Received:
19 September 2013

Revised:
13 November 2013

Accepted:
2 December 2013

doi: 10.1259/bjr.20130603

Cite this article as:

Shetty D, Bailey AG, Freeman SJ. Testicular microlithiasis an ultrasound dilemma: survey of opinions regarding significance and management amongst UK ultrasound practitioners. *Br J Radiol* 2014;87:20130603.

FULL PAPER

Testicular microlithiasis an ultrasound dilemma: survey of opinions regarding significance and management amongst UK ultrasound practitioners

¹D SHETTY, MRCP, FRCR, ²A G BAILEY, MSc and ¹S J FREEMAN, MRCP, FRCR

¹Imaging Directorate, Level 6, Derriford Hospital, Plymouth, UK

²Centre for Biostatistics, Bioinformatics and Biomarkers, Peninsula School of Medicine and Dentistry, Plymouth, UK

Address correspondence to: Dr Simon Freeman

E-mail: simonfreeman@nhs.net

Objective: To establish whether there is a consensus regarding the significance of testicular microlithiasis and a strategy for managing patients with this condition, amongst ultrasound practitioners in the UK.

Methods: An electronic questionnaire was distributed to 1482 members of the British Medical Ultrasound Society (BMUS), requesting information from ultrasound practitioners involved in scrotal ultrasound about their interpretation of the risk associated with testicular microlithiasis and their departmental or personal recommendations for managing patients with this condition.

Results: Responses were obtained from 221 BMUS members. Analysis demonstrated a wide variation in the significance attributed to the discovery of testicular microlithiasis and the risk of subsequent development

of testicular germ cell tumours. There was also great variation in strategies for management of patients with testicular microlithiasis, including the need for surveillance ultrasound, amongst ultrasound practitioners regardless of their job description.

Conclusion: Lack of consensus shown by this study highlights significant differences across the UK in managing patients with testicular microlithiasis and validates the importance of guidance currently being formulated by the European Society of Urogenital Radiology.

Advances in knowledge: We believe that this is the first survey to be conducted amongst imaging specialists in the UK regarding testicular microlithiasis and demonstrates that there is currently no uniform practice in managing patients with this condition.

Testicular microlithiasis (TM) is a condition characterized by the presence of microcalcifications within the testicular parenchyma and is usually an incidental finding on scrotal ultrasound studies. An association between scrotal calcifications and testicular malignancy was first reported in 1988;¹ a case report in 1991 described TM and testicular intratubular germ cell neoplasia in a patient with metastatic germ cell tumour.² Since then, there have been numerous publications confirming the association between TM, intratesticular germ cell neoplasia of unclassified type (ITGCNU—also known as testicular carcinoma *in situ* and testicular intraepithelial neoplasia) and testicular germ cell tumour (TGCT), although the strength of the association and evidence for a causal link between these conditions has remained controversial.³

Although most imaging specialists are aware of the association between TM and TGCT, the management of a patient with incidentally discovered TM, particularly the need for ultrasound surveillance, is much less certain. The

ultrasound practitioner is faced with a bewildering variety of recommendations for management, including advising regular self-examination, expert clinical examination, ultrasound surveillance⁴ (with different regimens of surveillance intervals and duration), measurement of TGCT serum markers⁵ and testicular biopsy.⁶

More recently, it has been proposed that TM is associated with the testicular dysgenesis syndrome (TDS)⁷—patients with this condition may present with a variety of conditions that include hypospadias, cryptorchidism, testicular atrophy and infertility as well as ITGCNU and TGCT—and some consensus regarding the optimal management of TM is beginning to emerge.

The lack of definitive evidence and guidance regarding the risk of TGCT developing in males with TM has led to widely varying practices. In 2006, Ravichandran et al⁸ conducted a survey of British Association of Urological Surgeons (BAUS) consultant members regarding the

investigation and surveillance of patients with TM and concluded that practice varied widely, but the majority of participants believed that surveillance did not confer a survival benefit. We thought that a similar variation in attitudes towards the significance and management of TM might exist amongst UK ultrasound practitioners and distributed an electronic survey to the members of the British Medical Ultrasound Society (BMUS), asking for information regarding their practice in patients with TM.

