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MINIREVIEWS

Survey of the management of borderline ovarian tumors in the United Kingdom

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Abstract

Borderline ovarian tumors (BOTs) represent approximately 10% of ovarian neoplasms and are a heterogeneous group of tumors with variable biological behaviour. The majority present with disease confined to the ovary and have an excellent prognosis after surgical removal. A small proportion subsequently has recurrent disease or progression to invasive cancer. Tumor recurrence can occur up to 20 years after surgical resection. There are no robust clinical, histological or molecular markers that distinguish high risk cases and no satisfactory treatment for patients with progressive disease. This results in great variability in management in different centres. We conducted a national survey on the management of borderline ovarian tumors in cancer centres representing different regions in the United Kingdom. In this article we review the literature for the current concepts in diagnosis, treatment and follow up of BOTs and we report the results of the survey of current practice in the United Kingdom. On that basis we provide recommendations for the management of patients with BOTs.

Key words: Borderline; Ovarian; Tumors; Survey; Management

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INTRODUCTION

Borderline ovarian tumors (BOTs) account for 10% of all ovarian neoplasms. Six hundred cases occur annually in the United Kingdom, mostly affecting women of reproductive age[1]. BOTs are a heterogeneous group of tumors with variable biological behaviour. The majority (85%) present with disease confined to the ovary and have an excellent prognosis after surgical removal. A small proportion subsequently have recurrent disease or progression to invasive cancer[1-5].

As tumor recurrence tends to occur late, up to 20 years from original resection, many authors advocate long-term follow-up[6,7]. There are many controversies regarding the significance of different histological features that can be

seen in these tumors, and also regarding the best management and follow up strategies. Also there are no robust clinical, histological or molecular markers that distinguish high risk cases. Also, to date there is no satisfactory treatment for patients with progressive disease[8-12].

There is no national protocol for the management of BOTs, yet the nature and extent of variability or uniformity of management between different centres of the UK is not documented. This has prompted us to carry out a structured survey addressing the current clinical management of BOTs to gain information that will help in the development of proposals for standardised management and prospective trials and to identify the demand for further education and research activities.

QUESTIONNAIRE

A questionnaire was developed in a multistep process. Relevant topics and a list of questions were formulated by an expert group including gynaecological oncologists and pathologists. All possible answers and combinations were provided in a multiple-choice manner, with the additional option of free text in some parts. The drafted survey was finally reviewed and ratified by the steering committee of the Ovarian subgroup of the National Cancer Research Network (NCRN). The survey was approved and sponsored by the ovarian subgroup of the NCRN and the Scottish Gynaecological Clinical Trials Group.

The survey was sent to lead gynaecology clinicians in the 35 cancer networks *via* e-mail and the responses were received by e-mail or by post. The survey was launched in March 2010 and concluded in March 2011. All analyses were worked out in a primarily descriptive manner.

We received responses from representative hospitals in 16/35 (46%) cancer networks including East Midlands, Yorkshire, South West London, North London, Mount Vernon, Northern Ireland, West London, Dorset, Kent, Sussex, Greater Midland, Merseyside and Cheshire, North Wales, Anglia, Pan Birmingham, Leicester, Northampton, Rutland and West Scotland.

Incidence of BOTs

To address the incidence of BOTs in different network hospitals, we asked the question "How many cases of BOTs are seen annually in your network?": Fifteen centres answered this question. Seven network hospitals (47%) treat 11-15 cases per year, 1/15 (6%) treat 16-20 and 7/15 (47%) treat more than 20 cases a year.

To address the stage of tumors at presentation, we asked the question "In terms of stage, what is the breakdown of BOTs seen annually in your network?: Compiling the data from 15 network hospitals it was found that the vast majority of tumors presented at stage Ⅰ, followed by stages Ⅱ and Ⅲ. The incidence range in different centres was for stage Ⅰ: 80%-97%, stage Ⅱ: 1%-20% and stage Ⅲ: 5%-30%.

