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Imaging Use and Cryptorchidism: Determinants of Practice Patterns

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Abstract

Purpose—We determined the rate of diagnostic imaging use for the preoperative evaluation of boys with cryptorchidism and the factors that influence referring providers to obtain imaging.

Materials and Methods—We conducted a national cross-sectional survey of pediatricians randomly sampled from the American Medical Association Physician Masterfile. The primary outcome was whether the respondent obtained imaging at the initial evaluation of boys with cryptorchidism. Participants were queried regarding practice location and type, length of time in practice, frequency of reading academic journals and the accessibility of surgical sub-specialists. For those who ordered imaging, respondents were asked how frequently they ordered imaging, and were asked to select patient factors and professional beliefs that influenced their decision to obtain imaging. Factors associated with imaging use were identified using multivariate logistic regression.

Results—Of the pediatricians who acknowledged contact by surveyors 47% completed the survey and 34% of respondents reported always or usually ordering imaging. Of those who obtained imaging 96.4% used ultrasound. Pediatricians in practice fewer than 20 years (OR 3.43, 95% CI 1.92–6.16) and those in nonacademic practices (OR 3.00, 95% CI 1.34 – 6.71) were more likely to order imaging. Pediatricians obtained imaging because of beliefs that imaging reliably identifies a nonpalpable testis, reassures the family and assists the surgeon with operative planning.

Conclusions—Ultrasound is heavily used by pediatricians for the preoperative evaluation of cryptorchidism, especially when the testis is nonpalpable. Given the poor diagnostic performance of ultrasound in this setting, we recommend developing strategies to reduce imaging use in cryptorchidism.

Keywords

diagnostic imaging; ultrasonography; cryptorchidism; physician's practice patterns

Cryptorchidism is usually diagnosed on physical examination by the pediatrician, who then refers the child to a pediatric urologist for orchiopexy. Although pediatric urologists do not generally recommend or obtain routine preoperative imaging for the evaluation of a boy with cryptorchidism,^{1,2} at our institution we have observed that pediatricians often obtain diagnostic imaging before surgical referral.

Diagnostic imaging has limited use in the evaluation of undescended testes and does not change its management.²⁻⁵ Current U.S. Department of Health and Human Services guidelines state that ultrasound, CT or MRI does not provide additional information to the physical examination.⁶ In addition, imaging is expensive and, among Medicare beneficiaries it adds significantly to annual health care expenditures and is growing faster than any other physician ordered service.^{7,8} Studies on the cost of diagnostic imaging for the pediatric population are lacking. Furthermore, we do not know how often pediatricians in the United States use diagnostic imaging for the pre-referral evaluation of boys with cryptorchidism. Therefore, we determined the frequency with which pediatricians use diagnostic imaging for the preoperative evaluation of boys with cryptorchidism. We also ascertained patient factors and provider beliefs that influence provider decisions to order imaging.

MATERIALS AND METHODS

Study Design

Study participants were primary care pediatricians practicing in the United States. Participants were selected from the AMA Physician Masterfile, which is a database of all allopathic and osteopathic physicians in the United States, and is recognized as the most comprehensive and accurate list of licensed United States physicians. We accessed the Masterfile through Medical Marketing Systems (WoodDale, Illinois). Physicians classified by the AMA as pediatricians in office based, medical teaching or hospital staff practices were eligible for inclusion in the study. Residents, pediatricians with subspecialty accreditation, and/or those in administration or research practices were excluded from analysis. A cross-sectional sample of 3,109 pediatricians was randomly selected from a total population of 24,657 using these criteria. An invitation was e-mailed to the sample asking them to complete a web based survey (www.questionpro.com) on the evaluation practices of boys with cryptorchidism. Nonresponders received a followup e-mail 3 weeks after the initial request again asking for their participation. Participants who completed the survey were entered into a drawing for a \$200 gift certificate. This study was approved by the University of California, San Francisco Committee on Human Research.

Survey Instrument

The survey took approximately 3 minutes to complete and consisted of 9 or 11 multiple choice questions, depending on whether the respondent ordered imaging during the evaluation of boys with cryptorchidism. The primary outcome measure was whether the provider ordered imaging during the evaluation of a boy with cryptorchidism. If the respondent did obtain imaging, the frequency of how often imaging was ordered was determined using an ordinal scale (never, rarely, usually or always). Those who obtained imaging were asked to select which imaging modalities they used, the factor(s) that

influenced their decision to order imaging and the role(s) that imaging has in the evaluation of cryptorchidism. Participants were also asked to choose a dollar amount closest to the cost of an abdominal-scrotal ultrasound. The frequency with which the respondent read academic journals, the number of boys with cryptorchidism seen per year and ultrasound cost were quantified using an ordinal scale.

