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PRACTICE GUIDELINE

Treatment and follow-up strategies in desmoid tumours: a practice guideline

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ABSTRACT

Objectives

We set out to

- determine the optimal treatment options—surgery, radiation therapy (RT), systemic therapy, or any combinations thereof—for patients with desmoid tumours once the decision to undergo active treatment has been made (that is, monitoring and observation have been determined to be inadequate).
- provide clinical-expert consensus opinions on follow-up strategies in patients with desmoid tumours after primary interventional management.

Methods

This guideline was developed by Cancer Care Ontario's Program in Evidence-Based Care and the Sarcoma Disease Site Group. The MEDLINE, EMBASE, and Cochrane Library databases, main guideline Web sites, and abstracts of relevant annual meetings (1990 to September 2012) were searched. Internal and external reviews were conducted, with final approval by the Program in Evidence-Based Care and the Sarcoma Disease Site Group.

Recommendations

Treatments

- Surgery with or without RT can be a reasonable treatment option for patients with desmoid tumours whose surgical morbidity is deemed to be low.
- The decision about whether RT should be offered in conjunction with surgery should be made by clinicians and patients after weighing the potential benefit of improved local control against the potential harms and toxicity associated with RT.
- Depending on individual patient preferences, systemic therapy alone or RT alone might also be reasonable treatment options, regardless of whether the desmoid tumours are deemed to be resectable.

Follow-Up Strategies

- Undergo evaluation for rehabilitation (occupational therapy or physical therapy, or both).
- Continue with rehabilitation until maximal function is achieved.
- Undergo history and physical examinations with appropriate imaging every 3–6 months for 2–3 years, and then annually.

KEY WORDS

Clinical practice guideline, desmoid tumours, follow-up, treatment

1. INTRODUCTION

Desmoid tumours, also known as aggressive fibromatoses, are rare neoplasms. The global incidence of desmoid tumours is 2–4 new cases per million population per year[1,2]. Although desmoid tumours are non-malignant and non-metastasizing, and seldom cause death, they are locally invasive and exhibit a high risk for recurrence[2]. Generally, they are asymptomatic, but they can cause significant local and neuropathic pain, can compress local structures, and might limit function. Some tumours can grow to a large size; others remain stable without intervention. Clinical observation is therefore a preferable management option in patients without symptoms.

Several treatments are available for patients with desmoid tumour when the decision has been made to pursue active (non-observational) treatment such as surgery, radiotherapy (RT), systemic therapy, or a combination of those options. However, there is little consensus about which treatment strategy leads to

a lower recurrence rate and less long-term toxicity. Thus, the Sarcoma Disease Site Group (DSG), in association with the Program in Evidence-Based Care (PEBC) of Cancer Care Ontario, decided to develop a clinical guideline for Ontario addressing two research questions.

2. QUESTIONS

- When the decision has been made to pursue active treatment for a patient with desmoid tumour, what is the optimal treatment option—considering surgery, RT, systemic therapy, and any combinations thereof—for improving clinical outcomes (that is, rates of relapse-free survival, local control, progression-free survival, response, and toxicity, and patient-reported outcomes, among others)?
- After primary treatment, what are reasonable follow-up strategies for patients with desmoid tumours?

3. METHODS

This guideline, developed by Cancer Care Ontario's PEBC and the Sarcoma DSG, used the methods of the practice guidelines development cycle[3]. For this project, the core methodology used to develop the evidentiary base was the systematic review. The PEBC is mandated to post its approved practice guidelines on the Cancer Care Ontario Web site (http://www.cancercare.on.ca/) for dissemination to Ontario oncologists[4].

