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Straight to the Operating Room: An Emergent Surgery Track for Acute Testicular Torsion Transfers

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Abstract

Objective—To assess the effect of implementing an emergency surgery track for testicular torsion transfers. We hypothesized that transferring children from other facilities diagnosed with torsion straight to the operating room (STOR) would decrease ischemia time, lower costs, and reduce testicular loss.

Study design—Demographics, arrival to incision time, hospital cost in dollars, and testicular outcome (determined by testicular ultrasound) at follow up were retrospectively compared in all patients transferred to our tertiary care children's hospital with a diagnosis of testicular torsion from 2012 – 2016. Clinical data for STOR and non-STOR patients were compared by Wilcoxon rank sum, 2-tailed t-test, or Fisher exact test as appropriate.

Results—68 patients met inclusion criteria: 35 STOR and 33 non-STOR. Children taken STOR had a shorter median arrival to incision time (STOR: 54 min vs non-STOR: 94 min, $P < .0001$) and lower median total hospital costs (STOR: \$3,882 vs non-STOR: \$4,419, $p < 0.0001$). However, only 46.8% of STOR patients and 48.4% of non-STOR patients achieved surgery within 6 hours of symptom onset. Testicular salvage rates in STOR and non-STOR patients were not significantly different (STOR: 68.4% vs non-STOR: 36.8%, $p = 0.1$), but follow up was poor.

Conclusions—STOR decreased arrival to incision time and hospital cost, but did not affect testicular loss. The bulk of ischemia time in torsion transfers occurred prior to arrival at our tertiary care center. Further interventions addressing delays in diagnosis and transfer are needed to truly improve testicular salvage rates in these patients.

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Keywords

spermatic cord torsion; operating room; pediatric hospitals

Approximately 15% of children presenting with acute unilateral scrotal pain will be diagnosed with testicular torsion, a frequent pediatric emergency affecting 3.8 per 100,000 boys in the United States.^{1, 2} The identification and management of torsion-induced testicular ischemia is a race against time, for the rate of testicular salvage is highest within the first 6 hours of symptoms.^{3–5} Obstacles to timely care are multifactorial, and in combination, contribute to post-torsion orchiectomy rates > 40% nationwide.^{1, 6, 7}

Despite the urgency with which suspected torsions must be treated, approximately one third of torsion patients will be transferred to a tertiary care center for their surgery.⁸ Reasons for transfer include family preference, desire for pediatric anesthesia/surgical expertise, or unwillingness of the on-call local surgeon/urologist to care for a child with torsion. As the transfer inevitably adds to total ischemic time, the ability to accept these patients expeditiously is of utmost importance. Consequently, we implemented an emergent surgery track that maneuvered ultrasound-confirmed torsion transfers directly from the ambulance bay straight to the operating room (STOR), bypassing redundant emergency room re-evaluation. We hypothesized that STOR cases would have decreased arrival to incision time compared with those who were taken first to the ER, save healthcare dollars, and reduce testicular losses. For the first 52 months after implementation, a retrospective clinical effectiveness review was conducted as well as a cost analysis of this new management model.

Methods

With IRB approval, patients from February 2012 to May 2016 who received care at Children's Health (CH) with a diagnosis of testicular torsion were identified by ICD-9 (608.2), ICD-10 (N44.0) and CPT codes relating to orchiectomy, orchiopexy, or testicular torsion reduction (54600, 54620, 54650, and 54800). A retrospective chart review was performed to identify inter-hospital transfers. Exclusion criteria included 1) cases transferred via AC without sonographic confirmation of acute torsion, 2) perinatal torsion, 3) cases requiring additional medical evaluation due to co-morbid conditions, 4) cases where an elective, non-urgent orchiectomy was performed secondary to length of ischemia time, and 5) cases performed at satellite facilities. Transferred cases meeting inclusion criteria were categorized as STOR and non-STOR by cross-referencing AC records of whom had been transferred STOR.

