

Diagnostic Role of High Frequency Ultrasound with Colour Doppler in Evaluation of Scrotal PathologiesKaran Lalwani¹, Nishant Mehta², Heti Mistry³, Nilesh Prajapati⁴¹Consultant Radiologist, Divine Life Hospital, Adipur, Kutch, Gujarat²Consultant Radiologist, Zydus Hospital, Vadodara, Gujarat³Assistant Professor, Department of General Medicine, GMERS Medical College, Gotri, Vadodara, Gujarat⁴Assistant Professor, Department of Community Medicine, Swaminarayan Institute of Medical Sciences & Research, Kalol, Gandhinagar, Gujarat

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Abstract:

Background: Both testes are located superficially within a cutaneous bag scrotum. Though it is accessible for clinical examination, it is challenging to distinguish benign and malignant swellings and intra-testicular from extra-testicular swellings, and hydrocele makes it harder to determine the condition of the underlying testis. The acute scrotum is a clinical picture of sudden-onset of scrotal pain, redness, and swelling, most frequently caused by acute epididymo-orchitis, torsion of the testicular appendages, or testicular torsion, differentiation of these conditions is necessary for determining appropriate treatment.

Objective: to determine diagnostic accuracy and differentiation of various scrotal and testicular diseases using grey scale ultrasound and color Doppler findings, so that timely management can be offered to the patients and to avoid unnecessary complications.

Methodology: A prospective observational study was carried out on 50 patients who came to radio-diagnosis department with clinical signs and symptoms related to scrotal and testicular diseases. Patients were selected according to the inclusion and exclusion criteria's over a period of 1 year. All the patients underwent grey scale ultrasonography of the scrotum and color Doppler was supplemented to it to increase the diagnostic accuracy. Findings were noted and the patients were guided further and were asked to contact the referring physician/surgeon, so that timely treatment can be done and unnecessary complications can be avoided.

Results: Out of 50 cases studied, the mean \pm SD of age of cases studied was 39.58 ± 21.97 years and the minimum – maximum age range was 1 day to 91 years. The most common symptom was swelling which was seen in 14 cases (28.0%), 13 cases (26.0%) had pain, 12 cases (24.0%) had pain and swelling, 5 cases (10.0%) had scrotal heaviness, 2 cases (4.0%) each had empty scrotal sac, infertility and the trauma. Out of 50 cases studied, 5 cases (10.0%) had Normal diagnosis, 8 cases (16.0%) had Epididymitis, 6 cases (12.0%) had Epididymo-orchitis, 4 cases (8.0%) had Orchitis, 4 cases (8.0%) had Funiculitis, 2 cases (4.0%) had Varicocele, 3 cases (6.0%) had Hydrocele, 3 cases (6.0%) had Hernia, 4 cases (8.0%) had Epididymal cyst and 11 cases (22.0%) had other diagnosis in the study group.

Conclusion: High-frequency ultrasonography and color Doppler sonography is an extremely valuable tool in the diagnosis of scrotal and testicular pathologies. It provides a number of benefits over other imaging techniques, including as ionizing radiation abstinence, non-invasiveness, ease of use, accessibility, and repeatability.

Keywords: High-frequency ultrasonography, Color Doppler, Sonography, Testis, Scrotum, Swelling.

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Introduction

Both testes are located superficially within a cutaneous bag scrotum. Though it is accessible for clinical examination, it is challenging to distinguish benign and malignant swellings and intra-testicular from extra-testicular swellings, and hydrocele makes it harder to determine the condition of the underlying testis. Due to tenderness, swelling, or obvious deformation of the scrotal contents, a physical evaluation alone during the clinical

examination of the scrotal swelling may not be sufficient. The normal examination may overlook significant pathology and physical signs elicited may be improperly interpreted. Clinical signs and symptoms are usually nonspecific, variable, and misleading. The acute scrotum is a clinical picture of sudden-onset of scrotal pain, redness, and swelling, most frequently caused by acute epididymo-orchitis, torsion of the testicular