To address the frequency of the different types of BOTs, we asked the question "In terms of histological type, what is the breakdown of BOTs seen annually in your network?": Compiling the data from 15 network hospitals the incidence of serous tumors ranged between 25%-80% and mucinous tumors ranged from 20%-75%. In most centres serous tumors were the commoner type and only few centres reported a higher incidence of mucinous tumors. Few centres reported encountering other types ranging from 1%-10%.

Multidisciplinary team discussion

To explore whether all BOTs were discussed in the multidisciplinary team meeting, we asked the question "Are all BOT cases discussed at the central cancer centre gynaecologic oncology multidisciplinary team meeting?": All but one centre (94%) confirmed referral of all cases for multidisciplinary team (MDT) discussion. In the one centre cases are only referred for MDT discussion if there are implants, microinvasion, intramucosal carcinoma, the patient is considered for chemotherapy, has ascites and all advanced stage cases.

Surgical management, to address the surgical management, we asked the following questions

"What percentage of patients diagnosed with BOTs undergo a formal cancer operation? (i.e., TAH and BSO, omentectomy, washings): Fourteen centres replied to this question. The number of patients who undergo a formal cancer operation in different centres varied, being 30% (1/14 centres), 50% (3/14 centres), 60% (1/14 centres), 70% (3/14 centres), 80% (3/14), 90% (2/14 centres) and 99% (1/14 centres).

To explore whether this was influenced by patients' desire to preserve fertility, we asked the question "Do all patients diagnosed with BOTs have full surgical staging if the patient does not consider fertility preservation?": Sixteen centres answered this question. In 8/16 (50%) centres all patients who do not wish to preserve fertility undergo full surgical staging, whereas in 8/16 (50%) centres not all patients do.

To find if the type of surgery is decided by the histological type or special features in the tumor, we asked the question "Is the decision influenced by histological type or histological features?": Fourteen centres answered this question. In 4/14 (29%) centres the decision is influenced by tumor type and histological features, but not in 10/14 (71%).

"If yes, does this include lymphadenectomy?": Eleven centres replied to this question. All but two centres (81%) do not do lymphadenectomy.

"Do you recommend completion surgery to all patients after completing their family?": Fourteen centres replied to this question. In 5/14 (36%) centres completion

Table 1 Different follow up protocols in the United Kingdom

Follow up (82% of centres)
Follow up for 5 yr at 3 and 9 mo, then 3 monthly for 2 yr then 6 monthly for 3 yr
Follow up for 5 yr, 3 monthly for the first 2 yr then 6 monthly onwards
Follow up for 5 yr at 6-12 mo, depending on the pathology
Follow up for 5 yr; 3 monthly for the first year, 4 monthly for the second year, 6 monthly for third year, and then annually for the fourth and fifth years
Follow up for 5 yr; every 6 months for 2 yr, then once a year for further 3 yr
Follow up for 3 yr, six monthly
All stage Ⅰ patients are discharged. Patients with stages Ⅱ and Ⅲ disease are followed up: 3 monthly for 1 yr, 4 monthly for year 2 and 6 monthly for a third year
Stage Ⅰ A fully staged are discharged, and all other patients have annual follow up for 10 yr
Stage Ⅰ A completely staged are discharged and all other patients are followed up 6 monthly for 2 yr then annually up to 10 yr then every other year up to 20 yr
Stage Ⅰ A fully staged are discharged, and all other patients are followed up monthly for 2 yr, then once in the third year and then discharged
Follow up is patient initiated. However, patients who retain their ovary are followed up by ultrasound every 6 mo
Follow up for patients who had fertility sparing surgery 6 monthly for life
Patients with Stage Ⅰ disease have only one follow up visit. Patients with stage Ⅲ are followed for several years
No follow up (18% of centres)

surgery is not recommended. In 2/14 (14%) this option is offered and discussed with the patient, but not recommended, while 7/14 (50%) recommended completion surgery.

