Testicular Torsion: An Analysis of Rural Geography and Socioeconomic Status

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Abstract

Objectives Testicular torsion is a time-critical, organ-threatening diagnosis requiring prompt surgical intervention for successful salvage of the organ. In Australia, 28% of individuals live in rural and remote areas and face barriers to health care such as greater distance, lower socioeconomic status, (SES), and limited health infrastructure. We hypothesize that these barriers would delay intervention and access to surgical care, and lead to higher orchidectomy rates.

Objectives A 12-year retrospective audit was conducted at a large rural referral center in Australia, focusing on patients undergoing scrotal exploration for testicular torsion. Primary outcomes were orchidectomy rate, time to operation, and ultrasound (US) and their relationship with patient distance, SES, age, and peripheral hospital attendance. Data on SES for geographic postcodes was obtained from the Australian Government Socio-Economic Indexes for Areas 2016. Statistical analysis was performed using IBM SPSS Statistics software, and a P value < 0.05 was considered significant.

Results The study involved 107 patients, of whom 46% had left-sided pathology. The median age of the patients was 14 years. Median SES was in the 37% to 41% centile range, median distance from travelled was 62 kilometers, and median time to operation from triage was 194 minutes. Of the patients, 34 attended a peripheral hospital. No significant risk factors for orchidectomy were identified. US was used in 65% of cases, with torsion detected in 50% of those cases, and orchidectomy performed in 11 patients. US had a sensitivity of 86.1% and specificity of 52.9%.

Conclusion Despite significant differences in geographical distance, SES, age, and access to health care, patients in rural and remote areas of Australia experienced equivalent outcomes in testicular torsion management. Testiculartorsion was safely managed at a central referral center using a peripheral hospital catchment in rural and remote areas of Australia, despite significant time delays due to greater distance or lower SES.

Introduction

Testicular torsion is a medical emergency, requiring prompt surgical intervention within 6 hours to salvage the affected organ[1]. International guidelines such as those from the European Association of Urology (EAU) and British Association of Urological Surgeons (BAUS) endorse urgent scrotal exploration as the mainstay of treatment[2,3].

In Australia, 7 million people (28% of the population) live in rural and remote areas, with higher health morbidity and mortality due to poor access and use of primary health care services compared with metropolitan areas[4]. Socioeconomic status (SES) plays a crucial role in determining health outcomes, and rural geography is a risk factor for low SES[5–7].

Key Words

Orchidectomy, testis, testicular torsion, rural health

Competing Interests

None declared.

Article Information

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The Royal Australasian College of Surgeons (RACS) position statement on acute scrotal pain endorses the orchidectomy rates. Necessitate patient transfer and lead to potential delays in surgical intervention due to increased distance from rural areas, hospital transfers, and reduced access to operating theaters and anesthesia, and 24-hour on-call availability of ultrasonography and sonographers.

Electronic medical records from the Cerner application were used to identify patients of all ages who underwent scrotal exploration as a theater event. Baseline demographic information, residential postcode, time from triage to operation, age, laterality, ultrasonography usage, diagnosis at operation, and operative details were recorded. Patients with cryptorchidism, malignancy, and neonatal patients were excluded from the study.

Socioeconomic status
Socioeconomic status (SES) data was obtained from the publicly available Australian Bureau of Statistics: Socio-Economic Indexes for Areas 2016 (SEIFA)[9]. Four categories of SES were assessed: Index of Relative Socio-economic Disadvantage (IRSD), Index of Relative Socio-economic Advantage and Disadvantage (IRSD+), Index of Economic Resources (IER), and Index of Relative Socio-economic Disadvantage (IRSD). SEIFA 2016 ranks postcodes according to the variant and disadvantage including income, education, employment, housing, disability, and access to infrastructure. Postcodes are assigned a national centile, with 1 indicating the lowest SES and 100 indicating the highest.

Peripheral hospital attendance and distance
The distance from the treating hospital was determined using Google Maps, considering road travel distance as all inter-hospital transfers were conducted by road transport. The distance was calculated from the center of the patient’s residential postcode to the patient’s local environmental resource and access to infrastructure.[10]

Dubbo Base Hospital serves as a catchment for over 259,258 people. The hospital has a 24-hour on-call surgical service, access to operating theaters and anesthesia, and 24-hour on-call availability of ultrasonography and sonographers.

Primary outcome
Primary outcome was to determine the association between socioeconomic status, road distance, or peripheral hospital attendance and orchidectomy rate. Patients with intraoperative assessment of testicular torsion were considered true positive. Orchidectomy was performed when intraoperative findings were confirmed after de-torsion and a minimum 15 minutes of warming. Orchidectomy was performed for viable testes according to the BURST-UA5 consensus guideline.[2]

Secondary outcome
Secondary outcome included an assessment of ultrasonography usage and its sensitivity, specificity, positive predictive value, negative predictive value, and accuracy in a rural setting. Ultrasonography was performed with color Doppler, and a positive finding was considered low or absent blood flow with suspicious findings considered positive. Furthermore, an assessment was performed to determine whether SES, distance, and a rural hospital attendance influenced use of ultrasonography.