A clinical effectiveness database was constructed to compare outcomes of these 2 groups. Demographics, insurance status, imaging studies, operative reports, and follow up clinical examinations were extracted from the medical record. The primary outcome of interest was time from arrival at CH to time of first incision (arrival to incision time). The secondary outcomes of interest were overall ischemia time, testicular loss, and hospital cost. Overall ischemia time was defined as total time from symptom onset to first incision. Patients achieving surgery within 6 hours were considered to have undergone treatment within the

critical ischemic window. Testicular loss was defined as either surgical orchiectomy or determination of significant atrophy per routine post-operative ultrasound. A >50% difference in volume compared with the contralateral testis or absence of blood flow on Doppler was considered to represent testicular loss.⁹ Hospital cost was defined as all direct and indirect hospital costs obtained from the CH billing database. Ambulance costs were excluded as these values were available only for patients transported by CH ambulances. Totals were adjusted for inflation employing monthly, seasonally-adjusted chain-type price indices and are presented in constant 2016 US dollars.

STOR pathway

In 2012, CH implemented a novel pathway to improve the care of sonographically-diagnosed torsion transfers by bypassing the ER. After receiving a physician transfer request, CH Access Center (AC) employees initiated the STOR pathway by establishing a physician-to-physician phone conversation. This conversation established patient history and physical examination, including symptom duration and the results of the testicular ultrasound. After telephone confirmation by the accepting pediatric urologist, the AC arranged patient transfer and relayed estimated time of arrival information to the on-call nursing staff for operating room (OR) team mobilization. Patients were transported directly from the ambulance bay to the preoperative area, then promptly re-evaluated by the pediatric urologist and anesthesiologist; if surgery was still indicated, consents were obtained, and the child was taken directly to the OR.

Not all transferred patients undergoing surgical detorsion went through the STOR pathway at our hospital. Reasons for this included: 1) transfers arranged outside of the AC, 2) failure of the AC to initiate the STOR process, and/or 3) failure of the accepting pediatric urologist to utilize the STOR pathway. As the STOR pathway became better established and known by hospital employees, implementation improved yearly from only 20% execution in 2012 to 100% execution in 2016 (Figure 1).

Surgical exploration for suspected torsion

All patients for whom surgery was indicated proceeded to the OR for scrotal exploration. During the duration of the study period, most patients with confirmed torsion underwent orchiopexy regardless of presumed testis viability in accordance with a separate, ongoing, NIH-funded clinical trial. In rare cases performed by nonparticipating surgeons, select patients underwent orchiectomy off-protocol at the surgeon's discretion.

Statistical Analysis

Continuous variables were analyzed using the Wilcoxon rank sum or 2-tailed t-test as appropriate. Categorical variables were compared using the Fisher exact test. Statistical analysis was performed using SPSS (Chicago, Illinois) and a p-value of 0.05 was chosen for significance.

Results

From February 2012 until May 2016, 96 patients with a pre-operative diagnosis of testicular torsion were transferred to CH for surgical exploration (Figure 2). A total of 28 patients were excluded for perinatal torsion (n = 3), lack of testicular ultrasound (n = 9), non-urgent orchiectomy (n = 11), performance at satellite facilities (n = 4), or delayed surgery secondary to comorbidities (n = 1). Of the remaining 68 patients, 35 followed the STOR and 33 followed the non-STOR pathway (Table I). The catchment area for operated torsions spanned six different counties of Texas, encompassing a 60-mile radius around our hospital. In total, transferred torsions accounted for 28% of patients undergoing exploration at our institution during the study period.