As a pilot study the questionnaire was administered to 20 University of California, San Francisco faculty members in the division of General Pediatrics, and feedback was solicited. After revising the questionnaire based on the feedback received from the pilot study, the survey request was e-mailed to the aforementioned national sample of pediatricians.

Statistical Analyses

Responses were summarized with frequency tables. ANOVA with Bonferroni correction was performed to test for differences in imaging use among respondents based on years in practice, type of practice and practice location. We condensed practice location into 4 regions as defined by the U.S. Census Bureau.

Multivariate logistic regression was performed to identify factors associated with ordering imaging. The primary outcome measure (ordering imaging) was treated as a binary variable. The covariates in the regression model were years in practice, type of practice, distance to a pediatric surgical subspecialist, frequency of children with cryptorchidism seen in the practice and the frequency of reading academic pediatric journals. Linearity of the covariables was determined by performing LOWESS regression. Based on the LOWESS curve, time (years) in practice was dichotomized (20 years or less vs greater than 20 years). The practice type variable was collapsed into academic vs nonacademic practice after verifying that there was no statistical difference between nonacademic practice categories and their association with the outcome. The relationship of all other predictor variables to the outcome variable was linear. Forward stepwise selection of covariates was used to identify the variables that were significantly associated with each outcome with a p value set at 0.1. A sensitivity analysis was performed using backward stepwise selection of covariates to ensure that we did not exclude variables in the original model due to negative confounding. All analyses were 2-sided and $p < 0.05$ was considered significant. Statistical analysis was performed using Stata® 11.

RESULTS

Sample

Of 3,109 e-mails 142 (4.57%) were undeliverable and 2,442 were never opened. Thus, the 2,442 recipients viewed neither the survey invitation nor the questionnaire content and, thus, were excluded from the analysis. There were 525 pediatricians who opened the e-mail asking for participation in the survey, of whom 252 started and 246 completed the survey, yielding a response rate of 47%. A total of 8.5% of those to whom the e-mail was delivered completed the survey. These 252 responses represent an estimation of the practices of the total population of 24,657 general pediatricians with a margin of error of 6%. Age, practice type and practice location of respondents did not differ from the nonrespondents, those who

never opened the invitation and the total population from which the sample was selected (table 1).

Imaging Use

A total of 170 (67.1%) respondents reported ordering imaging during the preoperative evaluation of boys with cryptorchidism, with 12% and 22% always or usually ordering imaging, respectively. Of the respondents 163 (96.4%) used ultrasound, 10 (5.9%) used MRI and 9 (5.3%) used CT. There was regional variation in the use of imaging. Physicians in practice 0 to 5, 6 to 10 and 11 to 20 years ordered imaging with similar frequency, whereas those in practice 21 to 30 or more than 30 years obtained imaging less often (table 2).

On multivariate analysis respondents in practice fewer than 20 years and those in a nonacademic practice were more likely to order imaging (table 3). Excluding from analysis the respondents who rarely ordered imaging (as this may represent a group that uses imaging on a selective basis) and choosing forward or backward stepwise regression did not change the significance of the association between years in practice and type of practice with ordering imaging. Frequency of reading the literature, number of children with cryptorchidism seen per year, time needed to travel to a surgical specialist and perceived cost of an abdominal-scrotal ultrasound were not associated with ordering imaging.

Patient Factors and Provider Beliefs That Influence Imaging Use

The most frequently chosen patient factors that influenced respondents to obtain imaging were non-palpable testis (79.9%), followed by bilateral undescended testes (56.2%) and cryptorchidism in a patient older than 1 year (43.8%, fig. 1). Of the respondents who order imaging 86.4% do so because they believe imaging reveals the presence or absence of a nonpalpable testis, while approximately half believe that imaging provides reassurance to the family and assists the surgeon in planning the operative approach (fig. 2). Of the respondents 44% selected "I do not know" when asked the cost of an abdominal-scrotal ultrasound.

DISCUSSION

This cross-sectional study demonstrated that the majority of pediatricians surveyed order imaging for the initial evaluation of boys with cryptorchidism, which suggests that this holds true for the majority of general pediatricians in the nation. Pediatricians in practice fewer than 20 years and those in nonacademic practices were more likely to order imaging compared with those in practice more than 20 years and those in an academic practice.