To study that in more detail, we asked "When a BOT has been identified and full staging surgery has not been performed, what are your local policies with regards to future management?": Fifteen centres answered this question. Four centres (27%) offer all options including no further surgery, full surgical staging and full surgical staging after completion of family; recommendation is individualised to patients. In 6/15 (40%) centres no further surgery is recommended. In 2/15 (13%) they perform full surgical staging and in 3/15 (20%) centres they perform full surgical staging after completion of family.

Follow up, to explore follow up protocols for patients in different centres, we asked the following questions

"Are patients offered regular follow-up appointments at your institution?": All centres replied to this question and 14/17 (82%) confirmed having a follow up protocol, while 3/17 (18%) centres do not follow up patients with BOTs.

"If patients are offered regular follow up appointments, what is the frequency of these visits and the duration of the follow up?": Each of the fourteen centres that responded to this question had a different follow up protocol. These were: (1) Follow up for 5 years at 3 and 9 mo, then 3 monthly for 2 years then 6 monthly for 3 years; (2) Follow up for 5 years, 3 monthly for the first 2 years then 6 monthly onwards; (3) Follow up for 5 years at 6-12 mo, depending on the pathology; (4) Follow up for 5 years; 3 monthly for the first year, 4 monthly for the second year, 6 monthly for third year, and then annually for the fourth and fifth years; (5) Follow up for 5 years; every 6 mo for 2 years, then once a year for further 3 years; (6) Follow up for 3 years, six monthly; (7) All stage I patients are discharged. Patients with stages Ⅱ and Ⅲ disease are followed up: 3 monthly for 1 year, 4 monthly for year 2 and 6 monthly for a third year; (8) Stage I A fully staged are discharged, and all other patients have annual follow up for 10 years; (9) Stage I A completely staged are discharged and all other patients are followed up 6 monthly for 2 years then annually up to 10 years then every other year up to 20 years; (10) Stage I A fully staged are discharged, and all other patients are followed up monthly for 2 years, then once in the third year and then discharged; (11) Follow up is patient initiated. However, patients who retain their ovary are followed up by ultrasound every 6 mo; (12) Follow up for patients who had fertility sparing surgery 6 monthly for life; (13) Patients with Stage I disease have only one follow up visit. Patients with stage Ⅲ are followed for several years; and (14) Varies around the region, no details given. Table 1 summarises the follow up protocols in different centres of the United Kingdom.

"What tests and/or examinations are undertaken at these follow up appointments?": Fifteen centres answered this question. In 4/15 (26%) centres patients undergo physical examination and serum CA 125; in 3/15 (20%) patients undergo physical examination and transvaginal ultrasound, in 2/15 (13%) patients undergo physical examination and if the patient has a retained ovary then transvaginal ultrasound is done as well. In 1/15 (7%) patients undergo transvaginal ultrasound only, in 1/15 (7%) CA 125, in 2/15 (13%) physical examination, CA 125 and transvaginal ultrasound and in 1/15 (7%) physical examination, CA 125 and if the patient had fertility sparing surgery then transvaginal ultrasound as well and in 1/15 (7%) CA 125 and computed tomography scan.

"Does the follow up protocol vary according to the patient's age?": Thirteen centres answered this question. In 9/13 centres (69%) age had no effect and in 4/13 (31%) the protocol varied with age.

"Does the follow up protocol vary if the patient had

Table 2 Management of relapsed disease in different United Kingdom centres

Management	Percentage of centres (%)
Surgery only	53
Surgery followed by chemotherapy	13
Surgery followed by chemotherapy only if there is invasive disease	13
Chemotherapy followed by surgery	7
Chemotherapy only	7
Variable depending on MDT decision	7

MDT: Multidisciplinary team.