appendages, or testicular torsion, differentiation of these conditions is necessary for determining appropriate treatment. Until mid-1970 clinical evaluation of scrotal contents was confined to palpation and trans-illumination. In addition to radioisotope studies and testicular angiography, the present-day diagnostic armamentarium includes gray scale Ultrasonography, Doppler studies, and Magnetic Resonance Imaging. Since Murray Miskin and Jerald Bain¹ first published a report about using diagnostic ultrasound as a modality of investigating scrotal pathologies in 1974, instrumentation, and transducer design advancements have progressed to the point where the high-frequency US is the modality of choice in investigating scrotal and testicular pathology. While CT and MRI have dominated imaging of other regions of the body, they have certain limitations in the evaluation of scrotal diseases. MRI imaging is expensive and difficult to get, whereas computed tomography exposes the gonads to radiation. Radioisotope provides information only in limited conditions of scrotal pathologies. High-resolution sonography provides excellent anatomical detail of the scrotal wall, testis, and epididymis; when color Doppler and power Doppler imaging are added, testicular perfusion can be assessed. Sonography is quick, easy to conduct, non-invasive, reasonably priced, repeatable, widely available, and it doesn't expose the gonads to radiation. High-resolution and color Doppler sonography are now widely accepted as the method of choice for screening and diagnosis of both acute and non-acute scrotal diseases. Therefore, this study entitled "Diagnostic role of high-frequency ultrasound with colour Doppler in the evaluation of scrotal pathologies" is done to assess the usefulness of high-frequency US and color doppler studies in the evaluation of various scrotal pathologies.

Materials and Methods

A prospective hospital based observational study was carried out on 50 patients who came to radiodiagnosis department in Jehangir hospital, Pune with clinical signs and symptoms related to scrotal and testicular diseases. All age groups patients and patients with scrotal complaints with USG showing scrotal pathology were selected for study over a period of 1 year. Informed consent of patient will be taken for participation in study.

Patient's details, detailed clinical history will be obtained along with thorough physical examination prior to subjecting the patients for ultrasound examination. The colour Doppler sonography will be performed in all patients using 9-12 MHz linear transducer; abdominal ultrasonography will be done using 3.5 to 5.0 MHz convex curved array transducer (whenever needed) of Sonography machine. All the patients underwent grey scale ultrasonography of the scrotum and color Doppler was supple-

mented to it to increase the diagnostic accuracy. Findings were noted and the patients were guided further and were asked to contact the referring physician/surgeon, so that timely treatment can be done and unnecessary complications can be avoided. Sample size was determined by using the prevalence of outcome measures from the previously published study (Alka M et al. J Family Med Prim Care. 2014) and with the help of following formula:

$$\begin{aligned} (n) &= 4pq / d^2 \\ &= 4 \times 0.861 \times 0.139 / 0.01 \\ &= 45.97 \end{aligned}$$

$p = 0.861$ (86.1%) (Published estimate of sensitivity of US in the diagnosis of epididymo-orchitis, the most common diagnosis), $q = 0.139$ (13.9%) (Complement of 'p'), $Z = 1.96$ (Standard normal score at 95% confidence interval), $d = 0.10$ (10.0%, margin of error).

Thus, the minimum sample size required according to this formula is 45.97 OR 46. To ease the computations of frequency distributions, the sample size will be rounded off to 50. The data on categorical variables will be presented as n (% of subject) and the values on continuous variables will be presented as Mean \pm Standard deviation (SD). The statistical significance of difference of distribution of categorical variables will be tested using Chi-Square test or Fisher's exact probability test for 2 x 2 contingency table if more than 20% of cells have expected count less than 5. The diagnostic efficacy measures such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy will be calculated with appropriate reference standard. P-values less than 0.05 will be considered to be statistically significant. All hypotheses will be formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data will be statistically analyzed using SPSS version 24.0, IBM Corporation; NY, USA for MS Windows.

