Original Research Article

Acute Scrotum: Validating the role of Color Doppler Ultrasonography in children and young adults

Singh B.[1], Keshri A.[2], Kour M.[3]

[1]Dr. Biant Singh, Professor and Head, [2]Dr. Amit Keshri, Assistant Professor, [3]Dr. Manpreet Kour, Resident, All Authors are affiliated with the Department of Surgery, VCSG Govt. MS&RI, Srinagar-Garhwal, Uttarakhand, India.

Corresponding Author: Dr. Biant Singh, Professor and Head, Department of Surgery, VCSG Govt. MS&RI, Srinagar-Garhwal, Uttarakhand, India. E-mail: dr.biantsingh@gmail.com

Abstract

Introduction: Acute scrotum is a surgical emergency and a rapid diagnosis is important to save testis from irreversible harm. Study was carried out to outline the etiology of acute scrotum in children and young adults to establish the role of Doppler Ultrasonography substantiating the role of clinical examination. **Materials and Methods:** In this study we examined reliability of color Doppler ultrasonography comparing operative finding and clinical course. 50 patients of less than 25 years of age with acute scrotum admitted or managed in OPD were included in the study. The patients were categorized into two groups. One group comprised of patients who needed immediate surgical exploration on the basis of history, physical examination and Doppler Ultrasonography (suggestive of testicular torsion).The second group, had patients who on the basis of history, physical examination and Doppler Ultrasonography (suggestive of epididymo-orchitis, etc) were managed conservatively. **Results**: Doppler ultrasonography in acute scrotum diagnosed the condition with torsion of testis, epididymo-orchitis and torsion of testicular appendages. Sensitivity and specificity of Color Doppler ultrasonography for testicular torsion was 86.93% and 92.6% respectively and for epididymo-orchitis was 95.3% and 100% respectively. **Conclusion:** Color Doppler Ultrasonography is highly sensitive, specific, very safe and a noninvasive method of evaluating acute scrotum in children and young adults. It is not only helpful in timely surgical intervention for testicular salvage but also helps in avoiding unnecessary surgical exploration.

Keywords: Acute scrotum, Color Doppler Ultrasonography, Epididymo-orchitis, Torsion

Introduction

Clinical entity “acute scrotum” is a condition presenting as red, swollen and tender scrotum (unilateral or bilateral) with extreme pain demanding a prompt clinical diagnosis and early timely surgery if indicated. The condition is to be viewed as clinical equivalent of acute abdomen. Even experienced surgeons have difficulty in differentiating ischemic from an inflammatory etiology, solely on the basis of clinical signs and symptoms. In ischemic origin cases if the diagnosis is prompt and surgery is timely it results in testicular salvage. Delay in diagnosis and expectant treatment is frequently disappointing.

Despite increasing sophisticated diagnostic techniques distinguishing testicular torsion from other causes of acute scrotum still remains a challenge. The acute scrotum in childhood or adolescence is a medical emergency and is defined as scrotal pain, swelling, and redness of acute onset. As the testicular parenchyma cannot tolerate ischemia for more than a short time, testicular torsion must be ruled out rapidly as the cause [1,2,3]. Testicular torsion accounts for about 25% cases of acute scrotum, with an incidence of roughly 1 per 4000 young males per year. A careful history, a thorough physical examination, and appropriate diagnostic tests can substantially narrow the differential diagnosis. The diversity of etiologies related to this clinical presentation makes the diagnosis a difficult one, and an objective and reliable imaging procedure is demanded.

Doppler ultrasonography (DUS) is a noninvasive examination that lacks ionizing radiation and is highly sensitive in the detection of intrascrotal abnormalities [3]; therefore, it is considered nowadays the first imaging modality for the assessment of acute scrotum. A DUS study includes a gray scale imaging and color and spectral Doppler flow of the scrotal contents, mainly the testis and epididymis. By enabling the distinction between surgical emergencies, such as testicular torsion and traumatic testicular rupture, which mandate immediate scrotal

Manuscript Received: 6th November 2019
Reviewed: 16th November 2019
Author Corrected: 24th November 2019
Accepted for Publication: 28th November 2019

exploration to prevent testicular loss, and surgical non-emergencies and nonsurgical entities, scrotal DUS has become the standard diagnostic test on which the therapeutic approach in patients with acute scrotum is based.