The mean patient age was 13.0 years (range 0.8 – 17.3 years). There was no significant difference between groups in terms of race, ethnicity, or insurance status (Table 1). STOR patients were on average 2.3 years older than non-STOR patients (14.1 vs 11.8 years, $p = 0.004$). The majority of patients underwent orchiopexy (28/35 STOR, 27/33 non-STOR) per the ongoing NIH study protocol; 3 STOR and 3 non-STOR patients underwent orchiectomy by nonparticipating surgeons. Seven patients (4 STOR, 3 non-STOR) had tunica vaginalis flap performed concomitant with orchiopexy.

Two patients with suspected torsion were found to have alternative operative etiologies intraoperatively (incarcerated inguinal hernia and scrotal trauma with bilateral hematomas). All other patients showed evidence of torsion with active twisting of the spermatic cord or testis discoloration or swelling consistent with spontaneous or manual detorsion. Follow-up with postoperative testicular ultrasound was achieved in 32/62 (52%) of orchiopexy patients at a median of 3 months (IQR: 2 – 5 months), limiting salvage data. Three patients had no recorded time of symptom onset to determine overall ischemia time. One patient returned incomplete cost data and was excluded from cost analysis.

Table 2 compares results between STOR and non-STOR patients. Patients taken STOR had a median arrival to incision time of 54 minutes (IQR: 39.5 – 65.5 minutes) compared with 94 minutes (IQR: 76 – 147 minutes) for the non-STOR patients ($p < 0.0001$). Median overall ischemia time from symptom onset to first incision was 6.0 hours (IQR: 4.1 – 9.7) in the STOR group and 6.2 hours (IQR: 5.0 – 15) in the non-STOR group ($p = 0.3$). Only 46.8% of STOR patients and 48.4% of non-STOR patients underwent surgery within the critical ischemic window. Rates of testicular loss were 32% in STOR patients vs 63% in non-STOR patients ($p = 0.1$). In both groups, testicular salvage was significantly higher in those achieving surgery within their critical ischemic window (76.9% vs 40.0%, $p = 0.04$). The median cost for STOR totaled \$3,882 (IQR: \$3,327 – \$4,200) per patient. Children who were part of the non-STOR group had a median total cost of \$4,419 (IQR: \$3,881 – \$5,161) per patient. This represented a substantial difference in costs (\$537, $p < 0.0001$). Total median ER costs were \$730 (IQR: \$476 – \$798).

Discussion

Depending on referral area, pediatric hospitals may accept as many as 45 percent of their torsion patients as transfers.¹⁰ With STOR, arrival to incision time for transferred torsions was expedited by 40 minutes. Given the limited window to salvage a testicle in this emergent situation, this improvement is substantial. Furthermore, bypassing the ER and avoiding reevaluation provided an added benefit of cost-savings, averaging \$537 per patient. This was accomplished without any unnecessary OR costs as all patients did require emergent surgical management: the two patients in this study who were ultimately found not to have torsion were surgical emergencies in their own merit. By saving both time and money, this fast-track pathway for testicular torsion represents a quality improvement measure that could benefit hundreds of torsion patients burdened with the transfer process each year.

Despite demonstrating substantial time saved and financial gains, the largest potential benefit of the STOR pathway—reduction of testicular loss—was not observed. Examination of postoperative ultrasounds in STOR and non-STOR patients showed no significant difference in salvage rates; however, the ratio of testicular loss was nearly twice as high in the non-STOR group. Conceivably, our small numbers and limited follow up blunted the true effect of STOR on testicular outcomes, and if STOR were more widely implemented, a statistically significant difference in testicular salvage could be demonstrated. Previous investigation found a significantly higher orchiectomy rate (68.9% v. 47.8%) in patients transferred to a tertiary care center who incurred a mean transfer delay of 75-minutes.¹¹ Presumably, the 40 minutes of time saved by STOR has the potential to affect outcomes in an opposite manner, particularly for patients at the breakpoint of their critical ischemic window.