Statistical analysis
IBM SPSS Statistics version 28[12] and Microsoft Excel were used for statistical analysis. The Shapiro-Wilk test was performed, along with data to determine normality. Independent t tests and chi-square tests were performed to compare baseline characteristics with normal distribution, and the non-parametric Mann-Whitney test was performed if the data distribution was not normal. Univariate regression and bivariate Pearson correlation were performed to compare outcomes of subgroups for dichotomous and continuous data, respectively. Multivariate regression was performed when significant results were found in the univariate regression to correct for potential confounding variables. A P value of < 0.05 was considered statistically significant.

Results
Patient characteristics
During the study period, 145 patients were identified, but only 107 were included in the analysis due to 38 patients having incomplete data or meeting the exclusion criteria. The most common reason for exclusion was cryptorchidism. Median age was 14 years, with 46% presenting with left-sided symptoms (Table 1). All patients were from rural areas under the Modified Monash Model MM3-7. Torsion was present in 50% of cases, with left-sided torsion observed in 49%. Orchidectomy was performed in 12 patients, with median age of 13.5 years, and 83% of the cases were left sided. The degree of torsion was documented in 18 patients, and all 3 patients who underwent orchidectomy had rotation greater than 360 degrees. Of the 54 patients without torsion, 22 (22.2%) patients had torsion of the appendix testis and 10 (18.5%) had epididymitis. No cases of repeat scrotal exploration were identified. The median time to operation was 194 minutes from triage, but it was significantly longer (335 minutes) in patients who attended a peripheral health service. Upon arrival to emergency department of the operating hospital, median time between decision to operate and the actual operation was 32 minutes (interquartile range [IQR], 35 minutes). In patients with testicular torsion, no significant association was found between time from triage to operation and orchidectomy rate (odds ratio

### TABLE 1. Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>All patients</th>
<th>Peripheral hospital attendance</th>
<th>Non-peripheral hospital attendance</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years, median (IQR)</td>
<td>14 (11)</td>
<td>13.5 (9)</td>
<td>14.9 (10)</td>
<td>0.237</td>
</tr>
<tr>
<td>Side of pathology</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>0.35</td>
</tr>
<tr>
<td>Left, n (%)</td>
<td>49 (46)</td>
<td>21 (62)</td>
<td>28 (38)</td>
<td>0.024</td>
</tr>
<tr>
<td>Right, n (%)</td>
<td>58 (54)</td>
<td>13 (38)</td>
<td>45 (62)</td>
<td>0.067</td>
</tr>
<tr>
<td>Side in torsion</td>
<td>53</td>
<td>20</td>
<td>33</td>
<td>0.37</td>
</tr>
<tr>
<td>Left, n (%)</td>
<td>26 (49)</td>
<td>13 (65)</td>
<td>13 (39)</td>
<td>0.071</td>
</tr>
<tr>
<td>Right, n (%)</td>
<td>27 (51)</td>
<td>7 (35)</td>
<td>20 (61)</td>
<td>0.071</td>
</tr>
<tr>
<td>Distance, km, median (IQR)</td>
<td>62 (10)</td>
<td>122 (121)</td>
<td>11 (14)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SES</td>
<td>IRSD percentile, median (IQR)</td>
<td>31 (27)</td>
<td>17 (32)</td>
<td>40 (11)</td>
</tr>
<tr>
<td>IRSD+ percentile, median (IQR)</td>
<td>37 (18)</td>
<td>22 (29)</td>
<td>38 (10)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>IER percentile, median (IQR)</td>
<td>38 (14)</td>
<td>29 (18)</td>
<td>38 (3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>IEDI percentile, median (IQR)</td>
<td>41 (21)</td>
<td>21 (19)</td>
<td>41 (15.5)</td>
<td>0.044</td>
</tr>
<tr>
<td>Time to surgery from triage, minutes, median (IQR)</td>
<td>194 (220.5)</td>
<td>35 (191.25)</td>
<td>194 (223)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ultrasound performed, n (%)</td>
<td>75 (69)</td>
<td>23 (69)</td>
<td>52 (75)</td>
<td>0.371</td>
</tr>
<tr>
<td>Torsion present, n (%)</td>
<td>53 (50)</td>
<td>20 (65)</td>
<td>33 (46)</td>
<td>0.104</td>
</tr>
<tr>
<td>Orchidectomy, n (%)</td>
<td>12 (11)</td>
<td>3 (9)</td>
<td>9 (12)</td>
<td>0.583</td>
</tr>
</tbody>
</table>

IEO: Index of Education and Occupation; IER: Index of Economic Resources; IQR: interquartile range; IRSD: Index of Relative Socio-economic Advantage and Disadvantage; IRSAD: Index of Relative Socio-economic Disadvantage; km: kilometers; SES: socioeconomic status.
patients who underwent orchidectomy, 9 patients had preoperative ultrasonography, which correctly diagnosed the testicular torsion in all cases. Patients who underwent ultrasonography had significantly longer time to operation (349 minutes; standard deviation [SD], 348.8 minutes) compared to those without ultrasonography (176 minutes; SD, 131.3 minutes; \( P = 0.005 \)), but there was no significant difference in the orchidectomy rate \(( P = 0.464)\).