Results

Present study was an observational study that was conducted to study the diagnostic role of high-frequency ultrasound with color doppler in the evaluation of scrotal pathologies. A total of 50 patients were included in the study. The mean \pm SD of age of cases studied was 39.58 \pm 21.97 years and the minimum – maximum age range was 1 day to 91 years. Out of 50 cases studied, 3 cases (6.0%) had age below 10 years, 8 cases (16.0%) had age between 11 – 20 years, 6 cases (12.0%) had age between 21 – 30 years, 12 cases (24%) had age between 31-40 years, 4 cases (8.0%) had age between 41 – 50 years, 8 cases (16.0%) had age between 51 – 60 years, 4 cases (8.0%) had age between 61 – 70 years, 4 cases (8.0%) had age between 71 – 80 years and 1 case (2.0%) had age

above 80 years in the study group. The mean \pm SD of age of cases studied was 39.58 ± 21.97 years and the minimum – maximum age range was 1 day to 91 years.

Table 1 show that Out of 50 cases studied, the most common symptom was swelling which was seen in 14 cases (28.0%), 13 cases (26.0%) had pain, 12 cases (24.0%) had pain and swelling, 5 cases (10.0%) had scrotal heaviness, 2 cases (4.0%) each had empty scrotal sac, infertility and the trauma. Out of 50 cases studied, 23 cases (46.0%) had an inflammatory type of pathology, 15 cases (30.0%) had non-inflammatory pathology, 4 cases (8.0%) had neoplastic pathology, 2 cases (4.0%) had trauma, 1 case (2.0%) had torsion and 5 cases (1.0%) had normal pathology in the study group. Out of 50 cases studied, 5 cases (10.0%) had normal study, 31 cases (62.0%) had unilateral involvement, 10 cases (20.0%) had bilateral involvement and 4 cases (8.0%) had scrotal wall pathology in the study group.

Out of 50 cases studied, 5 cases (10.0%) had normal study, 27 cases (54.0%) had extra- testicular location of pathology, 9 cases (18.0%) had testicular, and 9 cases (18.0%) had extra-testicular and testicular type of location of pathology in the study group Out of 50 cases studied, 28 cases (56.0%) had an increase in the size of the affected organ on ultrasound examination in the study group Out of 50 cases studied, 13 cases (26.0%) had heterogeneous appearance, 13 cases (26.0%) had hypoechoic, 4 cases (8.0%) had hyperechoic, 10 cases (20.0%) had isoechoic, 9 cases (18.0%) had anechoic and 1 case (2.0%) had testicular calcification in the study group Out of 50 cases studied, 18 cases (36.0%) had normal vascularity, 14 cases (28.0%) had Focal increase in vascularity, 4 cases (8.0%) had Focal decrease in vascularity, 13 cases (26.0%) had Diffuse increase in vascularity and 1 case (2.0%) had Diffuse decrease in vascularity on Doppler evaluation in the study group. Table 2

shows that Out of 50 cases studied, 5 cases (10.0%) had Normal diagnosis, 8 cases (16.0%) had Epididymitis, 6 cases (12.0%) had Epididymo-orchitis, 4 cases (8.0%) had Orchitis, 4 cases (8.0%) had Funiculitis, 2 cases (4.0%) had Varicocele, 3 cases (6.0%) had Hydrocele, 3 cases (6.0%) had Hernia, 4 cases (8.0%) had Epididymal cyst and 11 cases (22.0%) had other diagnosis in the study group. Out of 50 cases studied, 21 cases (42.0%) had medical treatment, 18 cases (36.0%) had surgical treatment, 6 cases (12.0%) were advised follow-up, and 5 cases (10.0%) required no treatment. Table 3 shows that Out of 14 cases with swelling, none had normal findings, 1 case (7.1%) had Epididymitis, 3 (21.4%) had hydrocele, 3 cases (21.4%) had hernia, 4 cases (28.6%) had Epididymal cyst, 3 cases (21.4%) had other diagnosis.

Out of 13 cases with pain, 2 cases (15.4%) had the normal diagnosis, 5 (38.5%) had Epididymitis, 1 case (7.7%) had Epididymo-orchitis, 1 case (7.7%) had Orchitis, 3 cases (23.1%) had Funiculitis and 1 case (7.7%) had other diagnosis. Out of 12 cases with pain and swelling, 1 case (8.3%) had the normal diagnosis, 2 cases (16.7%) had Epididymitis, 5 cases (41.7%) had Epididymo-orchitis, 3 cases (25.0%) had Orchitis, 1 case (8.3%) had Funiculitis. Out of 5 cases with scrotal heaviness, 2 cases (40.0%) had normal study and 3 cases (60.0%) had other diagnosis (one case had a testicular epidermoid cyst, one had testicular microlithiasis and one case had tubular ectasia of rete testis).