3.1 Literature Search

For the second research question of this guideline, the authors agreed at the project planning stage that few or no original studies in the literature compared various follow-up strategies or intervals, and that the Sarcoma DSG would make final recommendations based on existing clinical practice guidelines and the clinical experience of experts in Ontario. The systematic review for the first research question is published separately[5]. Briefly, the MEDLINE and EMBASE databases, and the Cochrane Library (January 1990 to September 2012); guideline Web sites; and the American Society of Clinical Oncology and Connective Tissue Oncology Society annual meeting abstracts (January 2009 to September 2012) were searched. Preplanned study selection criteria were used to screen the literature retrieved.

3.2 Internal Review

Before this draft report was submitted for external review, it was reviewed and approved by the Sarcoma DSG members and by the PEBC Report Approval Panel (RAP), which has a membership of three: two oncologists with expertise in clinical and methodology issues and one methodologist.

3.3 External Review

The PEBC external review process is two-pronged: a targeted peer review obtains direct feedback on the draft report from a small number of specified content experts, and a professional consultation facilitates dissemination of the final guidance report to Ontario practitioners.

3.3.1 Targeted Peer Review

During the guideline development process, the Sarcoma DSG identified 9 targeted international peer reviewers considered to be clinical or methodology experts on the topic. Several weeks before completion of the draft report, the nominees were contacted by e-mail and asked to serve as reviewers. The draft report and a questionnaire were sent by e-mail to the 5 reviewers who consented to participate. The questionnaire consisted of items evaluating the methods, results, and interpretive summary used to inform the draft recommendations and whether the draft recommendations should be approved as a guideline. Written comments were invited. Follow-up reminders were sent at 2 weeks (e-mail) and at 4 weeks (telephone call).

3.3.2 Professional Consultation

Feedback was obtained through a brief online survey of health care professionals who are the intended users of the guideline in Ontario. Clinicians in the PEBC database who were identified using the key word "sarcoma" (n = 51) were asked to rate the overall quality of the guideline and to indicate whether they would use or recommend it. Written comments were invited. Participants were contacted by e-mail and directed to the survey Web site, where they were provided with access to the survey, the guideline recommendations, and the evidentiary base.

4. RESULTS

4.1 Literature Search Results

For the first research question, 3791 citations were identified in the searches of MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials. A search of abstracts from the American Society of Clinical Oncology and the Connective Tissue Oncology Society annual meetings yielded no abstracts that met the study selection criteria. The reference lists of the included articles were hand-searched, and no further eligible papers were found. The quality of the evidence in the forty-six full-text articles[6–51] and one systematic review[52] that met the preplanned study selection criteria was poor to moderate[4].

For the second research question, one consensus guideline was identified. That guideline—*Soft Tissue Sarcoma,* from the U.S. National Comprehensive Cancer Network (version 2.2012)[53]—provided

recommendations on follow-up strategies in patients with desmoid tumours. The quality of the guideline was assessed using the AGREE II instrument (Table I)[54].

4.2 Internal Review

The draft guideline prepared by the authors was circulated to the Sarcoma DSG members for review and discussion. The authors incorporated the comments from the DSG members into the draft guideline and forwarded the resulting document to the PEBC's RAP. The following key issues were raised by the RAP:

- The reference for "wide margin" appears only in the recommendation. It is not referred to in the introduction, evidence, or discussion.
- Is overall survival not an important outcome?
- Studies that compare surgery with surgery plus RT, RT with surgery, and RT with surgery plus RT are addressing different questions.
- Where does drug treatment fit in sequentially? Is it always after surgery and RT having failed, or are there patients for whom drug treatment would be a primary option?
- There may be improvement in local regional control. Is this a good enough outcome?

4.3 Consensus Process

Feedback received from the RAP was addressed by the authors[4]. On July 9, 2013, the revised guideline was sent to the Sarcoma DSG members for final approval. Of the 13 members of the Sarcoma DSG, 10 cast votes and 3 abstained (77% response rate). Of the 10 who cast votes, all approved the document (100%).

4.4 External Review

After approval of the document at the internal review, the authors circulated the draft document to external review participants on September 5, 2013, for review and feedback.