Pediatricians in practice fewer than 20 years were significantly more likely to obtain imaging during the evaluation of a boy with cryptorchidism. This suggests that physicians who trained before the proliferation of imaging technology may rely more on physical examination skills than on radiological assessment. This finding may have important future ramifications since it is likely that imaging use will increase as the older cohort of pediatricians retire.

Pediatricians in a nonacademic practice were also more likely to order imaging. Multiple hypotheses could explain this finding. It is plausible that the integrated clinical, administrative and research environment of an academic institution increases pediatrician access to evidence-based practices by facilitating feedback from surgeons regarding the lack of utility of imaging for the operative planning for boys with cryptorchidism. It is also possible that the increased availability of teaching conferences increases the exposure of pediatricians to the cryptorchidism literature, which has primarily been published in surgical journals.

These 2 findings are somewhat contradictory. If pediatricians in academic centers order less imaging, then the younger pediatricians, the ones who have been most recently exposed to academic practices, should order imaging less often than older physicians. We postulate that the steep learning curve and immediate independence of physicians newly graduated from residency may influence young pediatricians to use diagnostic tests to confirm physical examination findings.

Implications for Clinical Practice

More than 90% of respondents ordered ultrasound as the sole imaging modality. The majority of respondents who ordered imaging did so to evaluate children with a nonpalpable testis and believe that imaging reliably localizes a nonpalpable testis. One can infer from these responses that there is a widely held belief that ultrasound has high sensitivity and specificity for locating a nonpalpable testis. However, the literature does not support this belief. Elder demonstrated that testes were often palpable on physical examination in a population of boys with cryptorchidism in which ultrasound did not localize the testes.² Furthermore, for those boys with non-palpable testes and negative ultrasound, viable testes or atrophic nubbins were found on surgical exploration in all cases indicating the inaccuracy of ultrasound. Numerous other studies corroborate these results, which supports the conclusion that ultrasound has limited utility in the preoperative evaluation of boys with cryptorchidism.^{3,4,9}

The belief that imaging assists the urologist in planning the operative approach was reported by half of the respondents. However, physical examination alone can determine the operative approach. When the testis is palpable, imaging is unnecessary and an inguinal orchiopexy is recommended.² In the setting of a non-palpable testis diagnostic laparoscopy or an inguinal exploration is performed depending on surgeon preference.^{10–14} Preoperative ultrasound does not change the surgical approach in most patients with nonpalpable testes because of its low sensitivity and poor negative predictive value.^{3,9,15} While MRI is better at localizing an undescended testis, it is costly and requires anesthesia.¹⁶ CT is less costly but delivers significant radiation exposure, a risk that should be considered carefully in pediatric patients.¹⁷ Additionally, half of the respondents reported that they obtained imaging to reassure parents. Given the cost and poor accuracy of ultrasound, we propose that imaging would likely have the opposite effect by adding increased cost and anxiety should a testis not be found or misidentified.

Implications for Health Care Resource Use

Physicians are uniquely positioned to best assess health care resource efficacy and use. This internal assessment may become increasingly important in the current era of health care reform as costs are expected to increase.¹⁸ Diagnostic imaging represents a significant portion of health care expenditures and it seems prudent to identify those clinical situations in which imaging provides limited information.⁸ Reducing the use of imaging in these situations offers us the opportunity to curtail unnecessary health care costs. Indeed Brody recently proposed that all medical specialties identify and recommend against using heavily used and expensive diagnostic tests that offer little benefit for those in whom they are ordered.¹⁹ Ultrasound used to evaluate cryptorchidism meets these criteria.

Although this study has identified a common disease of childhood in which imaging is heavily used, changing these practice patterns will likely be difficult. In this study more than 90% of the respondents regularly read academic journals and imaging was ordered as frequently by those who read journals monthly as it was by those who read journals less than once a year. While we cannot be certain that our question accurately measured familiarity with studies that have demonstrated the limited use of ultrasound for the evaluation of cryptorchidism, it is possible that this message is not reaching pediatricians through the academic literature. Perhaps a policy statement on the lack of use of imaging for the evaluation of undescended testes from professional organizations will increase awareness among all physicians involved in the care of children with cryptorchidism.

Study Limitations

The study is limited by the low overall number of responses, which was due to potential participants who were not informed of the study because they did not open the invitation. This may be a limitation inherent to e-mailed surveys as one cannot be certain if the e-mail was blocked by a spam filter or was simply deleted before being read. However, a low response rate does not necessarily decrease the validity of survey results or increase the response bias.²⁰ In general response rates to physician surveys have decreased during the last decade. However, lower response rates have not increased response bias.^{20,21} Because age and gender are associated with response bias, Cull et al recommend placing more emphasis on the assessment of these factors than on the overall response rate.²⁰ Regarding these factors in this study we showed that respondents were similar to nonrespondents as well as to the total population. Furthermore, the similarities in physician age and AMA defined practice type among these groups are particularly important as these are surrogate markers for years in practice and type of practice, which were significant predictors of imaging use.

