Inappropriate Use of Ultrasound in Management of Pediatric Cryptorchidism

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abstract

BACKGROUND AND OBJECTIVES: There is a limited role for ultrasound in the management of an undescended testicle (UDT). We hypothesized that ultrasound remains overused by referring physicians. Our goal was to characterize the trends, patterns, and impact of ultrasound use for UDT and to reaffirm its limited diagnostic value for this indication.

METHODS: The records of boys aged 0 to 18 years with UDT in Ontario, Canada, between 2000 and 2011 were reviewed by using health administrative data housed at the Institute for Clinical and Evaluative Sciences (ICES). A second review of boys referred to our institution with UDT between 2007 and 2011 was conducted to supplement the health administrative data. Trends in frequency, distribution, and costs of ultrasound use were assessed. Time delays between diagnosis and definitive management were compared between the ultrasound and non-ultrasound groups. Using our institutional data, we analyzed demographic patterns of ultrasound use and compared its diagnostic accuracy by using surgical findings as the gold standard.

RESULTS: Ultrasound was used in 33.5% of provincial referrals and 50% of institutional referrals. Children who underwent ultrasound experienced an approximate 3-month delay in definitive surgical management. Ultrasound correctly predicted physical examination findings in only 54% of patients. Physicians in community practice, and those with fewer years in practice, were more likely to order ultrasound.

CONCLUSIONS: Ultrasound has limited value for the management of UDT but remains widely overused, with an increasing trend over time. This practice has negative implications for access to care and cost-containment. Widespread educational efforts should be undertaken, targeting current and future referring physicians.

WHAT’S KNOWN ON THIS SUBJECT: The value of ultrasound imaging for the diagnosis, prognosis, and surgical planning of cryptorchidism is limited at best.

WHAT THIS STUDY ADDS: Ultrasound remains grossly overused by referring physicians throughout Ontario, Canada, which resulted in a 3-month delay to definitive surgery and unnecessary expenditures.

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Dr Kanaroglou helped design the study and data collection tools for both the Institute for Clinical and Evaluative Sciences (ICES) and local reviews, collected tertiary care institution data, analyzed descriptive statistics, performed a review of the literature, and wrote/revised all drafts of the manuscript; Dr To helped conceptualize and design the ICES portion of the study, supervised data collection as well as analysis and interpretation, and critically reviewed the final manuscript; Ms Zhu helped design the ICES data collection tools, performed the statistical analysis of these data, and edited the final manuscript; Dr Braga led and performed the external validation of data and critically reviewed the manuscript; Drs Hajiha and Wehbi performed a large portion of the local tertiary center data collection; Drs Salle, Bagli, and Koyle helped with conceptualizing the study design and reviewed the final manuscript; Dr Lorenzo conceptualized and designed the study, supervised all portions of data collection and analysis, and helped revise all drafts of the manuscript; and all authors approved the final draft of the manuscript as submitted.

This work was presented in part at the American Urologic Association Meeting (Orlando, May 16–21, 2014; San Diego, May 4–8, 2013); the Society of Pediatric Urology Fall Congress (Las Vegas, Sept 9–11, 2013); the University of Toronto Gallie Day (Toronto, May 10, 2013); and the Canadian Urologic Association Meeting (Niagara, June 22–25, 2013).