4.4.1 Targeted Peer Review

Responses were received from 4 reviewers by October 17, 2013. Table II summarizes key results of the feedback survey. Main concerns expressed in the written comments were these:

- We must be careful in emphasizing even "microscopically negative margins" for not a metastasizing tumour. At times surgery is indicated to palliate, knowing that positive margins will result. This is acceptable when decided about by an experienced sarcoma board.
- Under Introduction in section 2, desmoids are rarely truly asymptomatic and most patients find them at least annoying. Experts understand the subtlety, but given that these are guidelines for potentially less experienced providers, it might be better to clarify that unless the mass is growing, causing true pain, or easy to remove, observation is not only acceptable but may be preferable, even if mildly "symptomatic."
- Combinations of a nonsteroidal anti-inflammatory drug (often sulindac) and tamoxifen are commonly used as primary treatment of desmoids. Is the evidence entirely anecdotal (that is, the studies do not meet the criteria for inclusion in the guideline)? If so, it may be important to mention this. Similarly for the use of doxorubicin (and liposomal forms) and/or dacarbazine.
- Some places are not very clear. In bullet 2 under Key Evidence, "Goy *et al.* showed a similar result" is confusing (intended to mean similar results to Spear *et al.,* but could be read as not difference between groups); on page 3, the second paragraph under Justification for Recommendation does not seem to fit there.

4.4.2 Professional Consultation

The notification e-mail was sent on September 5, 2013, and the consultation period ended on October 17, 2013. Among the 14 responders (27%), 7 indicated that they had no interest in this area or were currently unavailable to review the guideline. Table III summarizes the key results of the feedback survey from the other 7 clinicians. The main written comments were these:

- One shortcoming: there is no definition of a "microscopically negative margin."
- Who would be recommended to follow up the patients?

TABLE I Results of AGREE II quality rating for the U.S. National Comprehensive Cancer Network guideline[a] on soft tissue sarcoma, version 2.2012

AGREE II domain score (%)					
Scope and purpose	*Stakeholder involvement*	*Rigour of development*	*Clarity and presentation*	*Applicability*	*Editorial independence*
64.8	40.7	25.7	87.0	22.2	61.1

[a] Adopted from the Standards and Guidelines Evidence Inventory of Cancer Guidelines developed by the Canadian Partnership Against Cancer (http://cancerguidelines.ca/Guidelines/inventory/index.php).

TABLE II Responses to eight items on the targeted peer reviewer questionnaire

Item	*Reviewer ratings (*n=*4)*				
	Lowest quality				*Highest quality*
	1	*2*	*3*	*4*	*5*
Rate the guideline development methods.	0	0	0	0	4
Rate the guideline presentation.	0	0	0	1	3
Rate the guideline recommendations.	0	0	0	2	2
Rate the completeness of reporting.	0	0	0	1	3
Does this document provide sufficient information to inform your decisions?	0	0	1	2	1
If not, what areas are missing?					
Rate the overall quality of the guideline report.	0	0	0	3	1
	Strongly disagree				*Strongly agree*
	1	*2*	*3*	*4*	*5*
I would make use of this guideline in my professional decisions.	0	0	1	1	2
I would recommend this guideline for use in practice.	0	0	0	2	2

TABLE III Responses to three items on the professional consultation survey

Item	*Ratings*				
	Lowest quality				*Highest quality*
	1	*2*	*3*	*4*	*5*
Rate the overall quality of the guideline report.	0	0	14	57	29
	Strongly disagree				*Strongly agree*
	1	*2*	*3*	*4*	*5*
I would make use of this guideline in my professional decisions.	0	14	0	43	43
I would recommend this guideline for use in practice.	0	0	0	43	57

5. PRACTICE GUIDELINE

The present report integrates the feedback obtained through the external review process with the final approval given by the Sarcoma DSG and the PEBC RAP[4].