Diagnosis of acute scrotum is difficult because of the diverse etiologies and extreme local tenderness, which makes clinical examination very difficult. The main goal is to differentiate between surgical emergencies and nonsurgical problems.

Doppler ultrasonography is considered the primary imaging modality for such evaluations. The main diagnosis to be confirmed or ruled out by DUS is testicular torsion, which warrants emergency surgical intervention. In the literature, the reported diagnostic performance values for DUS of testicular torsion varied from 69% to 86% sensitivity, 87% to 100% specificity, 73% to 97% accuracy, a 100% PPV, and a 97.5% NPV [4–8].

Materials and Method

Study Population, duration and type of study- The present prospective study was carried over a period of three years in the Department of General Surgery. Fifty patients of less than 25 years of age with acute scrotum admitted or managed in OPD from February 2016 to March 2019 were included in the study. Institutional Review Board approval was obtained.

Data collection- Detailed history, consent taking and clinical examination substantiated with base line investigations like haemogram, urine exam and culture sensitivity were done in all the cases of acute scrotum. All patients were subjected to scrotal Doppler ultrasonography. It was performed using Phillips IU22 high end color Doppler machine using 7-14 MHz high frequency linear transducer. Asymptomatic side was scanned initially to allow comparison with the affected side. Color and pulsed doppler were used to display blood flow in the testis and scrotal structures. The patients were categorized into two groups. One group comprised of patients who needed immediate surgical exploration on the basis of history, physical examination and Doppler Ultrasonography (suggestive of testicular torsion). The operative findings were recorded and corroborated to Doppler Ultrasonography findings. The second group, had patients who on the basis of history, physical examination and Doppler Ultrasonography (suggestive of epididymo-orchitis, etc) were managed conservatively with antibiotics anti-inflammatory drugs, proteolytic enzymes and scrotal support. Follow up of four weeks was done for the patients.

Data Analysis- Record of the data collected was subjected to statistical analysis using Excel software (Microsoft Corporation, Redmond, WA). The statistical analyses were performed with the Pearson $\chi 2$ test and SPSS version 14 software for Windows (SPSS Inc, Chicago, IL).

Results

The most common entity comprising of acute scrotum in children and young adults was testicular torsion (46%) followed by epididymo-orchitis (42%), torsion of testicular appendages (6%), idiopathic scrotal edema (2%), incarcerated inguinal hernia (2%) and hematocele (2%) (Table 1). Mean age for testicular torsion was 13.5 years and for epididymo-orchitis was 17 years (statistically significant).

Results of Doppler ultrasonography in acute scrotum diagnosed the condition with torsion of testis (true positive-20, false positive-2, true negative-25, false negative-3), epididymo-orchitis (true positive-20, false positive-0, true negative-29, false negative-1) and torsion of testicular appendages (true positive-2, false positive-0, true negative-47, false negative-1). Three patients with equivocal Doppler findings, but strong clinical suspicion of testicular torsion were explored, and testis was found to be torsed in all the three patients (Table 2) (Figure 1-3).

Table-1: Clinical entities comprising the acute scrotum (n=50).

Diagnosis	No. of cases	%age
Torsion of testis	23	46
Epididymo-orchitis	21	42
Torsion of testicular appendages	3	6
Idiopathic scrotal edema	1	2
Incarcerated inguinal hernia	1	2
Scrotal trauma (haematocele)	1	2
Total	**50**	**100**

Table-2: Results of Doppler ultrasonography in acute scrotum (n=50).

Diagnosis	Sonological diagnosis (DUS)	Final diagnosis (operative findings/ follow up)
Torsion of testis	22	23
Epididymo-orchitis	20	21
Torsion of testicular appendages	2	3
Idiopathic scrotal edema	1	1
Incarcerated Inguinal hernia	1	1
Scrotal trauma (Hematocele)	1	1
Equivocal	3	

Table 3 shows the clinical presentation of patients in acute scrotum. More than one sign and symptoms were present in most patients. Cremasteric reflex was absent in all patients of Testicular torsion and showed reliability. Prehn's sign was not reliable in acute scrotum. Blue dot sign was present in one of the three patients of torsion of testicular appendages (33%).

Table-3: Clinical presentation in acute scrotum (n=50).