Out of 2 cases with empty scrotal sacs, both these cases had other diagnosis (Undescended/Ectopic Testis). Out of 2 cases with infertility, both these cases had varicocele. Out of 2 cases with trauma, both these cases had other diagnosis (Scrotal wall hematoma). Distribution of type of diagnosis differs significantly across various symptoms in the study group (P-value<0.05).

Table 1: Distribution of symptoms among the cases studied.

Symptoms	No. of cases	% of cases
Swelling	14	28.0
Pain	13	26.0
Pain and swelling	12	24.0
Scrotal heaviness	5	10.0
Empty scrotal sac	2	4.0
Infertility	2	4.0
Trauma	2	4.0
Total	50	100.0

Table 2: Distribution of diagnosis among the cases studied.

Diagnosis	No. of cases	% of cases
Normal	5	10.0
Epididymitis	8	16.0
Epididymo-orchitis	6	12.0
Orchitis	4	8.0

Funiculitis	4	8.0
Varicocele	2	4.0
Hydrocele	3	6.0
Hernia	3	6.0
Epididymal cyst	4	8.0
Others	11	22.0
Total	50	100.0

Table 3: Distribution of type of diagnosis according to the symptoms among the cases studied

Diagnosis	Symptoms													
	Swelling		Pain		Pain and swelling		Scrotal heaviness		Empty scrotal sac		Infertility		Trauma	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Normal	0	0.0	2	15.4	1	8.3	2	40.0	0	0.0	0	0.0	0	0.0
Epididymitis	1	7.1	5	38.5	2	16.7	0	0.0	0	0.0	0	0.0	0	0.0
Epididymo-orchitis	0	0.0	1	7.7	5	41.7	0	0.0	0	0.0	0	0.0	0	0.0
Orchitis	0	0.0	1	7.7	3	25.0	0	0.0	0	0.0	0	0.0	0	0.0
Funiculitis	0	0.0	3	23.1	1	8.3	0	0.0	0	0.0	0	0.0	0	0.0
Varicocele	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	100.0	0	0.0
Hydrocele	3	21.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Hernia	3	21.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Epididymal cyst	4	28.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Others	3	21.4	1	7.7	0	0.0	3	60.0	2	100.0	0	0.0	2	100.0
Total	14	100.0	13	100.0	12	100.0	5	100.0	2	100.0	2	100.0	2	100.0
P-value	0.001*** (Statistically highly significant).													
P-value by Chi-Square test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001.														

Discussion:

The superficial location of the scrotal contents makes them ideally suited for sonographic examination. The accuracy of scrotal sonographic exams has increased due to the emergence of high-frequency, real-time scanners. Scrotal ultrasonography has developed to the point where it can now serve as the sole imaging test required to assess the contents of the scrotum.

In this study, 50 patients underwent high-frequency ultrasound examinations, and color Doppler studies were performed when appropriate to look for scrotal and testicular disease. Cases with a strong clinical suspicion of scrotal disease were referred from the departments of urology and surgery. Age distributions of the study's cases, which ranged from 1 day to 91 years. The age range of 31 to 40 years had the highest percentage of instances (12 cases,

or 24%). The age group > 80 years had the fewest cases (1 case, or 2%). Swelling was the most common complaint of the patients (14 patients- 28%), of which 11 cases (22%) had unilateral hemiscrotal swelling, 1 case (2%) had bilateral hemiscrotal swelling and 2 cases (4%) had scrotal wall pathology. Pain was the second most frequent presenting symptom among patients (13 cases, or 26%). The intensity of the pain varied from gradual ache to sudden onset of intense pain. The majority of patients involving inflammatory disease showed a slow onset of pain, while instances involving trauma and torsion showed an abrupt onset of severe pain. 12 patients (24%) had combination of symptoms like pain and swelling. Out of 50 cases, 31 (62%) had unilateral hemi-scrotal pathology, 10 (20%) had bilateral hemi-scrotal pathology, 4 (8%) had scrotal wall pathology and 5 (10%) cases had normal study.