5.1 Recommendation 1: Optimal Treatment Options

- Surgery with or without RT can be a reasonable treatment option for patients with desmoid tumours whose surgical morbidity is deemed to be low.
- The decision about whether RT should be offered in conjunction with surgery should be made by clinicians and patients after weighing the potential benefit of improved local control against the potential harms and toxicity associated with RT.
- Depending on individual patient preferences, systemic therapy alone or RT alone might also be reasonable treatment options, regardless of whether the desmoid tumours are deemed to be resectable.

5.1.1 Qualifying Statements

- Given the variability of the clinical course of desmoid tumours and the potential for complications that can arise as a result of therapy, the cases of

all patients with desmoid tumours who will undergo active treatment should be discussed by an experienced multidisciplinary sarcoma team, and the treatment plan should take into consideration patient preferences.
- Negative margin status (defined as surgical resection with microscopically negative margins) should be achieved, if possible, for a patient who is managed surgically.
- Young patients might have a higher risk for local relapse.
- The optimal dose of RT, used as a surgical adjuvant or as primary therapy, has not been defined. Reported radiation doses have ranged from 10 Gy to 75 Gy for RT used alone, and from 9 Gy to 72 Gy for RT used as an adjuvant to surgery. Complication rates have been reported to increase significantly with doses exceeding 56 Gy[12].
- Imatinib and the cytotoxic combination of vinblastine and methotrexate are associated with manageable toxicities. Results are considered reasonable enough to merit discussion as an option for previously untreated patients or after failure of surgery or RT (or both). However, other combinations of nonsteroidal anti-inflammatory drugs (often sulindac); tamoxifen or doxorubicin (and its liposomal forms), with or without dacarbazine; and dacarbazine alone have, among other agents, occasionally been used as primary treatment of desmoids in some clinical centres. Because of small patient numbers, studies of these latter chemotherapy options did not meet our criteria for inclusion in the guideline.

5.1.2 Key Evidence

Of five retrospective comparative studies that conducted a multivariate analysis[10–12,18,23], one did not find a significant difference in patient characteristics at baseline[26]. Three single-arm phase II studies of systemic therapy[16,24,29] serve as the primary evidence base for the recommendations.

Spear *et al.*[11] reported that, compared with surgery alone, surgery plus RT led to a higher local control rate at 5 years (72% vs. 69%, $p = 0.03$). At 6 years in patients with microscopically positive margins, Goy *et al.*[10] reported results similar to those of the Spear *et al.* study (78% vs. 32%, $p = 0.02$). Ballo *et al.*[12] reported that, compared with surgery alone, surgery plus RT or RT alone both led to a higher local control rate at 10 years (75% vs. 76% vs. 62%, $p = 0.04$).

In a comparison of surgery plus RT with surgery alone for patients with primary desmoid tumours, Sorensen *et al.*[18] did not find a significant difference at 5 years in the rate of relapse-free survival (78% vs. 69%, $p = 0.10$) or of local control (82% vs. 68%, $p > 0.05$).

When surgery plus RT was compared with RT alone, Guadagnolo *et al.*[23] (primary desmoid tumours) and Rödiger *et al.*[26] (recurrent desmoid tumours) found no statistically significant differences in local control between the two groups at 4 or 10 years. The main complications of surgery included the need for reconstructive surgery, above-the-knee amputation, permanent disability, and chronic pain. The main radiation-related complications included healing problems, fibrosis, fracture, cellulitis, and secondary malignancy, among others.

In the five studies that conducted a multivariate analysis, three[10,11,18] included margin status in the model, and all three showed that positive margin status led to a worse rate of local control. Four studies indicated that younger age (≤30 years in three studies[12,18,23], ≤18 in one study[11]) was predictive of a higher local failure rate.

In three single-arm phase II studies, imatinib alone led to a progression-free survival rate of 58% at 3 years[24] and 55% at 2 years, with some grade 3–4 toxicities including rash, neutropenia, myalgia, asthenia, or a secondary cancer (clear cell renal carcinoma)[29]; and methotrexate plus vinblastine led to a progression-free survival rate of 67% at 10 years, with 93% of patients developing grade 3 or 4 leukopenia[16].