Clinical presentation	TT n=23	EO n=21	TTA n=3	Idiopathic scrotal edema (n=1)	Hematocele (n=1)	Incarcerated inguinal hernia (n=1)	Total no. of cases	%age
Symptoms								
Scrotal pain	23	20	3	1	1	1	49	98
Scrotal swelling	21	19	1	1	1	1	44	88
Nausea/vomiting	15	2	-	-			17	34
Fever	-	12	-	-			12	24
Urinary symptoms	-	6	-	-			6	12
Abdominal pain	1	-	-	-			1	2
Signs								
Scrotal erythema (redness)	17	17	17	1	1	1	39	78
Scrotal tenderness	22	21	21	-	1	1	47	94
Absent cremasteric reflex	23	1	1	-			24	48
Blue dot sign	-	-	-	-			1	2
Lab investigations								
Leucocytosis	11	1	1	-			24	48
Polymorphonuclear leucocytosis	11	-	-	-			23	46
Pyuria	-	-	-	-			6	12
Urine culture	-	-	-	-			4	8

Table-4: Doppler ultrasonography findings.

DUS findings	TT (n=23)	EO (n=21)	TTA (n=3)	Idiopathic scrotal edema (n=1)	Hematocele (n=1)	Incarcerated inguinal hernia (n=1)
Size of Testis						
Normal	3	1	3	1	1	1
Increased	20	20				
Decreased						
Echotexture of testis						
Normal		1	3	1	1	1
Hypoechoic	14	18				
Hyperechoic		1				
Hetrogeneous	9	1				
Echotexture of epididymis						
Normal	23	1	3	1	1	1
Hypoechoic		18				
Hyperechoic		1				
Hetrogeneous		1				
Size of epididymis						
Normal	23	1	3	1	1	1
Enlarged		20				
Intra-testicular blood flow						
Normal	3	1	2	1	1	1
Increased		19				
Decreased	3	1	1			
Absent	17					
Peritesticular fluid						
Present	20	11	3	1	1	
Absent	3	10				1
Spermatic cord rotation						
Present	12					
Absent	11	21	3	1	1	1
Spectral analysis						
PSV>15cm/sec		17				
RI<0.5		15				

Fig-1(a). Torsion of left testis in a 24 years old patient.

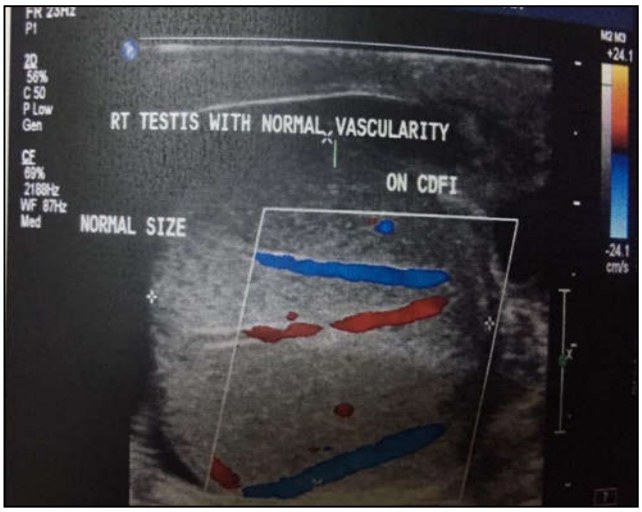

Fig-1(b). Color Doppler ultrasonography showing normal blood flow in testis on right side in the same 24 years old patient.

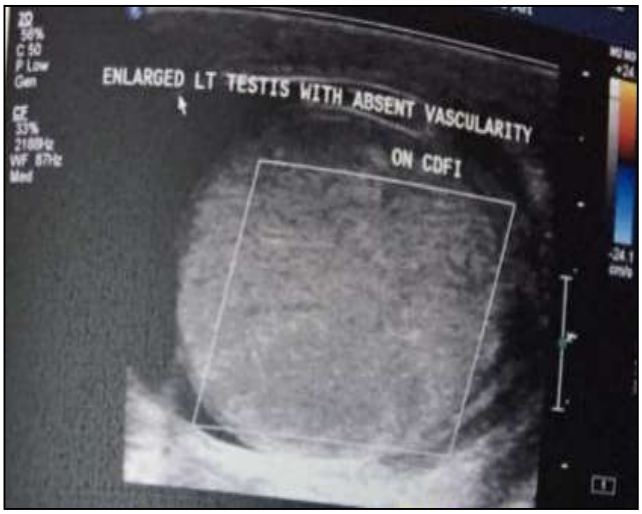

Fig-1(c). Color Doppler Ultrasonography showing absent blood flow in testis on left side in the same patient.