Table 3 Use of chemotherapy in treatment of borderline ovarian tumors in United Kingdom centres

Use of chemotherapy	Percentage of centres (%)
In the adjuvant setting	
No chemotherapy used	46
Chemotherapy used only if there is invasive disease	23
Chemotherapy used	31
First line treatment of advanced (stage Ⅲ or recurrent) disease	
No chemotherapy used	8.3
Chemotherapy used	91.6

Chemotherapy used is carboplatin ± paclitaxel.

fertility sparing surgery?": Fourteen centres answered this question. In 12/14 (86%) centres the follow up protocol for patients who had fertility sparing surgery was different from patients who had full staging, but in two centre all patients were followed up according to one protocol.

"If a patient fails to attend their follow up clinic appointment, what is your institution's policy?": Twelve centres answered this question. In 8/12 (67%) centres patients are sent a reminder letter with a new appointment. Three centres (25%) send a reminder letter to the patient with new appointment and letter to the GP for persistent non attendees. In one centre (8%), follow up was patient induced.

Management of relapsed disease, to address management of relapsed disease, we asked the following questions

"How do you manage relapsed disease?": Fifteen centres answered this question. In 8/15 (53%) relapsed disease is treated by surgery only. In 2/15 (13%) centres they use surgery followed by chemotherapy, in 1/15 (7%) usually chemotherapy, in 1/15 (7%) chemotherapy or surgery followed by chemotherapy, 1/15 (7%) variable depending on MDT decision, 2/15 (13%) surgery followed by chemotherapy if there is invasive disease. Table 2 summarises the different management protocols used in the United Kingdom for relapsed disease.

When using chemotherapy for treating tumor relapse or progressive disease what is your current regimen of choice in: (1) In the adjuvant setting: Thirteen centres answered this question. In 4/13 centres (31%) chemotherapy is used, in 6/13 centres (46%) no chemotherapy is used, in 3/13 (23%) no chemotherapy is used unless invasive disease is present. In centres that use chemotherapy 3 centres use taxol/carboplatin, in 2 carboplatin ± taxol, in 1 platinum based treatment only and in 1 centre the choice of chemotherapy was not given; and (2) First line treatment of advanced (stage Ⅲ or recurrent) disease: Twelve centres answered this question. In one centre no chemotherapy is used, in 5/12 carboplatin and taxol are used; in 2/12 carboplatin alone and in 3/12 carboplatin ± taxol are used. One centre uses carboplatin or enrols the patient in a phase I study. One centre does not use chemotherapy. Table 3 summarises the use of chemotherapy in management of BOTs in the United Kingdom.

Pathological assessment

"What sampling protocol is used for examining BOTs at your institution?": Twelve centres answered this question. Only three centres reported that pathologists sample 1 block per centimetre of tumor largest dimension and in one centre more than 1 block per centimetre is sampled. In 7/12 (58%) centres sampling varies according to macroscopic appearance.

"Does this protocol vary according to histological sub type?": Twelve centres answered this question. In 8/12 (67%) centres the protocol did not vary with the histological type of tumor and in 4/12 (33%) it did.

"Do your histopathologists routinely provide tumor staging in the histology report for BOTs?": Fourteen centres answered this question. In 12/14 (86%) centres pathologists provide tumor stage in the histopathology report and in two centres they do not.

DISCUSSION

This survey, is the first representative analysis of trends for the management of BOTs in the United Kingdom.

Incidence of BOTs

In all of the clinical departments participating in the survey, the vast majority treated no more than 25 patients with BOTs annually. Many of the centres reported treating between 10-15 cases per annum. Hence approximately 500-600 new cases of BOTs are seen in the United Kingdom annually. This finding is in line with national and international incidence data, where BOTs constitute 8%-10% of all ovarian tumors[13] and the ratio of patients with ovarian carcinoma to patients with BOTs is between 1:10 and 1:20[10,14].

The survey showed the majority of tumors presented at stage Ⅰ: 80%-97%; followed by stage Ⅱ: 1%-20% and stage Ⅲ: 5%-25%. This is in line with the reports in the literature which show that 85%-92% of patients with

BOTs have Stage I disease, 5.5%-7.9% have stage II and 3.5%-15% have Stage III disease[15,16].