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Cryptorchidism (or undescended testicle [UDT]) represents one of the most common congenital genitourinary anomalies in boys, affecting ~3% of term infants and 30% of premature infants. Most gonads descend to their expected location during the first 3 months of life, a process believed to be mediated by the physiologic testosterone surge in the neonatal period, such that only ~1% of boys still have cryptorchidism by 6 to 12 months of age. In these cases, contemporary management involves accurate diagnosis according to physical examination and timely surgical management, as highlighted in the recent American Urological Association guidelines on the evaluation and treatment of children with cryptorchidism. The goals of surgical exploration include identification of the gonad, obliteration of the often-associated patent processus vaginalis, and relocation of the testis into its normal anatomic location to facilitate screening for malignant degeneration (by self-examination) and maximize future spermatogenesis. Although there is little controversy regarding the benefits of orchidopexy, extensive literature discusses the ideal timing for the procedure. In general, consensus favors earlier orchidopexy (ie, between 6 and 12 months of age) to achieve these goals. The value of ultrasound imaging for the diagnosis, prognosis, and surgical planning of UDT is limited, which is underscored in the American Urological Association guidelines. Indeed, a growing body of literature supports the low sensitivity and specificity of this imaging technique. Performing a potentially unnecessary ultrasound not only results in avoidable health care expenditures but could also occupy equipment and technician time, thereby delaying testing for patients who truly require a timely diagnostic ultrasound. Furthermore, false-negative and false-positive ultrasound results for UDT can misguide surgical decision-making and counseling, and may generate unnecessary parental anxiety. Despite the technique’s reportedly poor diagnostic performance, cost, and disadvantages, recent survey data suggest that obtaining an ultrasound before referral to a specialist is common among surveyed medical practitioners. Objective data that describe and unify the usage, costs, benefits, and potential consequences of ultrasound for UDT are lacking. We hypothesized that ultrasound remains significantly overused in this context. The present study analyzed the use and expense of this imaging technique within a “universal access to health care” setting, resulting in the largest analysis to date on the subject. We determined how the practice may adversely affect access to timely definitive surgical care. In addition (included as Supplemental Information), we re-examined the diagnostic accuracy of ultrasound for UDT and evaluated the demographic characteristics of referring practitioners to help focus future educational efforts.

METHODS

This study was approved by the Research Ethics Board at The Hospital for Sick Children, Toronto, Ontario, Canada. A 2-pronged approach was used for data collection. We obtained access to a provincial population-based health administrative (HA) database, which includes data on all hospital and ambulatory services in our universal access, single-payer health care system in Ontario. To complement the inherent weaknesses of HA data, a chart review was conducted of patients referred to our institution, which is the largest pediatric tertiary referral center in the nation. Findings from this review were validated by examining data from McMaster Children’s Hospital. These 2 institutions serve as one of the largest pediatric urology referral centers in Canada and North America, with a combined catchment of ~7.2 million people.

Population-Based Analyses

Records of boys aged 0 to 18 years diagnosed with UDT in Ontario between 2000 and 2011 were linked by using unique, anonymized, encrypted identifiers across HA databases housed at the Institute for Clinical and Evaluative Sciences (ICES). ICES is a publicly funded nonprofit research organization that evaluates health care services and delivery in Ontario. The data sets used in this study (Canadian Institute for Health Information–Discharge Abstract Database, Canadian Institute for Health Information–Same Day Surgery, Canadian Institute for Health Information–National Ambulatory Care Reporting System, Ontario Health Insurance Plan, and the Registered Persons Database) contain information on all publicly insured hospital and physician services, and they are described in Supplemental Appendix 1.

Diagnoses originating from inpatient or emergency department visits were identified by using International Classification of Diseases, Ninth Revision, codes and ambulatory diagnoses according to the Ontario Health Insurance Plan code (Supplemental Appendix 2). Patients were stratified into groups based on whether an ultrasound (abdominal, pelvic, and/or scrotal) was performed within 1 year before specialist referral for assessment of cryptorchidism. If the ultrasound diagnostic code was missing, the patient was still included provided that the index diagnosis was “cryptorchidism,” there was a subsequent referral to a defined specialist, and an orchidopexy was performed. Specialists who perform orchidopexy were defined as urologists (adult/pediatric) and general surgeons (adult/pediatric). Patients who were referred to...
specialists were segregated into those who underwent orchidopexy for UDT and those who did not, based on the combined findings of diagnostic and procedure codes for UDT and related surgeries, respectively. Patients who underwent orchidopexy for unrelated conditions (eg, testicular torsion) were excluded. To ensure an adequate follow-up window, patients whose index diagnosis was <1 year from the study end date were also excluded.