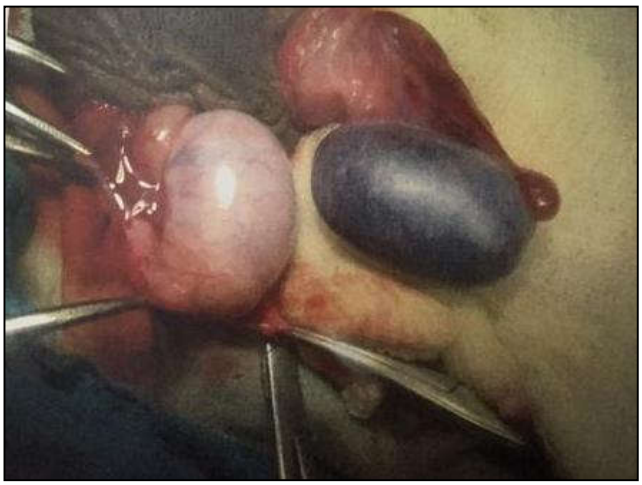

Fig-1(d). Operative photograph showing gangrenous changes in left testis with normal right testis.

Fig-2: Operative photograph showing torsion of appendix of epididymis on left side in a 9-year-old patient.

Fig-3(a.) Operative photograph showing torsion of left testis in a 13-year-old boy.

Fig-3 (b). Operative photograph after detorsion of left testis in the above patient.

Sensitivity and specificity of Color Doppler ultrasonography for testicular torsion was 86.93% and 92.6% respectively (Table 5).

Table-5: Sensitivity and specificity of Doppler ultrasonography for testicular torsion.

Doppler ultrasonography Result	Final Diagnosis (Torsion Testis)	Final Diagnosis (No Tortion Testis)
Positive	20 (true positive)	2 (false positive)
Negative	3 (false negative)	25 (true negative)
Total	**23**	**27**

Sensitivity and specificity of Color Doppler ultrasonography for epididymo-orchitis was 95.3% and 100% respectively (Table 6). Sensitivity of Doppler ultrasonsography for testicular torsion = True positive/ True positive + False negative x 100 = (20/20+3) x 100 = 86.95%.

Specificity of Doppler ultrasonography for testicular torsion = True negative/ False positive + True negative x 100 = (25/2+25) x 100 = 92.6%

Table-6: Sensitivity and specificity of Doppler ultrasonography for epididymo-orchitis.

Doppler ultrasonography Result	Final diagnosis (Epididymo-orchitis)	Final diagnosis (No epididymo-orchitis)
Positive	20 True positive	0 False positive
Negative	1 False negative	29 True negative
Total	**21**	**29**

In the present study, salvage rate of Testicular torsion was 43.47%. Table 7 shows the surgical procedures performed in 27 cases of acute scrotum. Development of testicular necrosis and gangrene was due to delayed presentation >12 hours and had to undergo ipsilateral orchiectomy and contralateral testicular fixation. We did Color Doppler ultrasonography in all the 50 cases. Operative group had 27 patients out of which 23 had testicular torsion and one case each of torsion of testicular appendage, epididymo-orchitis, incarcerated inguinal hernia and trauma (haematocele).

Sensitivity of Doppler ultrasonsography for epididymo-orchitis = True positive/ True positive + False negative x 100 = (20/20+1) x 100 = 95.23%

Specificity of Doppler ultrasonsography for epididymo-orchitis = True negative/ False positive + True negative x 100 = (29/0+29) x 100 = 100%

Table-7: Surgical procedures done in acute scrotum (n=27) Group A.

