Acute torsion of the testis in children and young adults: Role of high resolution and Color Doppler ultrasonography

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Abstract  Purpose: This study aimed to evaluate the combined role of both high resolution and Color Doppler ultrasonography (HRUS and CDUS) for the correct diagnosis of testicular torsion. Patients and methods: This study was conducted on patients with acute scrotal pain or swelling referred to emergency and general surgery departments of Nizwa Hospital, Oman during January 2011–December 2013. HRUS and CDUS were done for all 180 patients. Our study included 49 patients diagnosed as torsion of the testis; 47 patients were clinically diagnosed and 2 patients with other clinical diagnosis were diagnosed by CDUS examination. Results: Testicular torsion (TT) was surgically confirmed in 33 patients (18.33%) from the 180 patients who had an acute scrotum during the study period. In our study, CDUS showed sensitivity of about 84.85% (95% CI: 68.09–94.83%) while HRUS showed higher sensitivity of about 93.94% (95% CI: 79.74–99.08%). A combination of both HRUS and CDUS findings increased sensitivity to 100.00%.

Conclusion: Combination of HRUS and CDUS findings increased the accuracy of ultrasonographic study for the diagnosis of testicular torsion and decreased the rate of unnecessary surgical exploration.

1. Introduction

Acute scrotal pain is a common condition in children that requires an accurate and immediate diagnosis. Testicular torsion (TT) should be differentiated from other nonsurgical etiologies, but this is not always clinically possible. Color Doppler ultrasonography (CDUS), which assesses testicular vascularization, is still the procedure of choice to assist the surgeon in resolving this dilemma (1). Direct visualization of the
twisted cord with high resolution ultrasonography (HRUS) is a reliable indicator of the diagnosis of the spermatic cord torsion and whether its absence can dispense with an unnecessary surgery (2). To avoid testicular loss and eventual impaired fertility, prompt diagnosis and immediate surgery are the most important issues for the treatment of these patients (3).

This study aims to evaluate the combined role of both high resolution and Color Doppler ultrasonography (HRUS and CDUS) for the correct diagnosis of testicular torsion.

2. Patients and methods

2.1. Patients

This study was conducted on patients with acute scrotal pain or swelling referred to emergency and general surgery department of Nizwa Hospital, Oman during January 2011–December 2013. HRUS and CDUS were done for all 180 patients. Our study included 49 patients diagnosed as torsion of the testis; 47 patients were clinically diagnosed and 2 patients with other clinical diagnosis were diagnosed by CDUS examination.

The case notes were examined in detail: recording the age of the patient; presenting symptoms; duration of symptoms before seeking medical attention; provisional diagnosis and final diagnosis depending on operative findings or hospital outcome of patients who underwent medical treatment.

2.2. Imaging protocols

All HRUS and CDUS examinations were done within 30 min after being requested. Ultrasonography studies were performed with Toshiba-Xario machine by multi-frequency linear transducer TH for small parts (6–12 MHz). Longitudinal and transversal HRUS scans were performed on both sides, allowing comparison of testicular echogenicity, homogeneity and size. The spermatic cord was detected in the inguinal canal and was studied along its complete course on serial scans. Color Doppler followed by the power Doppler mode was used to examine the vascularity of both testes and the spermatic cord.

2.3. Image analysis

The ultrasonographic diagnosis of testicular torsion was established when there were either no detected/markedly decreased vascular flow inside the symptomatic testis or abrupt change in its spermatic cord course, size or echotexture forming para-testicular mass-like.

HRUS describes testicular parenchymal echogenicity as: (1) uniform isoechoic or mildly hypoechoic (homogeneous echo pattern), (2) diffuse mildly hypoechoic with tiny ill-defined more hypoechoic foci (non-homogenous echo pattern), (3) large discrete marked hypoechoic areas (heterogeneous echo pattern) and (4) mixed discrete hypo and hyperechoic areas (heterogeneous echo pattern).

2.4. Statistical analysis

The results of the ultrasonographic studies and patient’s outcome were entered into an excel worksheet and classified as true positive, true negative, false positive and false negative for the diagnosis of testicular torsion. Using the Med-Calc software, the sensitivities, specificities, positive predictive values (PPV) and negative predictive values (NPV), were calculated for individual CDUS and HRUS, then for the combined parameters used for the diagnosis of testicular torsion.

Fig. 1 A 16-year-old boy presented with sudden onset pain of the left hemiscrotum for 3 hours: (a) the left testis is mildly enlarged with homogenous isoechoic parenchyma, (b) no detected flow inside the left testis, (c) the left spermatic cord is abruptly terminated by mass-like at its terminal end, (d) nonvascular para-testicular mass compresses the epididymis with no detected flow inside the mass or epididymis. The left testis was found viable and showed rapid recovery after surgical detorsion.
Fig. 2 A 21-year-old patient presented with sudden onset pain of the left hemiscrotum for 9 hours: (a) the left testis is mildly enlarged with non-homogenous parenchyma stippled with numerous tiny ill-defined hypoechoic foci and no detected vascular flow inside, (b) a para-testicular mass-like compresses the epididymis, (c and d) one day post-surgical detorsion and orchiopexy, the left testis shows relative increased vascular flow.