Trends in frequency of performing ultrasound for UDT over the decade were assessed. Expenditures were calculated based on the sum of physician and technical fees for ultrasound reimbursement according to provincial fees (Ontario Schedule of Benefits), adjusted to the year the ultrasound was performed. Of note, charges, fees, and final reimbursements for specific services do not differ within a calendar year because they are centrally regulated by the single-payer provincial health plan. For patients with complete records from diagnosis and referral to surgery, times between index diagnosis by referring physician and specialist visit (Dx-Sp), index diagnosis by referring physician and surgery (Dx-Sx), and specialist examination to surgery (Sp-Sx) were compared between the ultrasound and non-ultrasound groups.

**Tertiary Referral Center Analyses**

Consecutive referrals for evaluation of UDT between June 1, 2007, and December 31, 2011, were evaluated; boys aged 0 to 18 years were included, and those with previous ipsilateral inguinal/scrotal surgery were excluded. Patients were stratified on the basis of whether an ultrasound was obtained by the referring practitioner before specialist assessment. Trends in the frequency of ultrasound use were compared. Costs incurred were estimated based on the type of ultrasound performed and contemporary reimbursement fees. Data were contrasted with information available from a neighboring academic pediatric institution.

Because detailed content of all reports and referrals was accessible, the relative timing of each ultrasound with respect to the referral date was accurately calculated. Patients were thus divided into 3 groups for comparison: (1) index diagnosis and referral occurred on the same day with no ultrasound ordered; (2) index diagnosis and referral occurred on the same day, and ultrasound occurred while patient awaits specialist appointment; and (3) the ultrasound was ordered at index diagnosis and completed before referral to specialist. As described in the population-based analysis, time delays were compared. If available, dated copies of ultrasound requisitions were obtained to further quantify the time between index diagnosis and ultrasound in the last group.

Detailed methods regarding referring practitioner data, ultrasound diagnostic accuracy, and statistical analyses are included in the Supplemental Methods.

**RESULTS**

**Population-Based Analyses**

**Diagnosis and Ultrasound Use**

During the study period, 101 278 boys were diagnosed with inguinal/scrotal pathologies including UDT and closely related conditions (defined in Supplemental Appendix 2). Of these, 16 160 (16.0%) had 1 ultrasound before definitive assessment, and 2450 (2.4%) had >1 ultrasound. Of all boys in the cohort, 46 234 (45.7%) were ultimately assessed by a specialist within 1 year of diagnosis. Of the children who were assessed by a specialist, 7466 (16.1%) underwent surgical exploration for a suspected diagnosis of UDT, and of these, 2483 (33.3%) had at least 1 previous ultrasound. The remaining 38 768 (83.9%) patients were assessed by a specialist but did not undergo surgical exploration, indicating an alternative diagnosis (eg, retractile testes). Of the 18 610 patients who underwent ultrasound in the entire cohort, 16 014 (86%) did not undergo surgery within 1 year of the ultrasound examination, again indicating the presence of an alternative, nonsurgical diagnosis.

**Ultrasound Trend Over Time**

Of the 7466 boys who underwent surgical exploration for UDT, there was a 31.4% increase in ultrasound use by referring practitioners over the decade ($P < .0001$ for trend), as shown in Fig 1. Patients with an index diagnosis in 2010 were excluded to ensure adequate follow-up.

**Ultrasound Costs**

When accounting for changes in the reimbursement schedule over the studied decade, of Can$1.8 million spent on ultrasounds for the study population, approximately $270 000 were devoted to children who underwent surgical exploration for UDT. Approximate contemporary provincial reimbursement for the technical and physician fees of an abdominal, pelvic, or scrotal ultrasound was $80 per test.