Table 4: Comparison of present study with other studies in context of types of scrotal and testicular pathology detected

Authors	No. of cases	Inflammatory pathology	Non-Inflammatory pathology
Willscher et al.	43	12 (28%)	28 (65%)
Richie et al.	124	31 (27%)	75 (66%)
Arger et al.	62	16 (26%)	45 (67%)
Present study	50	23 (46%)	15 (30%)

In our study, the bulk of the pathology detected by

high-resolution US are from two groups: Inflamma-

tory pathologies and non-inflammatory pathologies (38 cases=76%), which correlates with findings documented in previous studies. In contrast to previous studies, we found that the proportion of inflammatory pathology was higher in our study. In our study, out of 50 patients, 23 (46%) were detected to have inflammatory scrotal pathology on high frequency US and Doppler study. Epididymitis was the commonest inflammatory pathology detected in 8 cases (16 %), of which 6 cases (12%) had acute

epididymitis and 2 cases (4%) had chronic epididymitis. Next most frequent inflammatory pathology detected was epididymo-orchitis noted in 6 cases (12%), of which 5 cases (10%) had acute epididymo-orchitis and 1 case (2%) had chronic epididymo-orchitis. Other detected inflammatory pathologies include orchitis in 4 cases (8 %), Funiculitis in 4 cases (8%) and 1 case (2%) had Fournier's gangrene which was included in Inflammatory/Infective pathology.

Table 5: Comparison of present study with other studies in context of types of inflammatory pathology detected)

Inflammatory disease	Horstman et al.	Lerner et al.	Farriol et al.	Present study
Acute Epididymitis	25 (56%)	3 (60%)	11 (44%)	6 (12%)
Acute Epididymoorchitis	19 (42%)	2 (40%)	10 (40%)	5 (10%)
Complication of acute inflammation	1 (2%)		2 (8 %)	1 (2%)
Cellulitis of scrotal wall	5 (11%)			
Chronic Epididymoorchitis				1 (2%)
Chronic Epididymitis				2 (4%)

Compared to previous studies, a higher incidence of chronic epididymitis/epididymo-orchitis is noted and much higher rate of complications. The higher rate of chronic disease could be due to higher rate of tuberculosis in India. The higher rate of complications could be attributed to the fact that the pa-

tients in India tend to present late in the course of the disease. In our study, we examined 19 cases (38%) with non-inflammatory scrotal swellings. of 19 cases, 4 cases (8%) were neoplastic lesions, remaining 15 cases (30%) were non-inflammatory, non-neoplastic swellings.

Table 6: Comparison of present study with other studies in context of non-inflammatory swellings of the scrotum)

Authors	Cases	Neoplastic	Non-neoplastic
Arger et al.	54	16 (30%)	38 (70%)
Richie et al.	117	22 (19%)	53 (45%)
Willscher et al.	40	5 (12%)	20 (50%)
Present study	19	4 (21%)	15(79%)

The incidence of non-inflammatory, non-neoplastic scrotal swellings is significantly higher than that of neoplastic swellings in all the studies, including the current study. Of the 4 cases with neoplastic swellings, 1 case of Testicular tumor was histopathologically proven to be seminoma. Other 3 cases were of benign neoplastic swellings which included 1 case of Testicular epidermoid cyst, 1 case of bilateral Testicular microlithiasis which is considered to be premalignant and increases the risk of testicular tumors in future and 1 case had multiple scrotal wall sebaceous cysts. Out of 15 cases with non-inflammatory, non-neoplastic swellings most common pathology was Epididymal cyst which contributed 4 cases (8%). Epididymal cyst was noted as unilocular cystic lesions in head of epididymis. Leung et al [11], in their study of 40 subjects, detected 29 cases of epididymal cysts. Out of 15 cases with non-inflammatory, non-neoplastic swellings, 3 cases (6%) had Hydrocele. Of 3 cases, 1 case had hydrocele with clear fluid, 1 case had encysted hydrocele of the cord and 1 case had septated hydrocele. All cases had unilateral involvement of hem-