Fig. 3 A 25-year-old patient presented with sudden onset of intermittent pain of the right hemiscrotum for 19 hours: (a) the right testis is mildly enlarged with heterogeneous parenchyma, two ill-defined hypoechoic areas and no vascular flow inside the testis, (b) a para-testicular non vascular mass-like compresses the epididymis with minimal vascular flow in the epididymis, (c) One day post-operative, the right testis shows relative increased vascular flow with persistent non perfused hypoechoic area in its upper pole, (d) 6-month follow up US, the right testis is decreased in size with persistent hypoechoic non perfused areas in the upper and lower poles.
3. Results

Testicular torsion (TT) was surgically confirmed in 33 patients (18.33%) from the 180 patients who had an acute scrotum during the study period. The remaining 147 patients had other pathologies that included torsion of the testicular appendix, epididymitis, orchitis, idiopathic scrotal edema, abscess of the scrotum, etc. The outcome and follow up of these 147 patients did not prove any misdiagnosed cases of testicular torsion.

The mean age for patients with TT was 18.42 ± 6.7 years (6–33 years). Testicular torsion occurred predominantly on the left side, in 23 patients (76.2%), while in 10 patients (23.8%) were on the right. The average duration time between the onset of pain and presentation to the hospital was 6 h (range: 1–22 h) when the testes were successfully conserved, and 41 h (range: 25–72 h) when the testes had to be removed.

At the time of exploration, the affected testis was considered viable and was preserved (detorsion and orchiopexy) in 26 patients (78.78%). Meanwhile, in the remaining 7 patients, the testes were nonviable and removed (orchiectomy). Prophylactic orchiopexy was done for contralateral unaffected testes.

Out of 47 patients clinically diagnosed as testicular torsion, HRUS and CDUS confirmed the diagnosis in 31 patients and revealed other pathologies in the remaining patients. Also 2 patients were diagnosed by ultrasonographic studies as testicular torsion during examination for clinically suspected epididymo-orchitis. From the 33 patients of surgically confirmed testicular torsion, CDUS revealed absence of intra-testicular vascular flow in 28 patients (84.84%), and detected low flow in the remaining five testes. HRUS detected the changes of the distal end of the spermatic cord (para-testicular snail-shaped mass) in 31 patients (93.93%), while in 2 patients, the spermatic cord changes could not be detected and during surgery the spermatic cord was found to be long and twisted without obvious mass formation (Figs. 1–5) Table 1.

In our study, CDUS revealed sensitivity of about 84.85% (95% CI: 68.09–94.83%) and specificity of about 100.00% (95% CI: 79.24–100.00%). HRUS had the same specificity and higher sensitivity 93.94% (95% CI: 79.74–99.08%). A combination of both HRUS and CDUS findings increased sensitivity to 100.00% (95% CI: 89.32–100.00%) Table 2.

All the 15 torsed testes with parenchymal echo pattern I and 8 testes with parenchymal echo pattern II were salvaged (Figs. 1 and 2), while the 5 torsed testes with parenchymal echo pattern IV were excised (Figs. 4 and 5). From the 5 torsed testes with parenchymal echo pattern III, two testes were excised with torsion duration of more than 24 h, meanwhile the remaining three testes with torsion duration between 12 and 24 h were preserved. The latter three testes showed delayed recovery during surgery and a relative decrease in size after 6 months follow up with HRUS and CDUS (Fig. 3) (Table 3).

Fig. 4 A 17-year-old boy presented with intermittent pain of the left hemiscrotum for 3 days after minor trauma: (a) the left testis parenchyma is heterogeneous with multiple linear anechoic areas and no vascular flow inside, (b) abrupt termination and kinking of the distal end of the left spermatic cord, epididymis is also enlarged with heterogeneous echo pattern and no vascular flow inside, (c) mild hematocele with thin echogenic septations and thickened scrotal skin, (d) the left testis was found non-viable during surgery and left orchietomy was done.
4. Discussion

Torsion of the spermatic cord is one of the most frequent urological emergencies in pediatric urology, and any therapeutic delay may result in loss of the testis (4). The reversible ischemic period has traditionally been estimated as 6 h and testicular viability is markedly decreased after this interval (5). In some cases the value of the physical examination is limited because the symptoms may disappear completely (6) with partial detorsion, and clinical signs are not reliable in young children (7).

Many studies recommended CDUS as a valuable diagnostic tool for the diagnosis of testicular torsion based on the absence of testicular blood flow compared to the normal side (8). In our series CDUS was accurate in the diagnosis of 28 testes with torsion out of the 33 surgically confirmed testicular torsion. However, false negative result may occur and in our series testicular blood flow was not markedly decreased in 5 testes, hence reliance only on CDUS may lead to a dangerous nonsurgical strategy.