**Time Delays**

Complete data points (including dates of index diagnosis, ultrasound [if obtained], specialist referral, specialist visit, and surgery [if conducted]) were available in 1999 (27%) of 7466 patients. The remaining patients were excluded because: (1) =$1$ of the listed dates were missing; or (2) the time between the first and last data points exceeded a reasonable time period, arbitrarily chosen as 84 months. Patients who underwent ultrasound before specialist referral had statistically significantly longer Dx-Sp and Dx-Sx times than patients who did not have ultrasound, by a median of 3 and 2 months, respectively ($P < .001$). Sp-Sx times did not differ between groups, indicating that the
surgical delay was not related to specialists’ delays in performing surgery but rather in time to be assessed. Details are summarized in Table 1.

**Tertiary Center Analysis**

**Patient Demographic Characteristics and Ultrasound Use**

During the study period, 1310 consecutive patients presented for evaluation, and 119 were excluded due to previous ipsilateral inguinoscrotal surgery. Of the remaining 1191 patients, 598 (50%) had at least 1 ultrasound, arranged by the referring practitioner, before specialist assessment. Table 2 summarizes the patients’ demographic characteristics.

**Diagnosis and Ultrasound Use**

Of the 1191 patients included, 58 patients were ultimately not evaluated because of missed/canceled appointments or other unknown reasons. Of the remaining 1133 patients who were evaluated by a pediatric urologist, testicles were in a normal location or retractile in 449 (39.6%) patients; palpable UDT were noted in 471 (42.6%), nonpalpable UDT in 207 (18.3%), and atrophic (“nubbin”) testes in 6 (0.5%). Ultrasound was obtained in 41% (182 of 449) of normal/retractile testes, 53.7% (253 of 471) of palpable UDT, 62% (128 of 207) of nonpalpable UDT, and 100% (6 of 6) of nubbin testes. Patients with nonpalpable testes were more likely to have an ultrasound than patients with palpable testes ($P = .0002$).

**Ultrasound Trend Over Time**

There was a 15.6% increase in the proportion of patients with UDT who were referred with an ultrasound. This finding represents an increase from $\sim46.7%$ (42 of 90) of patients referred with ultrasound in 2007, to 54% (169 of 313) in 2011 (Fig 2).

**Ultrasound Costs**

Using the 2012 Ontario Schedule of Benefits, the technical and physician fees for an abdominal or pelvic ultrasound are $81.95 each and $77.05 for a scrotal ultrasound. Based on the dictated ultrasound reports, abdomen/pelvis/scrotum examinations were performed in 46 patients, abdomen/pelvis examinations in 8 patients, and pelvis/scrotum examinations in 544 patients. Serial pelvic/scrotal ultrasound examinations were performed for 18 patients. Based on these calculations, the estimated cost of ultrasound for UDT over the study period was Can$101 713.

**Access to Care and Treatment Delays**

Compared with patients with no ultrasounds, patients with ultrasounds before referral waited a median 110 days longer to see a specialist (Dx-Sp) and overall 104 days longer for surgery (Dx-Sx). There was no difference in median Sp-Sx between the ultrasound and non-ultrasound groups, as in our population-based review. Details are summarized in Table 3. In 104 patients for whom ultrasound request dates were also available, median time from ultrasound request (index diagnosis) to referral was 76 days. Detailed results regarding referring physician data, ultrasound diagnostic accuracy, and external validation are provided in the Supplemental Results.

**DISCUSSION**

Despite its limited value in the evaluation of UDT, ultrasound remains widely used. Our study reports this practice in 33.5% of provincial referrals and 50% of institutional referrals. Moreover, trends indicate that ultrasound use has increased over time. This overuse represents a substantial added cost in an already strained single-payer, universal access system. Perhaps more importantly, it delays timely corrective surgery by $\sim3$ months, which may adversely affect outcomes. These findings have widespread implications for resource utilization and access to care, even outside of the Canadian context.
The inaccuracy of ultrasound for cryptorchidism has been established previously. Our results confirm the unreliability of the test, but additionally, we highlight diagnostic pitfalls that can result in mismanagement, challenging parent counseling scenarios, and avoidable medico-legal concerns. For example, some “normal” or retractile testes on ultrasound were identified as intra-abdominal during surgery. With a falsely reassuring ultrasound, the referring physician may avoid or delay a necessary referral. Ultrasound also misdiagnosed absent testes as inguinal. Preoperative parental expectations in this case can result in awkward and difficult postoperative counseling scenarios, and even unnecessary added surgery or imaging. Numerous other potential clinical pitfalls exist, which, when combined with the cost and time-delay findings, make the drawbacks of ultrasound apparent. As highlighted in current guidelines, a thorough physical examination by an experienced examiner is the best preoperative assessment in most cases.