METHODS AND MATERIALS

A standardized electronic questionnaire was sent to all current members of the BMUS with a registered email address. The society is a multidisciplinary body whose main objectives are the advancement of the science and technology of ultrasonics as applied to medicine. Specialist groups within BMUS consist predominantly of sonographers (49%) and radiologists (25%).

The questionnaire was developed to obtain a national overview of the current clinical practices in the management of patients with TM. Ethical approval was not sought for this questionnaire-based evaluation of practice. The survey was distributed using the platform "SurveyMonkey®" (<http://www.surveymonkey.com>). Appendix A lists all the questions in the survey.

A statistical analysis of the responses was performed. For each question, a Fisher's exact test (with Bonferroni correction for multiple testing) was used to examine whether the responses to the survey varied between the different professional groupings. Responses were grouped into "Consultant Radiologist", "Sonographer" and "Other" for analysis. Each of the questions was also tested to see whether there was evidence to suggest that the responses were not selected at random by using a χ^2 goodness of fit test, where the proportions for each answer were compared with the proportions that were expected when the results had been selected at random; the *p*-values were adjusted for multiple testing using the Bonferroni correction. To test the inter-responder agreement, while taking account of random agreement, an AC₁ statistic⁹ (similar to a Kappa statistic) was calculated for each question.

RESULTS

Of the 1482 BMUS members invited to take part in the survey, 221 (14.9%) replied. The responders were primarily sonographers (71.0%) or consultant radiologists (19.5%). The remaining responses were from trainee sonographers (0.9%) and other multidisciplinary team members involved in ultrasound practice (8.6%).

Of the 221 responders, 30 were not involved in performing or reporting testicular ultrasound scans in their clinical practice, and these responses were excluded from further analysis.

There were 186 responses to whether TM was thought to predispose to TGCT. 30.6% felt TM did predispose to TGCT, 21.5% felt it did not and 47.9% were unsure. Amongst the 43 consultant radiologists, there was a remarkably even distribution of 13 (30.2%) who believed that TM predisposes to TGCT, 15 (34.8%) believed it did not and 15 (34.8%) were unsure. The proportion

of sonographers who believed in the existence of a link between TM and TGCT mirrored that of the radiologists (31.6%); however, a slightly greater proportion was unsure (51.9%).

The advice given to patients who were found to have TM varied greatly. 37.8% recommended self-examination, while 16.1% recommended both self-examination and a formal clinical examination. 37.2% offered neither and 8.9% referred for a formal clinical examination alone. The majority of the consultant radiologists (62.8%) advised self-examination alone, with only 9.3% referring for formal clinical examination. With regard to the frequency of self-examination and/or a formal clinical examination, significant variations were noted, with 30.6% suggesting examinations annually and 22.5% every 6 months, and 27.9% opting for monthly examinations. Of the remaining 18.9%, the majority deferred to the referring clinician to provide advice or did not provide a specific time giving verbal suggestions such as "every now and then" or "whenever you remember".

The majority of responders (67.1%) did not have a documented departmental policy on the management of patients with TM.

Of those with a departmental policy, 21.3% offered lifelong follow-up and 14.8% performed follow-up ultrasound examinations up to the age of 55 years; however, the majority of responses (63.9%) to surveillance intervals did not fit into the categories outlined by the questionnaire and required a text response for further information, with "not sure/unsure" making up a significant proportion of the replies. Other responses included surveillance up to the ages of 40 or 45 years, or being left to the discretion of the referring clinician. Overall, in the institutions with a departmental policy for TM, the majority do not seem to have a clear policy on the intended duration of follow-up. There was greater consistency regarding the frequency of ultrasound surveillance recommended by the departmental policies: 63.3% scanned patients annually and 15% every 6 months. 64.3% of responders with a departmental policy offered surveillance to all patients with TM, and amongst the other 35.7% there was significant variability between the criteria for surveillance. This is summarized in Appendix B.

Amongst the ultrasound practitioners without a formal departmental policy for management of TM, 46.2% did not personally suggest ultrasound surveillance. Of those recommending ultrasound follow-up, 36.8% recommended that this was lifelong, 31.6% up to the age of 55 years and the remaining 31.6% predominantly left the decision to the referring clinician. Recommended surveillance intervals in this group were similar to those with a departmental policy, with the majority recommending scans annually (56.8%) or every 6 months (27.0%).