The data shows the incidence of serous tumors ranges between 25%-80% and of mucinous tumors from 20%-75%. Few centres reported encountering other types of BOTs representing 1%-10% of tumors seen and including endometrioid, clear cell and mixed type tumors. In most centres serous tumors were the commoner type and only few centres reported a higher incidence of mucinous tumors. This is similar to the reports in the literature where serous and mucinous tumors are the most frequent types with only few cases of endometrioid and other variants seen. In reported series, some studies show that mucinous tumors are more than serous tumors in some centres, while in other centres the pattern is reversed with serous being the most common type of BOTs encountered[11,15,17]. This would justify that protocols for diagnosis and management of BOTs should be principally based around the clinicopathological characteristics of these two most common subtypes.

At a National Cancer Institute-sponsored workshop it was proposed that the borderline category of ovarian intestinal-type mucinous tumors (OInMTs) could be eliminated if the apparent benign behaviour of these tumors could be confirmed[18]. Nomura *et al*[19] studied 55 cases of borderline OInMTs without intraepithelial carcinoma to test whether these should still be considered tumors of low malignant potential. They concluded that that OInMTs, in which intraepithelial carcinoma has been ruled out, are benign tumors, not tumors of low malignant potential. The authors proposed that these tumors should be designated as high-grade mucinous adenoma, but recommended salpingo-oophorectomy rather than cystectomy for treatment, because cystectomy alone may allow local recurrence.

Chiesa *et al*[18] studied 33 FIGO stage I borderline OInMTs that were adequately sampled to exclude intraepithelial carcinoma, microinvasion, or invasive carcinoma. There were 2 cases with recurrence, secondary to incomplete excision or cystectomy, and no deaths from disease[18]. In a retrospective review of 97 patients after a median follow-up of 48 mo, 13 patients developed 14 recurrences: 7 were borderline and 7 were invasive lesions. The probability of recurrence in the form of carcinoma 5 and 10 years after the diagnosis was, respectively, 9% and 13% and the cumulative risk of recurrence in the form of invasive carcinoma at 10 years was 13%[20].

Benito *et al*[21] showed that serous histology is significantly related to the presence of peritoneal implants, positive peritoneal cytology and bilaterality, yet the overall survival (OS) rates at 2, 5 and 10 years were 100%, 96.4% and 93.6%, respectively. However, mucinous BOTs are associated with significantly lower OS rates than serous BOTs (10 years OS: 88.5% *vs* 98.2%, $P = 0.01$). So although serous tumors present more unfavourable anatomopathological characteristics, they are associated with better prognosis than mucinous tumors[21].

A fact that should also be taken in consideration is that borderline OInMTs are usually large and heterogeneous, and the standard sampling protocol for them is not evidence based and there is potential for a sampling artefact in which a focus of carcinoma is missed. Caution dictates retaining the current nomenclature to ensure the follow-up of patients affected by this disease until uncertainty regarding the extent of sampling needed to exclude the presence of carcinoma is resolved[18]. Also, limited experience with endocervical (müllerian)-type mucinous borderline tumors shows a possible relation to serous BOTs in clinicopathologic features and biologic behaviour[22].

As mucinous BOTs do not appear to be such a "safe" disease[20], mucinous BOT diagnosis should be retained so that physicians are aware that their aggressive potential is not negligible[21].

Histological assessment

The mainstay of diagnosis of BOTs is histopathology and central to this is the determination of epithelial subtype, and the recognition of invasion *vs* pseudoinvasion and microinvasion, identification of special features as micropapillary pattern and intraepithelial carcinoma and discrimination between invasive and non-invasive implants and FIGO staging[23]. It is crucial that tumors are thoroughly sampled and histologically assessed to identify all the potentially relevant histological features that may give indication to the likely behaviour of each tumor.