Diagnosis	Procedure done	Operative findings	No. of cases	%age	Follow up at 3 weeks
Testicular torsion	Ipsilateral orchidectomy with contralateral prophylactic orchidopexy	Twisting of cord with flabby non-viable testis	13	48.15%	Symptom free wound site healthy
	Surgical detorsion with ipsilateral orchidopexy and prophylactic contralateral orchidopexy	Twisting of cord with hyperemia of testis	10	37.03%	Symptom free wound site healthy
Epididymo-orchitis	Eversion of tunica vaginalis after evacuation of reactionary fluid	Hyperemic and edematous epididymis with small amount of reactionary fluid	1	3.7%	Symptom free wound site healthy
Torsion of testicular appendage	Excision of appendix of epididymis	Gangrene of appendix of epididymis with twisting of pedicle	1	3.7%	Symptom free wound site healthy
Incarcerated inguinal hernia	Herniotomy	Hernia sac containing hyperemic omentum	1	3.7%	Symptom free wound site healthy
Hematocele	Evacuation of hematoma with eversion of tunica-vaginalis	Large blood clot in tunica-vaginalis	1	3.7%	Symptom free wound site healthy

Table 8 and 9 show the methods of conservative management of acute scrotum and follow up in observative group having 23 patients (epididymo-orchitis 20, Torsion of testicular appendages 2 and one case of idiopathic scrotal edema).

Table-8: Group B- Conservative management of acute scrotum and follow up (n=23).

Diagnosis	No. of cases	Management					
		Rest	Support	Antibiotics	Anti-inflammatory	Anti-histamines	Proteolytic enzyme
Epididymo-orchitis	20	+	+	+	+	-	+
Torsion of testicular appendage	2	+	+	+	+	-	+
Idiopathic scrotal edema	1	+	+	-	+	+	-

Table-9: Group B- clinical improvement seen after conservative management of acute scrotum and follow up (n=23).

Diagnosis	No. of cases	DUS findings	Clinical improvement Yes No	Follow up at 1 week	Follow up at 3 weeks	Hospital stay
Epididymo-orchitis	20	Features of EO	+ -	Symptom free swelling	Healthy firm epididymis	5 days
Torsion of testicular appendage	2	Features of TTA	+ -	Symptom free swelling	healthy	4days
Idiopathic scrotal edema	1	Features of idiopathic scrotal edema	+ -	Symptom free swelling	healthy	2 days

Discussion

Color Doppler Ultrasonography (CDUS) is an important tool for diagnosis of scrotal diseases because of its ability to depict anatomy and perfusion in real time. Most common cause of acute scrotum in children < 15 years of age is torsion of testis. However in older children and young adults (15-25 years age) incidence of epididymo-orchitis is 42%. List of conditions leading to acute scrotum is wide and can be;

- Intrascrotal lesions- testicular torsion/ Torsion of spermatic cord. Acute epididymo-orchitis, acute bacterial epidymitis, acute orchitis, torsion of appendices of testis, torsion of vas abberans, testicular trauma, testicular tumour with intratumoral bleed, incarcerated scrotal hernia, testicular vasculitis, spermatic vein thrombosis.

- Scrotal sac lesions- scrotal hematoma, idiopathic scrotal edema, scrotitis, scrotal gangrene and henoch- schonlein purpura.

- Miscellaneous causes like incarcerated inguinal hernia (presenting as acute scrotal mass). Ruptured appendicitis-pus gravitating through patent processus vaginalis into the scrotum and tip of ventriculoperitoneal shunt migrating through patent processus vaginalis causing scrotal pain and mass [9.10]

The most common entity comprising of acute scrotum in children and young elders found in this study was testicular torsion (46%) and this is in close agreement with Liu CC et al and Knight PJ et al. [11,12] The scrotal catastrophe of testicular torsion can have a negative imprint on fertility, making the condition not inferior to myocardial infarction because here the progeny is at stake.

Since antigenic material from dying testis could be exposed to immune system and resulting antibodies can affect the normal contralateral testis. The hypothesis postulated to explain that the bilateral exocrine dysfunction after unilateral torsion could be aftermath of reflex vasospasm of normal testis leading to hypoxia. There is a report of 3.2 fold risk of developing testicular tumor in contra lateral testis 6-10 years after torsion.

Grey scale ultrasonography is a well-established modality for diagnosis of scrotal diseases; however, the major limitation of conventional grey scale ultrasonography is lack of specificity for parenchymal changes. Also benign and malignant lesions cannot be distinguished on the basis of ultrasonography alone [13]. Furthermore, in painful scrotum, grey scale ultrasonography cannot accurately differentiate testicular torsion from epididymo-orchitis.