80.1% of the responders did not advise the measurement of tumour markers in patients with TM. Of those who did, the majority were either measured annually (51.4%) or every 6 months (34.3%).

Statistical analysis

Analysis of the responses to examine whether opinions varied amongst the different professional groups (Fisher's exact test

Table 1. Summary of statistical analysis of responses obtained to the questionnaire

Question	Number of responses	<i>p</i> -value ^a	AC ₁	Strength of agreement ¹⁰
3	186	1.000	−0.002	Poor
4	180	0.000	0.108	Poor
5	111	1.000	0.006	Poor
6	171	0.000	0.53	Moderate
7	35	0.345	0.123	Poor
8	170	0.000	0.204	Fair
9	61	0.000	0.278	Fair
10	60	0.000	0.268	Fair
11	56	0.585	0.136	Poor
12	171	1.000	0.006	Poor
13	38	1.000	−0.023	Poor
14	37	0.098	0.163	Poor
15	37	0.111	0.331	Fair

^a χ^2 Bonferroni correction.

with Bonferroni correction) found little evidence to suggest a significant difference, except for Question 4, where a *p*-value < 0.05 indicates that there is evidence to suggest that consultant radiologists were less likely to recommend formal clinical examination than the other two groups. Further analysis of the responses to confirm that responses were not selected at random (χ^2 goodness of fit test with Bonferroni correction) showed that there was evidence to suggest that the answers were not selected at random for Questions 4, 6 and 8–10. Testing for inter-responder agreement (AC₁ statistic) showed that there was moderate agreement for one question (Do you advise routine monitoring of germ cell tumour markers in patients with TM?), fair agreement for four questions (Questions 8–10 and 15) and poor agreement for eight questions (Questions 3–5, 7 and 11–14).

Overall, it appears that the responses to the questions do not agree well with each other, suggesting that there is no clearly defined approach to managing TM. Statistical analysis of the results is summarized in Table 1.

DISCUSSION

TM is usually an incidental finding on scrotal ultrasound studies. The prevalence of TM varies widely in published reports; in the symptomatic population referred for ultrasound examinations, the reported prevalence range from 0.6% to 9%⁴ and in asymptomatic males between 2.4% and 5.6%.^{11,12} Pooled data from 15 published studies of 33 549 ultrasound examinations give an overall prevalence of 2.7% in adult males.¹³

The sonographic appearances of TM were first reported in the late 1980s¹⁴ and are characterized by the presence of small (1–3 mm), non-shadowing, echogenic foci that are diffusely or focally distributed within the testicular parenchyma (Figure 1); the condition is usually, but not always, bilateral. TM has been subdivided into “classical” and “limited” forms depending on whether there are more or less than five microliths on any single

ultrasound image;¹⁵ however, this arbitrary subdivision does not appear to have any prognostic value.

The potential significance of TM lies in its association with TGCT. In a study of 1535 patients undergoing scrotal ultrasound, 63 (4.1%) had TM diagnosed sonographically; of whom, 29 (46%) had a concomitant testicular tumour.⁶ Pooled data from 15 studies involving 752 symptomatic males with TM showed that 17.2% had a co-existent testicular tumour with TM conferring a relative risk of between 13.2 and 36.5 for the presence of a TGCT.¹³ It is unsurprising, therefore, that many authorities have recommended a variety of management strategies—regular self-examination, clinician-based examination, ultrasound surveillance, tumour marker surveillance and testicular biopsy—despite a lack of evidence proving a causal association. Evidence linking TM with TGCT remains largely based on case reports and retrospective series, introducing potential bias.

Figure 1. Ultrasound image showing the typical appearances of testicular microlithiasis. There are numerous small, non-shadowing, echogenic foci randomly distributed through the testicular parenchyma.