Regardless, salvage rates in the present study were overwhelmingly confounded by our transferred patients' overall ischemia time: less than half of patients in both cohorts reached the OR within their critical ischemic window, with obvious consequence. In our study, salvage rates were significantly higher in those achieving surgery within their critical ischemia windows. These results are consistent with previous literature finding time to OR and time to presentation to be the most significant predictors of testicular salvage.^{12, 13}

Such findings prompt re-examination of the factors contributing to delayed treatment of testicular torsion: 1) patient/family delays, 2) diagnostic delay, and 3) treatment team delay. Patient and family delays are challenging to surmount as differing education levels and socioeconomic status continue to influence speed of presentation.⁷ Poor general understanding of testicular torsion and its consequences also contributes to delays in presentation. In 2014, a survey of parents whose child had undergone scrotal exploration for torsion showed only 34% of parents admitted awareness of the implications of acute scrotal pain in their child.¹⁴ Similarly, another recent anonymous survey found that only 34% of parents had heard of testicular torsion, mostly through friends, and only 17% had heard about it through their pediatricians. Furthermore, such anecdotal knowledge of torsion still failed to affect the urgency with which parents would seek medical attention if their child had acute scrotal pain.¹⁵ Lack of awareness occurs not just in parents but male adolescents as well: in a survey of 12 to 18 year olds, 64% of respondents knew to seek medical care

within 2 hours for painful testicular swelling, but only 15% knew to also seek rapid attention for painless swelling.¹⁶ These studies highlight several social and societal barriers to timely evaluation of acute scrotal pain and represent an area of future study and intervention if testicular outcomes are to be improved.

Delays in diagnosis also contribute to overall ischemia time. To expedite diagnosis, testicular torsion scoring systems are now being validated in non-urologic medical providers, but are still early in their implementation.^{17, 18} Therefore in most emergency departments, providers continue to rely on ultrasound, which is 100% sensitive and 97.9% specific for testicular torsion.¹⁹ However, even with ultrasound, the diagnosis of testicular torsion in younger pre-pubertal patients can often be challenging due to non-classic presentation. Although older children may precisely pinpoint the onset of scrotal pain, younger children or those with developmental delay may have vague abdominal complaints that receive no attention for substantial periods of time; these populations are more susceptible to delayed presentation and misdiagnosis.²⁰ Interventions aimed at capturing these occult cases include always considering torsion in the male pediatric patient presenting with lower abdominal pain, and always performing a genitourinary examination in such cases.^{20, 21}

The STOR pathway itself works to address the final factor contributing to delays in detorsion: patient transfer and mobilization of the receiving treatment team. Inter-hospital transfer invariably consumes a portion of the patient's critical ischemic window. Although STOR was not designed to alter outside hospitals' decision to initiate the transfer, it did result in a 40-minute median reduction in time from admission to first incision. As previously stated, this time savings is considerable in the context of a mere 6-hour treatment window. STOR additionally eliminates the financial burden of a redundant ER visit. In our study, a median of \$537 per patient was saved when bypassing the emergency room. Recognizing that in tertiary care centers 23 – 35% of testicular torsion cases are transferred patients,^{10–12} the anticipated cost savings could be considerable if the STOR pathway is universally adopted across the United States. This said, we acknowledge that the costs saved in bypassing the tertiary emergency room are unlikely to offset the overall cost of an inter-hospital transfer, and these results should not be interpreted as incentive to routinely transfer torsion patients.

The STOR concept has broad applications outside the urologic field and may be applied to other high-risk, high-yield, high-morbidity pathologies that have similarly high diagnostic accuracy and depend on timely intervention. This concept has been proven in the adult sphere such as with rapid cardiac catheterization laboratory transfers or in trauma centers permitting patients to be conveyed directly to the OR under exigent circumstance.^{22, 23} The STOR pathway for ultrasound-confirmed testicular torsion demonstrates the utility of such quality-improvement processes for pediatric hospitals and may be expanded to include other emergent pediatric conditions.