Tumor sampling

The general recommendation in sampling ovarian tumors is at least 1 block per cm of the largest tumor dimension. If there is need for further sampling due to the macroscopic appearance of the tumor or due to histological features seen on examination of the original sections more blocks are taken. In the centres participating in the survey only one centre reported pathologists sample 1 block per centimetre and in another centre the pathologists sample more than 1 block per centimetre. Most centres reported that the number of blocks sampled in each case varies according to the gross appearance of the tumor, and in some centres it depends on tumor type. This is reasonable in principle as for example mucinous neoplasms may be extremely heterogeneous and more generous sampling may need to be undertaken[24].

Implants: In patients with BOTs, non-invasive implants are common, whereas 6% of the women present with invasive implants[23]. Stage and subclassification of extra-ovarian disease into invasive and noninvasive implants are the most important prognostic indicators for serous BOTs[1,25,26]. The 5-year rates of evolutive invasive disease in patients with non-invasive implants and invasive implants were 2% and 31%, respectively[27]. Patients with invasive implants have a statistically significantly higher relapse rate[28]. Invasive implants behave as carcinomas and are most likely metastatic. Noninvasive implants behave in a benign fashion. Five-year survival for stage I tumors is virtually 100%. Survival for advanced stage tumors

with noninvasive implants is 95.3%, whereas survival for tumors with invasive implants is 66%[28-30].

Microinvasion: In most studies, microinvasion has been found to have no adverse effect on prognosis, although foci of microinvasion in serous BOTs often coexist with other features which may be indicative of a worse prognosis, such as a micropapillary growth pattern[22,29,31-34]. However, in other studies microinvasion was associated with significantly higher recurrence and mortality rates[16,35,36] and correlated with adverse outcome, independent of stage of disease, micropapillary architecture, and implant type[23].

Micropapillary architecture: Serous BOTs with micropapillary growth pattern are more frequently bilateral and exophytic and strongly associated with invasive implants and decreased OS. Molecular data suggest that such tumors may represent an intermediate stage in a typical serous BOTs-invasive low-grade serous carcinoma progression[22,23,29]. Other studies show that although a micropapillary pattern is associated with higher stage, it does not adversely affect prognosis[34,37] and that only micropapillary tumors associated with invasive implants behave aggressively[38].

Seidman and Kurman propose that BOTs can be divided into benign and malignant subtypes providing the basis for replacing the borderline category. The benign subgroup is composed of typical serous BOTs, including those with noninvasive implants for which the term atypical proliferative serous tumor is appropriate. In contrast, tumors displaying a micropapillary growth pattern and tumors with invasive implants should be classified as carcinomas and treated accordingly[39].

Tumor staging

The results of the survey show that in all but one centre the pathologists consistently provide tumor stage in the report. This is extremely important as tumor stage at diagnosis is the most important prognostic marker[34,36]. The 5-year survival for women with Stage- I BOT is favourable, about 95%-97%, and the 10-year survival is only between 70% and 95%, caused by late recurrence. The 5-year survival for Stage Ⅱ-Ⅲ patients is 65%-87%[8,23].

So, it is essential that BOTs are reviewed by a specialist gynaecological pathologist to ensure appropriate classification of the tumor and verification of the presence or absence of all relevant histological features. As these tumors are not common, general pathologists may not have the opportunity to see enough of these tumors in their practice to gain enough experience in assessing them thoroughly. For example employing the agreed upon criteria for the differentiation between microinvasion and frank invasion in different types of BOTs and the recognition of different patterns of invasion in mucinous tumors are important and can sometimes be difficult. Also determining the kind of peritoneal implant can be difficult in some cases.

Surgical management

There are various modalities of surgery for the management of patients with BOTs[40]. Staging laparotomy for BOTs usually includes a hysterectomy and bilateral salpingo-oophorectomy, omentectomy together with peritoneal biopsies, washings and appendicectomy in certain instances. As BOTs frequently affect younger patients the clinical management is complicated by considerations such as preserving fertility and reducing postoperative morbidity. Over the past several decades surgical therapy has shifted from a radical approach to more conservative treatment. In young women, clinicians perform cystectomy, unilateral salpingo-oophorectomy and biopsies of the contralateral ovary[41,42].