Unfortunately, our data show that overreliance on ultrasound is increasing despite a growing body of evidence recommending against it. A literature review revealed that several smaller studies and editorials, in addition to those by Tasian, Copp, and Elder, have been published discussing the limited utility of ultrasound. There is a clear disparity between published evidence and the practice we have uncovered. Why the discrepancy, and how can we rectify the problem? As noted by Elder, this evidence has been largely published in the urology literature, rather than journals circulated among referring practitioners or radiologists. There is a resulting failure in communication and education, supported by the numbers in the present study. By disseminating these findings through publications, policies, and guidelines focused to referring physicians, we will more likely see a change in practice.

We further defined the problem by identifying high-yield groups: those in community practice and less experienced physicians. Perhaps physicians in nonacademic practice have less access to specialists, routine university rounds, or multidisciplinary continuing education activities. Technologies such as videoconferencing and e-newsletters can potentially improve the dialogue between community physicians and tertiary care subspecialists. Similarly, physicians with fewer years in practice may rely more heavily on diagnostic imaging overall. Due to faster, more accurate, and more widely available technologies, the use of radiologic tests has increased. In pediatric populations, there is a push toward minimizing ionizing radiation, thus favoring investigations such as MRI and ultrasound. For many conditions, earlier imaging has resulted in increased diagnostic yield and earlier presentation. Ultrasound for UDT should remain a clear exception to this trend. Focusing educational efforts at the medical school and internship levels may be the most effective long-term approach for achieving a durable change in practice.

An additional unexpected finding of our study was that only ~50% of children were referred before 2 years of age. This significant delay counters current guidelines and could negatively affect testicular function. This finding held true regardless of whether an ultrasound was ordered. In addition, it is unlikely that this delay resulted from limited specialist access in Canada; a similar finding has been recently published from a group based in the United Kingdom.
States. Wider dissemination of updated practice guidelines is clearly needed. When coupled with our other relevant findings, they may result in a more compelling case for change.

Cost-effective assessment of cryptorchidism should limit the use of ultrasound to select scenarios, a decision that can be safely deferred to the specialist. Even when considering the relatively low cost of ultrasound in our health care setting, the additive economic impact may be substantial. In addition, there are other hidden costs to society, including unmeasured figures such as loss of productive time and parent absenteeism. Lastly, in a strained system, obtaining an unnecessary ultrasound can lead to secondary delay for other patients truly in need of timely ultrasound assessment.

Although large population-based data sets are a powerful research tool, they introduce several limitations. One weakness of these retrospectively coded HA data are the possibility of missing or inaccurate codes. To address this bias, we eliminated patients from the time-delay analysis with missing or incongruent codes in their timeline. Although this method offers a cleaner data set, the study power is diminished. Another limitation results from the complete anonymity outside of the coded system, whereby researchers cannot access imaging report details, specific test indications, or surgical reports. Consequently, some assumptions must be made within the code-searching algorithm. The algorithms can be selective and complex, but we cannot ensure that no inappropriate inclusions or exclusions exist. Thus, to supplement these population-based analyses, we conducted tertiary care reviews, which still represent a sizable population, to help complete the picture by accessing to more detailed clinical information. There is a notable discrepancy in the ultrasound rates between the HA and local data. This outcome could represent an underestimate by the HA data due to misclassification, or an overestimate by the local data due to referral bias, because those referred to our high acuity tertiary center would more likely need surgery. Reality may lie in between, which reinforces the value of complimentary data sets. The conclusion that ultrasound is tremendously overused holds true regardless, which is also validated by data from the neighboring McMaster University. Despite these limitations, we paint a valuable picture of current practices by using these combined approaches and highlight worrisome trends. As we optimize evidence-based management of this common condition, there is a clear need to increase value and make productive, decisive strides toward improving management by effective use of finite health care resources.