The pretesting we performed and the overall simple design of the questionnaire likely ameliorated other common limitations of survey research such as misinterpretation of questions and the fatigue factor associated with longer surveys. Additionally, the low frequency of respondents selecting the “other” option available for all applicable questions indicates the answer choices offered provided a comprehensive list of the significant factors that influence the use of imaging and the role that imaging has in the evaluation of cryptorchidism. However, it is possible other factors which were not asked such as practice

population density and whether an imaging center was owned by or affiliated with a practice may affect rates of imaging use.

CONCLUSIONS

Ultrasound is heavily used by pediatricians for the initial evaluation of boys with cryptorchidism, especially when the testis is nonpalpable. This practice pattern diverges from current evidence on the utility of ultrasound. To improve the medical and fiscal efficacy of the care provided to this population of children, we advocate for increasing educational efforts, developing practice guidelines, and fostering communication between pediatricians and pediatric urologists to eliminate the unnecessary use of preoperative imaging in boys with cryptorchidism.

Abbreviations and Acronyms

AMA	American Medical Association
CT	computerized tomography
LOWESS	locally weighted scatterplot smoothing
MRI	magnetic resonance imaging

References

1. Hinman F Jr. Survey: localization and operation for nonpalpable testes. *Urology*. 1987; 30:193. [PubMed: 2888226]
2. Elder JS. Ultrasonography is unnecessary in evaluating boys with a nonpalpable testis. *Pediatrics*. 2002; 110:748. [PubMed: 12359789]
3. Kanemoto K, Hayashi Y, Kojima Y, et al. Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of non-palpable testis. *Int J Urol*. 2005; 12:668. [PubMed: 16045560]
4. Shah A. Impalpable testes—is imaging really helpful? *Indian Pediatr*. 2006; 43:720. [PubMed: 16951436]
5. Tasian GE, Copp HL. Diagnostic performance of ultrasound in nonpalpable cryptorchidism: a systematic review and meta-analysis. *Pediatrics*. 2011; 127:119. [PubMed: 21149435]
6. Tekgul, S.; Riedmiller, H.; Gerharz, E., et al. Guidelines on paediatric urology. Agency for Healthcare Research and Quality: U.S. Department of Health and Human Services; 2009.
7. Dinan MA, Curtis LH, Hammill BG, et al. Changes in the use and costs of diagnostic imaging among Medicare beneficiaries with cancer, 1999–2006. *JAMA*. 2010; 303:1625. [PubMed: 20424253]
8. Iglehart JK. Health insurers and medical-imaging policy—a work in progress. *N Engl J Med*. 2009; 360:1030. [PubMed: 19264694]
9. Nijs SM, Eijssbouts SW, Madern GC, et al. Non-palpable testes: is there a relationship between ultrasonographic and operative findings? *Pediatr Radiol*. 2007; 37:374. [PubMed: 17325824]
10. Gapany C, Frey P, Cachat F, et al. Management of cryptorchidism in children: guidelines. *Swiss Med Wkly*. 2008; 138:492. [PubMed: 18726735]
11. Moore RG, Peters CA, Bauer SB, et al. Laparoscopic evaluation of the nonpalpable testis: a prospective assessment of accuracy. *J Urol*. 1994; 151:728. [PubMed: 7905933]
12. Lotan G, Klin B, Efrati Y, et al. Laparoscopic evaluation and management of nonpalpable testis in children. *World J Surg*. 2001; 25:1542. [PubMed: 11775188]