Whereas the normal cord appears as a less than 5 mm linear structure limited by a highly echogenic stripe and containing

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<thead>
<tr>
<th>Table 1</th>
<th>Findings of HRUS and CDUS in surgically confirmed 33 patients of testicular torsion.</th>
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</thead>
<tbody>
<tr>
<td>Twisted cord (HRUS)</td>
<td>Vascular flow (CDUS)</td>
</tr>
<tr>
<td>Detected</td>
<td>26</td>
</tr>
<tr>
<td>No detected</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
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<th>Table 2</th>
<th>Statistical assessment of the HRUS and CDUS for diagnosis of testicular torsion in 49 patients.</th>
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<tr>
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<td>Sensitivity (%) (95% CI)</td>
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<tr>
<td>CDUS</td>
<td>84.85% (68.09–94.83%)</td>
</tr>
<tr>
<td>HRUS</td>
<td>93.94% (79.74–99.08%)</td>
</tr>
<tr>
<td>HRUS &amp; CDUS</td>
<td>100.00% (89.32–100.00%)</td>
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Fig. 5 A 23-year-old boy presented with intermittent pain of the left hemiscrotum for 3 days with redness of the scrotal skin since two days and failed medical treatment: (a) the left testis parenchyma is heterogeneous with mixed hypo and hyperechoic areas with no detected vascular flow inside representing infarction and hemorrhagic areas, (b) abrupt termination and kinking of the distal end of the left spermatic cord, epididymis is also enlarged with heterogeneous echo pattern and no vascular flow inside, (c) increased peri-testicular flow denoting attempt of revascularization through collaterals, (d) the testis was found non-viable during surgery and left orchiectomy was done.
testicular, cremasteric and deferential arteries, (9) the patho-
logical cord exhibits a spiral twist (10). In spite of the spiral
twist of the spermatic cord being a reliable sign for testicular
torsion (11), in our study it was detected in 31 of 33 patients,
while in 2 patients we could not detect it because of the long
spermatic cord twisted above the inguinal canal.

Depending upon both CDUS findings and detection of the
spermatic cord twisting sign by HRUS, there is an increase in
the sensitivity and specificity for the diagnosis of testicular tor-
sion (TT) with a subsequent reduction of the rate of unneces-
sary surgical exploration.

In our study, we confirmed the diagnosis of TT in 31 out of
47 patients clinically diagnosed as TT; hence we avoided
unnecessary surgical exploration in 16 patients (34%). The rate
of unnecessary surgical exploration in this study was 0% in
cases without torsion, which was much lower than that,
reported by Ben-Chaim J et al who mentioned a rate of unnec-
essary exploration of about 66% in children and 14% in adults
(12).

Also we detected 2 cases of late testicular torsion which
were clinically misdiagnosed as epididymo-orchitis. Thus,
HRUS and CDUS may change the medical treatment strategy
into a surgical one.

The sonographic appearance of testicular torsion is associ-
ated with testicular viability, which depends on the degree and
the duration of torsion (13). Bentley and et al. found that the
patterns depend mainly on the degree of blood perfusion and
ischemia, rather than the duration of symptoms, because testis
perfusion can be maintained for a prolonged period after tes-
ticular torsion in some cases, especially in incomplete torsion
and intermittent testicular torsion (14), thus suggesting that
patterns may primarily reflect the degree of damage to the tor-
sed testes and predict viability.

In this study, the duration of symptoms between different
patterns was various. In patterns I and II, all the testes were
salvaged and in patterns IV all the testes were lost. Meanwhile,
in pattern III the two testes with torsion duration of more than
24 h were lost and the other three testes with torsion duration
between 12 and 24 h showed delayed recovery during surgery
and salvage. These suggest that the patterns were related to
prognosis. This study was consistent in general with findings
by Nussbaum Blask and Rushton (15) that after 10 h of symp-
toms, most testes cannot be salvaged. In this study, the per-
centage of loss of testicular torsion between different
patterns was significantly different, which suggests the patterns
are related to the pathologic changes.

The potential limitations of the study were that the study
was retrospective and case selective.

5. Conclusion

Color Doppler ultrasonography (CDUS) is a reliable method
for the diagnosis of testicular torsion and avoidance of unnec-
essary surgical exploration. Yet, false negative results may
occur in cases of incomplete torsion or partial detorsion where
a significant vascular flow can still be maintained in the
affected testis.

The twisted spermatic cord sign detected by high resolution
ultrasonography (HRUS) is a highly reliable sign of testicular
torsion. Combination of HRUS and CDUS findings, increased
the accuracy of ultrasonographic study for the diagnosis of tes-
ticular torsion and decreased the rate of unnecessary
exploration.

In addition to the diagnostic value of HRUS, ultrasono-
graphic parenchymal echo pattern of the affected testis corre-
lates with its viability and contributes to determining testicular
prognosis.

Conflict of interest statement

We declare no conflict of interests prior and during prepara-
tion of this paper.

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Consent

This study was approved from the Nizwa Hospital & Al Dak-
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Author contributions

Dr. Yasser Abdel Razek: data collection, preparation of figures,
writing, design & editing manuscript.

Dr. Said Albroumi: data collection, writing, design and
editing manuscript.

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