5.1.3 Justification for Recommendation 1

Despite the large number of publications reporting outcomes in patients treated for desmoid tumours, the data are of poor-to-moderate quality, and no studies with a multivariate analysis compared the effectiveness of surgery with that of chemotherapy or the effectiveness of RT compared with that of chemotherapy. Because of the absence of good-quality evidence, little consensus has developed among clinicians about the optimal treatment for patients with desmoid tumours. Because desmoid tumours are non-malignant and non-metastasizing, and seldom cause death[2], local relapse is the main concern. Surgery, RT, systemic therapy, and the combination of surgery and RT have all shown moderate success in achieving local control in these patients. Therefore, in the authors' judgment, all of these modalities can be considered reasonable options, and the decision to use one modality over another should be made in conjunction with experts on a multidisciplinary sarcoma team. Given the trade-offs between the possible benefits and the potential harms of the various treatment options, patients should, as a part of the treatment decision-making process, be informed of the absence of definitive data favouring a particular type of treatment plan, and patient preferences should be taken into consideration.

5.2 Recommendation 2: Optimal Follow-Up Strategies

Cancer Care Ontario supports adoption of the follow-up strategy recommendations of the National Comprehensive Cancer Network's *Soft Tissue Sarcoma* guideline (version 2.2012). Specifically, it is recommended that

patients with desmoid tumours who have received primary treatment in Ontario

- undergo evaluation for rehabilitation (occupational therapy or physical therapy, or both).
- continue with rehabilitation until maximal function is achieved.
- undergo history and physical examinations with appropriate imaging every 3–6 months for 2–3 years, and then annually.

5.2.1 Qualifying Statement

If active treatment is not pursued, it is acceptable for patients to be followed annually by a sarcoma surgeon or any other member of the sarcoma team. Patients who are asymptomatic and who have clinically stable lesions can be discharged with the option of returning for treatment if symptoms or growth develop.

5.2.2 Justification for Recommendation 2

For the second objective of this guideline, the authors agreed at the project planning stage that the literature contained few or no original studies comparing various follow-up strategies or intervals. After discussion, the members of the Sarcoma DSG agreed that the follow-up strategies from the National Comprehensive Cancer Network's *Soft Tissue Sarcoma* guideline (version 2.2012)[53] were reasonable, given standard clinical practice in the Ontario context.

6. FUTURE RESEARCH

By January 21, 2013, only four ongoing single-arm phase II trials in the U.S. National Cancer Institute clinical trials database met our study selection criteria. Those four studies are investigating the effects of imatinib alone, toremifene alone, sulindac plus tamoxifen, and RT in patients with desmoid tumours[4]. Well-designed, high-quality randomized controlled trials, phase II trials, or prospective comparative studies are needed to compare various treatment options, the efficacy of various RT and systemic therapy strategies (including varying doses), and specific follow-up protocols in the target patients.

7. UPDATING

All PEBC documents are maintained and updated as described in the PEBC document assessment and review protocol.

8. ACKNOWLEDGMENTS

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9. CONFLICT OF INTEREST DISCLOSURES

The PEBC is supported by the Ontario Ministry of Health and Long-Term Care through Cancer Care Ontario. All work produced by the PEBC is editorially independent from its funding source. MG declared that she has published a systematic review on local control in patients with extra-abdominal desmoid tumours in *Rare Tumours*[55]. The remaining authors declared they had no financial or professional conflicts of interest.