There are only a limited number of prospective ultrasound surveillance studies in males with TM. In a recent literature review, Richenberg and Brejt¹⁶ analysed eight prospective studies of adults with TM with cohorts of at least 15 patients and a follow-up period of at least 24 months. Five of these studies did not show interval development of TGCT.^{17–21} In 3 studies, interval development of TGCT was documented. In the first study, 63 males were screened with ultrasound and 1 developed a TGCT at 5-year follow-up,²² and in the other 2 prospective studies, 3 patients developed interval tumours; however, all had co-existing risk factors for TGCT.^{6,23} Richenberg and Brejt¹⁶ combined data from their own surveillance programme (in which none developed testicular cancer) with the data from these 8 other prospective studies, producing a total surveillance population of 389 patients with TM, with four developing interval testicular tumours, 3 of whom had coexisting risk factors for testicular cancer. They concluded that the risk of development of testicular cancer in males with TM, but no other risk factors for TGCT, is small and does not justify ultrasound surveillance. They recommend annual ultrasound surveillance should be reserved for males with TM and coexistent risk factors for TGCT in addition to open ultrasound access for any patients with TM, identifying a change on self-examination. In another review, TM without features of TDS was thought to confer a minimal risk of testicular cancer of approximately 1–2%.²⁴ Recently published guidelines from the European Association of Urology do not recommend surveillance ultrasound, testicular biopsy, routine use of biochemical tumour markers or abdominal or pelvic CT for males with isolated TM without associated risk factors for TGCT but do recommend regular self-examination.²⁵

The TDS is the hypothesis that several different clinical entities may represent different manifestations of a single condition. Genetic and environmental factors acting on foetal testicular development are thought to alter Sertoli and Leydig cell function, resulting in impaired germ cell differentiation. This may result in varying clinical manifestations, including infertility, testicular atrophy, cryptorchidism, hypospadias and androgen insensitivity.⁷ TDS is also thought to be implicated in the development of ITGCNU, which is considered to be the precursor of almost all testicular germ cell tumours (with the exception of spermatocytic seminoma and certain tumours in infants). Testicular microliths are a histological feature associated with TDS and are also associated with ITGCNU.²⁶ It is believed that almost all patients with ITGCNU will ultimately proceed to overt testicular cancer,²⁷ although this may take many years to develop.²⁸ Meta-analysis has suggested that TM confers an approximately 10-fold increase in TGCT risk in patients with features of TDS.²⁹ It is therefore rational to recommend ultrasound surveillance or testicular biopsy in patients with TM who exhibit features of the TDS.

Unfortunately, a universally accepted definition of TM and large-scale, long-term, prospective studies defining its risk for development of TGCT in patients with and without associated risk factors are lacking. There are no universally agreed guidelines for managing this condition, although there is an emerging consensus that regular self-examination is adequate for patients with TM, and no other risk factors. Ultrasound surveillance (and in some cases testicular biopsy) is probably only indicated

in patients with TM, in groups who are at high-risk for TGCT.²⁵ The high-risk group includes patients with a history of cryptorchidism, patients with a history of TGCT in the contralateral testis, patients with testicular atrophy and patients with a history of TGCT in a first-degree relative.^{30–33} The interval and duration of ultrasound surveillance have yet to be defined.

This survey of practice amongst UK ultrasound practitioners confirms that there is a wide variation in practice reflecting the uncertainty of the strength of association between TM and TGCT in the literature. Statistical analysis of the pooled data shows that the agreement between responses for the questions asked was moderate for 1 question but only fair or poor for the 14 other questions. 47.9% of responders were unsure whether TM predisposes to TGCT, and it is noteworthy that amongst consultant radiologists, there was a fairly even split between those who believed a link existed, those who did not and those who were unsure. In view of the lack of consensus between the responders and the perceived risk of TM, it is not surprising that recommendations on further management also varied widely.

Our survey found that 37.2% of practitioners did not recommend either self-examination or formal clinical examination in patients with TM; this is at variance with the recommendations presented above, which advise that all patients with TM should be encouraged to undertake regular self-examinations and that rapid access to ultrasound should be available when an abnormality is discovered. This should be contrasted with the advice given to the general population of asymptomatic adults where regular scrotal self-examination has not identified a benefit.³⁴

The majority of ultrasound practitioners responding to the survey do not have a formal departmental policy regarding management of TM. Where ultrasound surveillance is offered, there is reasonable agreement on the interval (every 6 months or annual), but there is little agreement on the intended duration of surveillance, and many of those who responded are unsure how long surveillance ultrasound should continue. There was also considerable variation in whether surveillance should be offered to all patients with TM or only to those in a selected group. Where follow-up is restricted there is also a significant variation in the definition of the high-risk groups selected for surveillance. A significant majority of responders (80.1%) did not advise routine monitoring of tumour markers in patients with TM, and this concords with the EAU guidelines and a study by Peterson *et al*¹² who measured baseline tumour markers in 84 subjects with TM, all of which were normal.