13. Papparella A, Parmeggiani P, Cobellis G, et al. Laparoscopic management of nonpalpable testes: a multicenter study of the Italian Society of Video Surgery in Infancy. *J Pediatr Surg.* 2005; 40:696. [PubMed: 15852282]
14. Snodgrass WT, Yucel S, Ziada A. Scrotal exploration for unilateral nonpalpable testis. *J Urol.* 2007; 178:1718. [PubMed: 17707015]
15. Pekkaflali MZ, Sahin C, Ilbey YO, et al. Comparison of ultrasonographic and laparoscopic findings in adult nonpalpable testes cases. *Eur Urol.* 2003; 44:124. [PubMed: 12814687]
16. Maghnie M, Vanzulli A, Paesano P, et al. The accuracy of magnetic resonance imaging and ultrasonography compared with surgical findings in the localization of the undescended testis. *Arch Pediatr Adolesc Med.* 1994; 148:699. [PubMed: 7912611]
17. Smith-Bindman R, Lipson J, Marcus R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. *Arch Intern Med.* 2009; 169:2078. [PubMed: 20008690]
18. Foster, RS. Estimated Financial Effects of the “Patient Protection and Affordable Care Act of 2009,” as Proposed by the Senate Majority Leader on November 18, 2009. Department of Health & Human Services; 2009. p. 1-20.
19. Brody H. Medicine’s ethical responsibility for health care reform—the Top Five list. *N Engl J Med.* 2010; 362:283. [PubMed: 20032315]
20. Cull WL, O’Connor KG, Sharp S, et al. Response rates and response bias for 50 surveys of pediatricians. *Health Serv Res.* 2005; 40:213. [PubMed: 15663710]
21. Asch DA, Jedrzejewski MK, Christakis NA. Response rates to mail surveys published in medical journals. *J Clin Epidemiol.* 1997; 50:1129. [PubMed: 9368521]

Figure 1.

Factors cited by respondents as influential in determining imaging use. Respondents were able to select multiple factors which influenced their decision. Therefore, sum of percentages is greater than 100.

Figure 2.

Perceived benefits of imaging utility chosen by respondents. Respondents were able to select all choices that reflected perception of utility of preoperative imaging in evaluation of boys with cryptorchidism. Therefore, sum of percentages is greater than 100.

Table 1

Characteristics of survey recipients

	Respondents	Nonrespondents	Noncontacts	Total Population
No.	252	273	2,442	24,657*
Mean age (SD)	49.65 (10.26)	50.85 (11.05)	49.92 (11.39)	50 (11.1)
No. male (%)	118 (47)	145 (54) [†]	1,057 (43)	10,968 (45)
No. practice type (%):				
Office based	225 (89)	243 (89)	2,108 (86)	21,500 (87)
Medical teaching	7 (3)	2 (1)	46 (2)	414 (2)
Hospital staff	20 (8)	28 (10)	288 (12)	2,737 (11)
No. region (%):				
Northeast	65 (26)	68 (25)	587 (24)	5,949 (24)
Midwest	44 (17)	48 (18)	454 (18)	4,508 (18)
South	89 (35)	83 (30)	854 (35)	8,468 (30)
West	54 (21)	74 (27)	547 (22)	5,675 (23)

* Data on type of practice and region were available for 24,600 and 24,651 pediatricians in the total population, respectively.

[†] There was a higher proportion of male nonrespondents compared to the other categories ($p < 0.02$) but all other groups were similar.

Table 2

Imaging use rates

	No. (%)
United States regions: *	
Northeast	31 (49.2)
Midwest	26 (60.5)
South	73 (78.5)
West	39 (73.6)
Yrs in practice: †	
1–5	16 (76.2)
6–10	28 (75.7)
11–20	70 (76.1)
21–30	34 (53.1)
31 or Greater	21 (55.3)
Practice type:	
Academic	19 (52.8)
Private practice (solo)	16 (66.7)
Private practice (group)	77 (68.1)
Hospital based	17 (65.4)
Health maintenance organization	15 (75)
Community Clinic	17 (77.3)
Other	8 (72.7)

* Respondents practicing in the South and West had a higher rate of imaging use than those practicing in the Northeast ($p = 0.01$ and 0.03 , respectively).

† Physicians in practice for more than 20 years had a significantly lower proportion of ordering imaging ($F = 3.73$, $p < 0.01$).

Table 3

Factors associated with imaging use on multivariate analysis

Covariate	OR (95% CI)
Yrs in practice:	
Greater than 20	1 [Reference]
20 or Less	3.43 (1.92–6.16)*
Practice type:	
Academic	1 [Reference]
Nonacademic	3.00 (1.34–6.71)*
Increasing distance to surgical specialist (hrs)	0.97 (0.82–1.15)
Frequency of reading academic journals:	
Monthly	1 [Reference]
Every few months	0.79 (0.43–1.44)
Less than once yr	1.03 (0.17–6.16)
I have not read any recently published literature	0.17 (0.01–2.16)
No. children with cryptorchidism seen yr:	
Greater than 12	1 [Reference]
6–11	0.90 (0.24–3.32)
2–5	0.51 (0.17–1.55)
Less than 1	0.43 (0.12–1.59)

*
p < 0.01.