10. REFERENCES

1. Pakos EE, Tsekeris PG, Goussia AC. Desmoid tumours of the extremities and trunk: a review of the literature. *Int Orthop* 2005;29:210–13.
2. Roeder F, Timke C, Oertel S, *et al.* Intraoperative electron radiotherapy for the management of aggressive fibromatosis. *Int J Radiat Oncol Biol Phys* 2010;76:1154–60.
3. Browman GP, Levine MN, Mohide EA, *et al.* The practice guidelines development cycle: a conceptual tool for practice guidelines development and implementation. *J Clin Oncol* 1995;13:502–12.
4. Ghert M, Yao X, Corbett T, *et al.* and the Sarcoma Disease Site Group. *Optimal Treatment Options and Follow-Up Strategies in Patients with Desmoid Tumours.* Evidence-based series 11-3. Toronto, ON: Cancer Care Ontario; 2013.
5. Yao X, Corbett T, Gupta AA, *et al.* A systematic review of active treatment options in patients with desmoid tumours. *Curr Oncol* 2014;21:**(**COMP: Pls add page range**)**.
6. Brodsky JT, Gordon MS, Hajdu SI, Burt M. Desmoid tumors of the chest wall: a locally recurrent problem. *J Thorac Cariovasc Surg* 1992;104:900–3.
7. Acker JC, Bossen EH, Halperin EC. The management of desmoid tumors. *Int J Radiat Oncol Biol Phys* 1993;26:851–8.
8. Catton CN, O'Sullivan B, Bell R, Cummings B, Fornasier V, Panzarella T. Aggressive fibromatosis: optimisation of local management with a retrospective failure analysis. *Radiother Oncol* 1995;34:17–22.
9. Pritchard DJ, Nascimento AG, Petersen IA. Local control of extra-abdominal desmoid tumors. *J Bone Joint Surg Am* 1996;78:848–54.
10. Goy BW, Lee SP, Eilber F, *et al.* The role of adjuvant radiotherapy in the treatment of resectable desmoid tumors. *Int J Radiat Oncol Biol Phys* 1997;39:659–65.
1. Spear MA, Jennings LC, Mankin HJ, *et al.* Individualizing management of aggressive fibromatoses. *Int J Radiat Oncol Biol Phys* 1998;40:637–45.
12. Ballo MT, Zagars GK, Pollack A, Pisters PWT, Pollock RA. Desmoid tumor: prognostic factors and outcome after surgery, radiation therapy, or combined surgery and radiation therapy. *J Clin Oncol* 1999;17:158–67.
13. Merchant NB, Lewis JJ, Woodruff JM, Leung DH, Brennan MF. Extremity and trunk desmoid tumors: a multifactorial analysis of outcome. *Cancer* 1999;86:2045–52.
14. Mehrotra AK, Sheikh S, Aaron AD, Montgomery E, Goldblum JR. Fibromatoses of the extremities: clinicopathologic study of 36 cases. *J Surg Oncol* 2000;74:291–6.

