half of the study, but after 75 cases

of the first half of the study surgery resident showed 100% accuracy rate in second half of the study.

Scrotal colour Doppler and ultrasonography was performed by the surgery resident on a total of 150 patients with complains related to the scrotum. The scan was repeated by a single radiology resident of the same year dedicated by the instructor who was constant though out the study. Both the reports were handed over to the instructor, which were then evaluated at the end of the study. Of all the 150 cases surgery resident had positive scans in 132 cases and radiology resident had positive scans in 144 cases with a overall z value of 2.341 which was significant statistically (p <0.05).) An overall kappa agreement score of 92 was achieved between the scan reports of the surgery and radiology resident, which is graded as excellent agreement. All the errors done by surgery resident were in the first half of the study where the surgery resident had 66 positive scans compared to 77 positive scans of the radiology resident which was significant statistically. The surgery resident showed a significant improvement in the second half in which he reached the level of the radiology resident where both of the residents had 68 positive results which was statistically not significant. Irkorucu O *et al.* [13]. Concluded that both surgeon performed USG and radiologist performed USG have a high accuracy rate. Thus with proper training the surgery resident can achieve results in ultrasonography scanning of scrotum as that of radiology resident. This view was observed by Christopher LM *et al* [11]. In various settings. Of all the 150 scans done, surgery resident had Wilson diagnostic accuracy score of 88 compared to the final diagnosis, the accuracy improved in the second half of the study. These results achieved stand as example of technical attainability of focused Ultrasonography in Scrotum and also proves that scrotal ultrasonography by the surgeon is beneficial as other areas like breast ultrasonography, FAST protocol, vascular ultrasonography.

Conclusion

Clinical diagnosis in cases of scrotal pathologies needs the support of diagnostic modality like Colour Doppler ultrasonography to reach to a accurate final diagnosis. Colour Doppler ultrasonography is a choice of investigation for scrotal pathologies and helps in giving an accurate diagnosis. Ultrasonography contributes not only in giving additional information but also helps in avoiding unnecessary surgeries. Ultrasonography of scrotum by surgeons is feasible after adequate training. The scan results of the surgery resident are satisfactory when compared to the final diagnosis and the learning curve improves with every scan. The training of surgery resident in focused colour Doppler and ultrasonography is feasible during residency with satisfactory results comparable to that of radiology resident. Thus validating our training module.

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