William and colleagues studied 5 patients in whom no intratesticular blood flow was identified on symptomatic side while normal flow was detected on the opposite side. However, on grey scale ultrasonography, no abnormality could be detected in 3 patients while 2 subjects had non-specific findings [14]. Color Doppler ultrasonography has many advantages over conventional ultrasonography. In addition to detecting non-specific grey scale changes that can occur with testicular ischemia, it also shows blood flow in testicular arteries. Till recently, radionuclide scanning has played an important role in evaluation of equivocal cases of acute scrotal diseases. It has provided useful information regarding scrotal blood flow [15].

However, it cannot accurately depict the anatomy [16]. Middleton and associates evaluated 28 patients with acute scrotal pain by CDUS and scintigraphy. While CDUS correctly diagnosed all the subjects, scintigraphy failed to reach the diagnosis in one [17]. Also, CDUS was more rapid, non-invasive, and at least as accurate as scintigraphy [18]. Accurate clinical diagnoses of scrotal diseases are difficult as most patients present with similar signs and symptoms. Color Doppler ultrasonography is currently the most important imaging modality available for diagnosis of scrotal pathologies. It allows accurate evaluation of scrotal conditions as well as normal anatomy. Süzer and colleagues found CDUS to be 100% sensitive and 100% specific in diagnosis of acute scrotal conditions [19].

Clinical presentation of acute scrotum cases in the present study were checked using various signs, symptoms and lab investigations. As documented earlier by various authors [5,20], Prehn's sign was found to be unreliable in acute scrotum. Reliability of blue dot sign was also in accordance with the documentation of Aso C et al [5].

About 2/3rd of the surgical exploration for acute scrotum can be avoided by reliable imaging techniques. Grey scale sonography, high-resolution real-time sonography and color Doppler ultrasonography have become a well-established modality for detecting ischemic testis. Tec 99m pertechnitate nuclear scan and T_2W dynamic contrast enhanced MRI scan have a role in evaluating pediatric patients with acute scrotum but availability and cost is major hindrance [5,21].

Derouet and coworkers observed ultrasonography to be 90% sensitive and 55% specific in detection of testicular neoplasms [22] whereas Gallardo Agromayor and colleagues reported sensitivity of 100% for ultrasonography in diagnosing testicular neoplasm [23].Therefore, CDUS with its high sensitivity and specificity is the most important investigation for diagnosis of scrotal diseases, presenting especially in emergency clinical setting.

Conclusion

Color Doppler Ultrasonography is highly sensitive and specific in evaluating acute scrotum in children and young adults. Method is very safe, non-invasive and can be used at bed side. It is not only helpful in timely surgical intervention for testicular salvage but also helps in avoiding unnecessary surgical exploration. The findings of the physical examination and Color Doppler ultra-sonography are useful in deciding the treatment at the earliest. In the infrequent cases of diagnostic uncertainty, the only choice is to explore the dubious and immediate surgical exposure remains the treatment option.

What the study adds to the existing knowledge?

The study has proved the reliability of CDUS to rule out testicular torsion and helps in clearing clinical dilemma between torsion testis and epididymo-orchitis. Study was specially carried out to outline the etiology of acute scrotum in children and young adults, to establish the role of Doppler Ultrasonography substantiating the role of clinical examination. A distinctive diagnostic and therapeutic approach to the acute scrotum is presented in children and young adults by means of which avertible futile operations and irreversible damage to the testicular parenchyma can be avoided.

Author's contribution:

Prof. (Dr.) Biant Singh: Conceptualized the study, Principal investigator, prepared the study protocol, participated in data collection, entry, preparation and editing of all drafts.

Dr. Amit Keshri: Coinvestigator, Review of literature and preparation of the drafts.

Dr. Manpreet Kour: Coinvestigator, manuscript preparation.

Funding: No funding sources
Conflict of interest: None declared
Ethical Approval: This study was approved by the Institutional Ethics Committee

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How to cite this article?

Singh B, Keshri A, Kour M. Acute Scrotum: Validating the role of Color Doppler Ultrasonography in children and young adults. Surgical Update: *Int J surg Orthopedics.*2019;5(5):330-339.doi:10.17511/ijoso.2019.i05.04

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