Our survey did not demonstrate a significant difference between professional job status and responses to all but one of the questions (recommendation for formal clinical examination), indicating that uncertainty of the significance and management of TM exists amongst all professional groups.

The main limitation of this study is that only 14.9% of BMUS members responded to the invitation to participate in the survey, which is significantly lower than the proportion responding to the BAUS survey reported by Ravichandran *et al*.⁸ It is possible that this does not represent a truly representative sample of

UK ultrasound practitioners and departments; however, it is also possible that those who did reply are BMUS members with an interest in scrotal ultrasound and uncertainty might be even higher amongst those who did not respond, although we have no evidence to support this claim.

This study confirms that there is a wide variation both in the significance attributed to TM and follow-up and management of these patients amongst UK ultrasound practitioners. It indicates the need for guidelines on the definition and management of this condition, particularly ultrasound surveillance recommendations

for these patients. The European Society of Urogenital Radiology is currently devising guidelines on the definition and management of TM; it is hoped that dissemination of these recommendations will help to resolve the current uncertainties in clinical practice.

ACKNOWLEDGMENTS

The authors would like to acknowledge the assistance of the British Medical Ultrasound Society and, in particular, the General Secretary, Mrs Joy Whyte, for assistance in distribution of the electronic questionnaire and collation of the results.