**Discussion**

In Australia from 2020 to 2021, 1830 scrotal explorations were performed, as reported by the Australian Institute of Health and Welfare \[19\], an incidence of 1 per 50 000 in a population of 25·74 million in 2021. Australia has a population density of 3·3 people per square kilometre \[4\], primarily due to population sparsity in rural and remote areas, where 7 million (28%) of Australians live. The combination of geographic isolation and a rare pathology exacerbates the time,critical challenge of managing testicular torsion. The limited accessibility to healthcare infrastructure due to geographic distance acts as a major obstacle to achieving positive outcomes.

Testicular torsion is a medical emergency that necessitates prompt surgical intervention, with the duration of symptoms being the primary predictor in the success of salvage procedures \[4\]. We hypothesized that barriers to Princess Mary Hospital attendance, peripheral hospital attendance, and distance, peripheral hospital patients. Additionally, the time to operation was significantly longer for peripheral hospital attendees, with a median age of 13.5 years. The majority of peripheral hospital attendance and distance increased orchidectomy rate, ultrasound use, or time to operation \(( P \leq 0.071)\) in patients with diagnosis of torsion. The rate (9%) between these 2 patient groups \(( P = 0.04)\); however, IRSAD, IER, and IEO did not show a significant correlation.

**Ultrasonography**

Ultrasonography was performed in 65% of patients preoperatively, with a sensitivity of 86.1%, specificity of 52.9%, positive predictive value of 66%, negative predictive value of 78.3%, and accuracy 70% \( \text{(Table 3)} \). Five patients had false-negative ultrasound results, and 16 patients had false-positive results. Of the 12 patients who attended peripheral hospitals had a significantly lower median IRSAD, IRSAD, IER, and IEO compared to those who presented directly—\( P = 0.04\), respectively). Of those patients who presented directly, 46 lived in the same suburb as the operating hospital. No significant association was identified between the 4 SES categories and orchidectomy rate or ultrasound use. IRSAD, a measure of only SES disadvantage, correlated with increased time to operation \( (P = 0.04) \); however, IRSAD, IER, and IEO did not show a significant correlation.

**TABLE 3.** Ultrasonography diagnosis

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>86.1%</td>
<td>52.9%</td>
<td>66%</td>
<td>78.3%</td>
<td>70%</td>
</tr>
</tbody>
</table>

**Socioeconomic status**

The median IRSAD was 39, IRSAD was 37, IEO was 38, and IEO was 41, with all patients falling within the lower 50% of Australia’s national SES bracket. Patients who attended peripheral hospitals had a significantly lower median IRSAD, IRSAD, IER, and IEO compared to those who presented directly—\( P = 0.04\), respectively). Of those patients who presented directly, 46 lived in the same suburb as the operating hospital. No significant association was identified between the 4 SES categories and orchidectomy rate or ultrasound use. IRSAD, a measure of only SES disadvantage, correlated with increased time to operation \( (P = 0.04) \); however, IRSAD, IER, and IEO did not show a significant correlation.
In our study, we found much lower orchidectomy rates and non-peripheral hospitals. The orchidectomy rate in ultrasonography use were identified between peripheral surgery. In particular, this could explain the high rate of assessments and determining the need for transfer and practitioners, general surgeons, and urologists making decision-making, with a mix of registered nurses, general protocols resulted in inconsistency in clinician decision-making. Furthermore, the absence of network guidelines or was performed and thus its role could not be assessed. Because the majority of patients underwent surgery is < 24 hours, hospital transfer has been shown to significantly increase orchidectomy rates[29]. However, in this study, we found no significant increase in orchidectomy rates of major injury from a trauma registry dataset: delineation of hospital catchment areas (I).

Conclusion
In conclusion, our findings indicate that for patients residing in rural-remote areas of Australia, geographical distance, SES, age, and peripheral hospital attendance were not significant risk factors for orchidectomy rate. Despite significant time delays associated with peripheral hospital attendance, geographic remoteness, and low SES, we suggest that testicular torsion can be managed safely in rural health care settings, particularly within a rural referral center with a peripheral hospital catchment. Future multicenter, prospective studies examining symptom onset and clinical decision-making, such as TWIST score, should be performed in rural health care settings to assess the diagnostic accuracy and the role and safety of ultrasonography in the management of this organ-threatening condition.

Acknowledgments
The research protocol (PID01054/ETH09931/STE01878) was approved by the Greater Western Human Ethics Research Committee as a negligible/low-risk project. The data were retrospectively collected and de-identified, eliminating the need for informed consent from each patient. This study did not involve any trials or animal experiments. The authors would like to disclose that they have not received any grant support and they declare no conflicts of interest. All the authors have reviewed and agree upon the content of the manuscript. The manuscript has not been previously published and is not under consideration elsewhere.

References