**CONCLUSIONS**

Ultrasound has limited value for diagnosing, treatment planning, and prognosticating UDT. Although ultrasound may appear to be a harmless investigation, we found that it can delay access to timely corrective surgery and can mislead referring physicians and specialists alike. This weighty misallocation of resources could be channeled to children in need; it is also an area of potential cost savings at a time when health care budgets are under scrutiny. Furthermore, children are being referred late, regardless of whether ultrasound is used, which is another area with significant room for improvement.

Although widespread educational efforts should be undertaken, the targeting of current and future referring physicians is crucial. A multifaceted approach will likely have the biggest impact. Potential ideas include dissemination of guidelines in the pediatric and radiologic literature, interdisciplinary e-rounds, mandatory continuing medical education credits, telemedicine journal clubs, online “ask-the-expert” sessions, and targeted efforts in medical school. With the variety of communication and social media technologies available today, there is no better time to initiate a lasting change in practice.

**ACKNOWLEDGMENTS**

The HA data sets used in this study were linked by using unique encoded identifiers and analyzed at ICES.

**ABBREVIATIONS**

Dx-Sp: time between index diagnosis by referring physician and specialist visit
Dx-Sx: time between index diagnosis by referring physician and surgery
HA: health administrative
ICES: Institute for Clinical and Evaluative Sciences
Sp-Sx: time between specialist examination and surgery
UDT: undescended testicle

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**TABLE 3** Median Time (IQR) Between Specialist Evaluation and Surgery Stratified According to Whether and When an Ultrasound Was Performed (N = 1191)

<table>
<thead>
<tr>
<th>Median Time Interval in Days</th>
<th>Ultrasound Before Referral (n = 477)</th>
<th>Ultrasound After Referral (n = 121)</th>
<th>No Ultrasound (n = 593)</th>
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<tr>
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<td>Sp-Sx</td>
<td>93</td>
<td>103</td>
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IQR, interquartile range.

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REFERENCES


THE PERKS OF FREQUENT DINING: My wife and I recently had dinner with one of her brothers and his wife at an upscale restaurant in Brookline, MA that my brother-in-law likes very much. We had just returned from an overseas trip and wanted to thank him for taking us to the airport and picking us up upon our return. Unfortunately, our flight was delayed, so we were running late for our dinner reservations. My brother-in-law called the restaurant to let them know we would be late. He then asked the receptionist what table we had been assigned. After getting the answer (a number) he told us that the table was his least favorite, as it was immediately adjacent to the swinging doors entering the kitchen. I was a bit surprised that he knew the tables so well. He and his wife rarely cook and eat out frequently so his response made me contemplate the relationship between restaurants and frequent diners.

As reported in The Wall Street Journal (Life: May 12, 2015), restaurants keep close tabs on frequent diners – called VIPs, as corporate accounts from repeat customers can make up a substantial portion of revenue. A frequent diner is one who eats at a restaurant two to three times in two weeks. Restaurants use all sorts of methods to better understand their frequent diners including Google searches, a web site that pulls photos from Facebook and LinkedIn profiles, meticulous notes from discrete conversations with the diner, and ordering history. The favorite foods, beloved special sauces, favored seating arrangements, and table preferences are carefully noted so that all are ready upon arrival of the frequent diner. The top VIP diners may be showered with birthday presents, secret food deliveries, and free champagne. All this is done so that the frequent diners feel comfortable and do not have to look like they are asking for something special in front of clients.

As for me, I found the food at the restaurant good, and the doors did not bother me. I guess my brother-in-law – who mostly just dines with his wife – was not a VIP in the eyes of the restaurant, but he certainly is to me.

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