REFERENCES

- Martin B, Tubiana J-M. Significance of scrotal calcifications detected by sonography. *J Clin Ultrasound* 1988; **16**: 545–52.
- Kragel PJ, Delvecchio D, Orlando R, Garvin DF. Ultrasonographic findings of testicular microlithiasis associated with intratubular germ cell neoplasia. *Urology* 1991; **37**: 66–8.
- Miller FNAC, Sidhu PS. Does testicular microlithiasis matter? A review. *Clin Radiol* 2002; **57**: 883–90.
- Kim B, Winter TC 3rd, Ryu J-A. Testicular microlithiasis: clinical significance and review of the literature. *Eur Radiol* 2003; **13**: 2567–76. doi: 10.1007/s00330-003-2014-5
- Furness PD 3rd, Husmann DA, Brock JW 3rd, Steinhardt GF, Bukowski TP, Freedman AL, et al. Multi-institutional study of testicular microlithiasis in childhood: a benign or pre-malignant condition? *J Urol* 1998; **160**: 1151–4.
- Deroog M, Bevers RFM, Prins HJ, Jonges TGN, Elbers FH, Boon TA. Testicular microlithiasis, a premalignant condition: prevalence, histopathologic findings, and relation to testicular tumor. *Urology* 2001; **57**: 1133–7.
- Wohlfahrt-Veje C, Main KM, Skakkebaek NE. Testicular dysgenesis syndrome: foetal origin of adult reproductive problems. *Clin Endocrinol* 2009; **71**: 459–65. doi: 10.1111/j.1365-2265.2009.03545.x
- Ravichandran S, Smith R, Cornford PA, Fordham MVP. Surveillance of testicular microlithiasis? Results of an UK based national questionnaire survey. *BMC Urol* 2006; **6**: 8. doi: 10.1186/1471-2490-6-8
- Gwet KL. Computing inter-rater reliability and its variance in the presence of high agreement. *Br J Math Stat Psychol* 2008; **61**: 29–48. doi: 10.1348/000711006X126600
- Altman DG. *Practical statistics for medical research*. London, UK: Chapman & Hall; 1991.
- Serter S, Gümüş B, Ünlü M, Tunçyürek Ö, Tarhan S, Ayyıldız V, et al. Prevalence of testicular microlithiasis in an asymptomatic population. *Scand J Urol Nephrol* 2006; **40**: 212–14. doi: 10.1080/00365590600589641
- Peterson AC, Bauman JM, Light DE, McMann LP, Costabile RA. The prevalence of testicular microlithiasis in an asymptomatic population of men 18 to 35 years old. *J Urol* 2001; **166**: 2061–4.
- Mullooly C, Hickerton B, Weston R, Woolley PD. Testicular microlithiasis: is it significant? *Int J STD AIDS* 2012; **23**: 620–2. doi: 10.1258/ijsa.2012.011444
- Doherty FJ, Mullins TL, Saint GR, Drinkwater MA, Ucci AA. Testicular microlithiasis. A unique sonographic appearance. *J Ultrasound Med* 1987; **6**: 389–92.
- Middleton WD, Teefey SA, Santillan CS. Testicular microlithiasis: prospective analysis of prevalence and associated tumor. *Radiology* 2002; **224**: 425–8. doi: 10.1148/radiol.2242011137
- Richenberg J, Brejt N. Testicular microlithiasis: is there a need for surveillance in the absence of other risk factors? *Eur Radiol* 2012; **22**: 2540–6. doi: 10.1007/s00330-012-2520-4
- Bennett HF, Middleton WD, Bullock AD, Teefey SA. Testicular microlithiasis: US follow up. *Radiology* 2001; **218**: 359–63.
- Skyrme RJ, Fenn NJ, Jones AR, Bowsher WG. Testicular microlithiasis in a UK population: its incidence, associations and follow-up. *BJU Int* 2000; **86**: 482–5.
- Ganem JP, Workman KR, Shaban SF. Testicular microlithiasis is associated with testicular pathology. *Urology* 1999; **53**: 209–13.
- Pourbagher MA, Kilinc F, Guvel S, Pourbagher A, Egilmez T, Ozkardes H. Follow-up of testicular microlithiasis for subsequent testicular cancer development. *Urol Int* 2005; **74**: 108–13. doi: 10.1159/000083279
- Ou SM, Lee SS, Tang SH, Wu ST, Wu CJ, Cha T-L, et al. Testicular microlithiasis in Taiwanese men. *Arch Androl Med* 2007; **53**: 339–44.
- DeCastro BJ, Peterson AC, Costabile RA. A 5-year follow-up study of asymptomatic men with testicular microlithiasis. *J Urol* 2008; **179**: 1420–3. doi: 10.1016/j.juro.2007.11.080
- Otite U, Webb JAW, Oliver RTD, Badenoch DE, Nargund VH. Testicular microlithiasis: is it a benign condition with malignant potential? *Eur Urol* 2001; **40**: 538–42.
- Tan MH, Eng C. Testicular microlithiasis: recent advances in understanding and management. *Nat Rev Urol* 2011; **8**: 153–63. doi: 10.1038/nrurol.2011.1
- Jungwirth A, Diemer T, Dohle A, Giwercman A, Kopa Z, Tournaye H, et al. *Guidelines on male infertility*. European Association of Urology; 2013. Accessed June 2013. Available from: <http://www.uroweb.org/guidelines/online-guidelines>
- Joensen UN, Jørgensen N, Meyts ER-D, Skakkebaek NE. Testicular dysgenesis syndrome and Leydig cell function. *Basic Clin Pharmacol Toxicol* 2008; **102**: 155–61. doi: 10.1111/j.1742-7843.2007.00197.x
- Hoei-Hansen CE, Rajpert-De Meyts E, Daugaard G, Skakkebaek NE. Carcinoma *in situ* testis, the progenitor of testicular germ cell tumours: a clinical review. *Ann Oncol* 2005; **16**: 863–8. doi: 10.1093/annonc/mdi175
- Von der Maas H, Rørth M, Walbom-Jørgensen S, Sørensen BL, Christophersen IS, Hald T, et al. Carcinoma *in situ* of contralateral testis in patients with testicular germ cell cancer: study of 27 cases in 500 patients. *Br Med J (Clin Res Ed)* 1986; **293**: 1398–401.
- Tan IB, Ang KK, Ching BC, Mohan C, Toh CK, Tan MH. Testicular microlithiasis predicts concurrent testicular germ cell tumours and intratubular germ cell neoplasia of unclassified type in adults. *Cancer* 2010; **116**: 4520–32. doi: 10.1002/cncr.25231
- Manecksha RP, Fitzpatrick JM. Epidemiology of testicular cancer. *BJU Int* 2009; **104**:

- 1329–33. doi: [10.1111/j.1464-410X.2009.08854.x](https://doi.org/10.1111/j.1464-410X.2009.08854.x)
31. Wood HM, Elder JS. Cryptorchidism and testicular cancer: separating fact from fiction. *J Urol* 2009; **181**: 452–61. doi: [10.1016/j.juro.2008.10.074](https://doi.org/10.1016/j.juro.2008.10.074)
32. Fosså SD, Chen J, Schonfeld SJ, McGlynn KA, McMaster ML, Gail MH, et al. Risk of contralateral testicular cancer: a population-based study of 29,515 U.S. men. *J Nat Cancer Inst*. 2005; **97**: 1056–66. doi: [10.1093/jnci/dji185](https://doi.org/10.1093/jnci/dji185)
33. Hemminki K, Li X. Familial risk in testicular cancer as a clue to a heritable and environmental aetiology. *Br J Cancer* 2004; **90**: 1765–70. doi: [10.1038/sj.bjc.6601714](https://doi.org/10.1038/sj.bjc.6601714)
34. Hopcroft K. Routine testicular self examination: it's time to stop. *BMJ* 2012; **344**: e2120.

APPENDIX A. SURVEILLANCE OF TESTICULAR MICROLITHIASIS QUESTIONNAIRE

1. Please indicate your job title:	Consultant Radiologist/Consultant Urologist/Sonographer/Specialist Registrar Radiologist/Specialist Registrar Urologist/Trainee sonographer/Other
2. Do you undertake, report or advise on scrotal ultrasound?	Yes/No
3. Do you believe that testicular microlithiasis predisposes to testicular germ cell tumours?	Yes/No/Unsure
4. Do you recommend regular testicular self-examination or formal clinical examination in patients with testicular microlithiasis?	Self-examination/Formal clinical examination/Both/Neither
5. If regular self-examination/formal clinical examination is recommended how often is this advised?	Annually/6 monthly/Monthly/Other (please specify)
6. Do you advise routine monitoring of germ cell tumour markers in patients with testicular microlithiasis?	Yes/No
7. How often are these measured?	Annually/6 monthly/Other
8. Is there a departmental policy for ultrasound follow-up of testicular microlithiasis in your institution?	Yes/No
If "Yes" Please answer questions 9–12	
If "No" please answer questions 12–15	
9. What is the intended duration of follow-up?	Lifelong/Up to age 55 years/Other (please specify)
10. How often are patients scanned?	Annually/6 monthly/Other (please specify)
11. Are all patients with testicular microlithiasis routinely followed up or only a selected group?	All/Selected group (please specify)
12. If no policy exists for routine follow-up of microlithiasis in your institution do you personally suggest an interval follow-up scan?	Yes/No/Departmental policy exists
13. What is the intended duration of follow-up?	Life-long/Up to age 55 years/Other (please specify)
14. How often are patients scanned?	Annually/6 monthly/Other (please specify)
15. Do you include all patients with microlithiasis or only a selected group?	All/Selected group (please specify)

Thank you for taking the time to complete the questionnaire.

APPENDIX B. CRITERIA APPLIED FOR OFFERING ULTRASOUND SURVEILLANCE IN PATIENTS WITH TESTICULAR MICROLITHIASIS WHERE A DEPARTMENTAL POLICY WAS PRESENT

Selected group of patients with testicular microlithiasis followed-up as part of departmental policy
•under 40 years
•presence of risk factors: family history/undescended testes
•risk factors
•>5 micro-calcification per image
•widespread micro-calcification, not a couple of foci
•only extensive microlithiasis
•seven or more microliths per image
•in combination with other markers
•only those with a second risk factor for TGCT
•high-risk age group
•high-risk group
•additional risk factors
•those who cannot self-examine
•only bilateral microliths and <55 years of age
•secondary risk factor
•5 microliths per image
•depends on consultant
•young boys/males