iscrotum. These findings are in similarity to previous studies of Arger et al [6] and Willscher et al. Hydroceles appear as collection of clear fluid between two layers of tunica. In encysted hydrocele of cord, the collection of clear fluid along spermatic cord appeared as anechoic lesions adjacent to spermatic cord that moves with gentle traction to cord. In a case with septated hydrocele, multiple thin internal septa were seen within the fluid. Out of 50 cases studied, 4 cases of hernia were noted. 1 case had hernia along with orchitis, 1 case had inguinoscrotal hernia, 1 case had bilateral inguinal hernias and 1 case had Incarcerated hernia causing intestinal obstruction and was associated with vomiting and air-fluid levels on abdomen standing X-ray. 3 cases had unilateral involvement and 1 case had bilateral involvement. Out of 50 cases studied, 2 cases had varicocele. 1 case had unilateral varicocele and 1 case had bilateral varicocele. Both the patients came with complaints of Infertility. High-frequency grey scale US was used to determine the presence of varicocele when 2 or more veins could be seen, with at least 1 vein having a diameter of 3

mm or higher. If retrograde flow was noticed in the pampiniform plexus spontaneously or when performing the Valsalva maneuver, a varicocele was

assumed to be present. (Randall et al.) Varicocele was detected in patients presenting with symptoms like scrotal swelling, pain and infertility.

Table 7: Comparison of present study with other studies in context of Varicocele

Authors	Cases	Bilateral	Unilateral	Abnormal sperm count
Kondoh et al.	56	30 (54%)	26 (46%)	30 (54%)
McClure et al.	50	35 (70%)	15 (30 %)	34 (67%)
Randall et al.	12	4 (33%)	8 (67%)	5 (42%)
Present study	2	1 (50%)	1 (50%)	1 (50%)

Out of 50 cases studies, 2 cases (4%) of scrotal/testicular trauma were detected. Both the cases had scrotal wall hematoma as the main finding. Alexander S Cass et al., in their series of 86 patients with scrotal trauma, noted unilateral involvement in 81 cases (94%) and bilateral in 5

cases (6%). George Schuster 61 had stated that right sided traumas are more common.

In a series of 72 patients, right sided testicular injury noted in 40 patients (56%) and left sided injury noted in 32 patients (44%).

Table 8: Comparison of present study to Cass et al study in context of traumatic scrotal and testicular pathologies)

	Pathology	Cass et al.	Present study
1	Hematocele	4	0
2	Testicular torsion	1	0
3	Testicular hematoma	0	0
4	Testicular rupture	0	0
5	Scrotal wall hematoma	1	2

Out of 50 cases studied, 2 cases (4%) had empty scrotal sac and both the cases had Undescended/Ectopic testis. Both the cases had bilateral involvement and, in both cases, testes were found in inguinal regions. Hence ultrasound was highly accurate in the detection of undescended testis. Out of 50 cases studied, 1 case (2 %) of Testicular torsion was noted. The involved testis was noted to be enlarged hypoechoic with absent colour flow.

Conclusion

It is possible to clearly show the morphological changes linked to acute scrotal inflammatory disorders using high-frequency ultrasonography. When diagnosing acute scrotal disease, Doppler sonography is incredibly sensitive. Additionally, in acutely painful scrotal disorders, color Doppler sonography successfully distinguishes testicular ischemia and torsion from acute inflammatory illnesses. High-frequency ultrasonography is highly sensitive in differentiating solid from cystic scrotal masses. When there are significant hydroceles present, high-frequency ultrasonography is quite helpful in showing that the testes and epididymis are normal. High-frequency real-time sonography is quite sensitive in differentiating between testicular and extra-testicular masses in scrotal masses. High-frequency Doppler ultrasonography is quite sensitive to detecting varicoceles. It is much more sensitive than a physical examination at spotting sub-clinical varicoceles cases. High-frequency US and color Doppler provide a number of benefits

over other imaging techniques, including as ionizing radiation abstinence, non-invasiveness, ease of use, accessibility, and repeatability. We conclude that High-frequency ultrasonography and color Doppler sonography is an extremely valuable tool in the diagnosis of scrotal and testicular pathologies.

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