15. Pignatti G, Barbanti–Brodano G, Ferrari D, *et al.* Extraabdominal desmoid tumor. A study of 83 cases. *Clin Orthop Relat Res* 2000; (375):207–13.
16. Azzarelli A, Gronchi A, Bertulli R, *et al.* Low-dose chemotherapy with methotrexate and vinblastine for patients with advanced aggressive fibromatosis. *Cancer* 2001;92:1259–64.
17. Jelinek JA, Stelzer KJ, Conrad E, *et al.* The efficacy of radiotherapy as postoperative treatment for desmoid tumors. *Int J Radiat Oncol Biol Phys* 2001;50:121–5.
18. Sorensen A, Keller J, Nielsen OS, Jensen OM. Treatment of aggressive fibromatosis: a retrospective study of 72 patients followed for 1–27 years. *Acta Orthop Scand* 2002;73:213–19.
19. O'Dea FJ, Wunder J, Bell RS, Griffin AM, Catton C, O'Sullivan B. Preoperative radiotherapy is effective in the treatment of fibromatosis. *Clin Orthop Relat Res* 2003;(415):19–24.
20. Abbas AE, Deschamps C, Cassivi SD, *et al.* Chest wall desmoid tumors: results of surgical intervention. *Ann Thorac Surg* 2004;78:1219–23.
21. Duggal A, Dickinson IC, Sommerville S, Gallie P. The management of extra-abdominal desmoid tumours. *Int Orthop* 2004;28:252–6.
22. Sharma V, Chetty DN, Donde B, Mohiuddin M, Giraud A, Nayler S. Aggressive fibromatosis—impact of prognostic variables on management. *S Afr J Surg* 2006;44:6–8,10–11.
23. Guadagnolo BA, Zagars GK, Ballo MT. Long-term outcomes for desmoid tumors treated with radiation therapy. *Int J Radiat Oncol Biol Phys* 2008;71:441–7.
24. Chugh R, Wathen JK, Patel SR, *et al.* Efficacy of imatinib in aggressive fibromatosis: results of a phase II multicenter Sarcoma Alliance for Research through Collaboration (SARC) trial. *Clin Cancer Res* 2010;16:4884–91.
25. Mankin HJ, Hornicek FJ, Springfield DS. Extra-abdominal desmoid tumors: a report of 234 cases. *J Surg Oncol* 2010;102:380–4.
26. Rudiger HA, Ngan SYK, Ng M, Powell GJ, Choong PFM. Radiation therapy in the treatment of desmoid tumours reduces surgical indications. *Eur J Surg Oncol* 2010;36:84–8.
27. Constantinidou A, Jones RL, Scurr M, Al-Muderis O, Judson I. Advanced aggressive fibromatosis: effective palliation with chemotherapy. *Acta Oncol* 2011;50:455–61.
28. Gluck I, Griffith KA, Biermann JS, Feng FY, Lucas DR, Ben-Josef E. Role of radiotherapy in the management of desmoid tumors. *Int J Radiat Oncol Biol Phys* 2011;80:787–92.
29. Penel N, Le Cesne A, Bui BN, *et al.* Imatinib for progressive and recurrent aggressive fibromatosis (desmoid tumors): an FNCLCC/French Sarcoma Group phase II trial with a long-term follow-up. *Ann Oncol* 2011;22:452–7.
30. Rutenberg MS, Indelicato DJ, Knapik JA, *et al.* External-beam radiotherapy for pediatric and young adult desmoid tumors. *Pediatr Blood Cancer* 2011;57:435–42.
31. Garbay D, Le Cesne A, Penel N, *et al.* Chemotherapy in patients with desmoid tumors: a study from the French Sarcoma Group (FSG). *Ann Oncol* 2012;23:182–6.
32. Nishida Y, Tsukushi S, Shido Y, Urakawa H, Arai E, Ishiguro N. Transition of treatment for patients with extra-abdominal desmoid tumors: Nagoya University modality. *Cancer* 2012;4:88–99.
33. Oudot C, Orbach D, Minard–Colin V, *et al.* Desmoid fibromatosis in pediatric patients: management based on a retrospective analysis of 59 patients and a review of the literature. *Sarcoma* 2012;2012:475202. [Erratum in: *Sarcoma* 2013;2013:757915]
34. Miralbell R, Suit HD, Mankin HJ, Zuckerberg LR, Stracher MA, Rosenberg AE. Fibromatoses: from postsurgical surveillance to combined surgery and radiation therapy. *Int J Radiat Oncol Biol Phys* 1990;18:535–40.
35. Plukker JT, Van Oort I, Vermey A, *et al.* Aggressive fibromatosis (non-familial desmoid tumour): therapeutic problems and the role of adjuvant radiotherapy. *Br J Surg* 1995;82:510–14.
36. Weiss A, Lackman R. Therapy of desmoid tumors, fibromatosis, and related neoplasms. *Int J Oncol* 1995;7:773–6.
37. Soravia C, Berk T, McLeod RS, Cohen Z. Desmoid disease in patients with familial adenomatous polyposis. *Dis Colon Rectum* 2000;43:363–9.
38. Chew C, Reid R, O'Dwyer PJ. Evaluation of the long term outcome of patients with extremity desmoids. *Eur J Surg Oncol* 2004;30:428–32.
39. Baumert BG, Spahr MO, Von Hochstetter A, *et al.* The impact of radiotherapy in the treatment of desmoid tumours. An international survey of 110 patients. A study of the Rare Cancer Network. *Radiat Oncol* 2007;2:12.
40. Bertagnolli MM, Morgan JA, Fletcher CD, *et al.* Multimodality treatment of mesenteric desmoid tumours. *Eur J Cancer* 2008;44:2404–10.
41. Bonvalot S, Eldweny H, Haddad V, *et al.* Extra-abdominal primary fibromatosis: aggressive management could be avoided in a subgroup of patients. *Eur J Surg Oncol* 2008;34:462–8.
42. Huang K, Fu H, Shi YQ, Zhou Y, Du CY. Prognostic factors for extra-abdominal and abdominal wall desmoids: a 20-year experience at a single institution. *J Surg Oncol* 2009;100:563–9.
43. Stoeckle E, Coindre JM, Longy M, *et al.* A critical analysis of treatment strategies in desmoid tumours: a review of a series of 106 cases. *Eur J Surg Oncol* 2009;35:129–34.
44. de Camargo VP, Keohan ML, D'Adamo DR, *et al.* Clinical outcomes of systemic therapy for patients with deep fibromatosis (desmoid tumor). *Cancer* 2010;116:2258–65.
45. Meazza C, Bisogno G, Gronchi A, *et al.* Aggressive fibromatosis in children and adolescents: the Italian experience. *Cancer* 2010;116:233–40.
46. Nieuwenhuis MH, Mathus–Vliegen EM, Baeten CG, *et al.* Evaluation of management of desmoid tumours associated with familial adenomatous polyposis in Dutch patients. *Br J Cancer* 2011;104:37–42.
47. Colombo C, Foo WC, Whiting D, *et al.* FAP-related desmoid tumors: a series of 44 patients evaluated in a cancer referral center. *Histol Histopathol* 2012;27:641–9.
48. Sri–Ram K, Haddo O, Dannawi Z, *et al.* The outcome of extra-abdominal fibromatosis treated at a tertiary referral centre. *Eur J Surg Oncol* 2012;38:700–5.
49. Sherman NE, Romsdahl M, Evans H, Zagars G, Oswald MJ. Desmoid tumors: a 20-year radiotherapy experience. *Int J Radiat Oncol Biol Phys* 1990;19:37–40.
50. Faulkner LB, Hajdu SI, Kher U, *et al.* Pediatric desmoid tumor: retrospective analysis of 63 cases. *J Clin Oncol* 1995;13:2813–18.