Our study has several limitations, including its retrospective design and limited followup. Follow up was greatly affected by the size of our catchment area: some patients were transferred from hospitals as far as 60 miles away, creating a significant barrier to follow up in clinic. Consequently, outcomes data were available only for patients who underwent

orchiectomy or had a follow up testicular ultrasound to measure atrophy. We felt it unethical to randomize patients as the STOR program was a quality improvement measure. The mean age discrepancy, with the non-STOR cohort younger than the STOR cohort, gives evidence to a selection bias on the part of the accepting urologist and reflects diagnostic uncertainty in younger aged boys. Conversely, the presence of the STOR pathway likely accelerated processing of non-STOR patients: on some occasions, the urology team was already aware of impending non-STOR transfers and was stationed in the ER for patient arrival. This may mask an even greater difference in arrival to incision time between the two groups.

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Abbreviations

ER	emergency room
STOR	straight to the operating room
CH	Children's Health
AC	access center
OR	operating room

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Figure 1.
Success of STOR implementation from 2012–2016: Percentage of transfer patients sent through STOR pathway by year

Figure 2.

Flow diagram of patients undergoing scrotal exploration for testicular torsion at our tertiary care center from Feb 2012 – May 2016.

Table 1

Patient Demographics and Characteristics

Variable	Straight to OR (n=35)	Non-Straight to OR (n=33)	P-value
Patient Age (yrs)	14.1 (2.0)	11.8 (4.2)	0.004 ^a
Patient Race			0.07 ^b
White	11/35 (31%)	10/33 (30%)	
Black	16/35 (46%)	7/33 (21%)	
Hispanic	7/35 (20%)	11/33 (33%)	
Other	1/35 (3%)	5/33 (15%)	
Insurance Status			0.1 ^b
Commercial	18/35 (51%)	19/33 (58%)	
Medicaid	16/35 (46%)	9/33 (27%)	
Self-Pay/None	1/35 (3%)	5/33 (15%)	
Surgery Performed			1.0 ^b
Orchiectomy	3/35 (9%)	3/33 (9%)	
Orchiopexy	28/35 (80%)	27/33 (82%)	
Orchiopexy + TV flap	4/35 (11%)	3/33 (9%)	
Follow up			
Testicular u/s ^d	16/32 (50%)	16/30 (53%)	1.0 ^b
Time (months)	3.0 (1.8 – 4.0)	3.0 (2.0 – 8.0)	0.5 ^c

Data presented as mean (SD) for normally-distributed continuous variables or median (IQR). Dichotomous variables presented as proportion (percent)

^aTwo-tailed t-test

^bFisher's exact test

^cWilcoxon rank sum

^dOrchiopexy patients only

Table 2

Outcomes in STOR and non-STOR Patients

Variable	Straight to OR (n=35)	Non-Straight to OR (n=33)	P-value
Arrival to Incision (min)	54 (39.5 – 65.5)	94 (76 – 147)	<0.0001 ^a
Overall Ischemia Time (hrs)	6.0 (4.1 – 9.7)	6.2 (5.0 – 15)	0.3 ^a
Surgery Within 6 Hrs			1.0 ^b
6 hours	15/32 ^c (47%)	16/33 (48%)	
> 6 hours	17/32 (53%)	17/33 (52%)	
Testicular Outcomes			0.1 ^b
Salvaged	13/19 (68%)	7/19 (37%)	
Testicular Loss ^d	6/19 (32%)	12/19 (63%)	
Total Cost/pt	\$3,882 (\$3,327 – \$4,200)	\$4,419 ^e (\$3,881 – \$5,161)	<0.0001 ^a
Total ER Costs/pt	\$ -	\$730 (\$476 – \$798)	

Data presented as median (IQR) for continuous variable and proportion (percent) for dichotomous variables

^aWilcoxon rank sum^bFisher's exact test^c3 patients could not specify time of pain onset^dOrchiectomy or >50% volume loss on f/u ultrasound^eIncomplete cost data returned for 1 patient; excluded from analysis