51. Ballo MT, Zagars GK, Pollack A. Radiation therapy in the management of desmoid tumors. *Int J Radiat Oncol Biol Phys* 1998;42:1007–14.
52. Nuyttens JJ, Rust PF, Thomas CR Jr, Turrisi AT 3rd. Surgery versus radiation therapy for patients with aggressive fibromatosis or desmoid tumors: a comparative review of 22 articles. *Cancer* 2000;88:1517–23.
53. National Comprehensive Cancer Network (NCCN). *NCCN Clinical Practice Guidelines in Oncology: Soft Tissue Sarcoma.* Ver. 2.2012. Fort Washington, PA: NCCN; 2012. [Current version available online at: http://www.nccn.org/professionals/physician_gls/pdf/sarcoma.pdf (free registration required); cited June 15, 2014]
54. Canadian Partnership Against Cancer (CPAC). Home > Treatment and support > Professionals > Clinical guidelines > Guidelines resource centre. Hamilton, ON: CPAC; 2010. [Available online at: http://cancerguidelines.ca/Guidelines/inventory/index.php; cited February 18, 2013]
55. Wood TJ, Quinn KM, Farrokhyar F, Deheshi B, Corbett T, Ghert MA. Local control of extra-abdominal desmoid tumors: systematic review and meta-analysis. *Rare Tumors* 2013;5:e2.

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