High conception rates were achieved after a simple ovarian cystectomy[12,13,23,43], but the high risk of local recurrence can be up to 75%[44]. Results of cystectomy for BOT suggest a higher risk of intraoperative cyst rupture and of recurrence when compared with unilateral or bilateral salpingo-oophrectomy[4,45]. For this reason, ovarian cystectomy or a partial oophorectomy can be performed after informing of the patient about the recurrence risk and provided that the patient is willing to undergo a careful and prolonged follow-up[42,46,47].

The results of our survey showed when a BOT has been identified and full staging surgery has not been performed, the policies with regards to future patient management varied in different centres. Some authors believe a general recommendation for completion of full surgical staging and completion surgery cannot be suggested because of lack of a validated benefit for the patients[16,42,48]. This is due to the fact that many studies showed that following conservative surgical management for BOTs, the patient outcome is still excellent[4,49,50]. In one study recurrence rate for patients who underwent a primary pelvic clearance was 1.6% compared to fertility-sparing conservative surgery (3.3%) and no significant difference was noted in recurrence and mortality between fully staged *vs* unstaged patients[11]. In another study no patients treated conservatively had a recurrence[15]. Others have shown that the 5- and 10-year survival rates of women treated with fertility sparing surgery were 100% and thus not worse than those of radically operated patients (5- and 10-year survival 95.1% and 90.1%). Relapse rates in both groups were comparable with 10.5% and 10.0% (P = 0.723). Hence fertility sparing surgery in women at childbearing age can be an adequate treatment option in early stage disease[28]. The overall tumor-free survival was found to be significantly decreased in cases, performing fertility-sparing surgery, but the OS rates were comparable with surgically staged patients[51].

In contrast, other studies show that the strongest prognostic factor in patients with an advanced-stage BOT is the use of conservative surgery[37,52]. Patients who underwent conservative surgery had a higher recurrence rate (60% after conservative surgery and 8% after radical surgery)[53].

Zapardiel *et al*[54] evaluated the role of restaging sur-

gery in the management of patients with BOTs after being incompletely surgically staged on restaging surgery. Among stage I patients 12.3% were up-staged. The up-staging rate among serous tumors was 16.2%, and 4% among mucinous tumors. There were no differences in terms of OS between patients who were upstaged and those who were not. The authors conclude that restaging procedure does not seem to have a significant impact on the management of patients diagnosed with BOTs, especially in mucinous subtype and apparent FIGO stage higher than I[54].

However, surgical staging is important to identify invasive extraovarian implants that portend an adverse prognosis[11]. A study by Anfinan *et al*[35] included patients treated for BOTs with complete (group Ⅰ) and incomplete (group Ⅱ) surgical staging. Twelve patients were found to have implants as result of the staging procedure; two of them were invasive implants and both required chemotherapy. Nine (6.5%) patients experienced recurrence: five (5.6%) patients in group Ⅰ *vs* four (8.2%) patients in group Ⅱ. There was no difference in recurrence rates observed between the study groups. However, surgical staging is important for identifying invasive extraovarian implants that need to be treated with chemotherapy.

A prospective long-term extension study of a randomized controlled trial aimed to assess the risk-benefit ratio of an ultra-conservative fertility-sparing approach in patients with bilateral BOTs. The experimental group (n = 15) was treated with an ultra-conservative surgical approach consisting of bilateral cystectomy, whereas the control group (n = 17) received a less conservative surgery consisting of oophorectomy and contralateral cystectomy. All patients received a complete laparoscopic staging followed by a fertility enhancement programme. Although the time to first recurrence was significantly ($P < 0.01$) shorter for the experimental group, in the regression analysis the difference did not reach the statistic significance ($P = 0.14$), and the RR of recurrence (1.23, 95%CI: 0.62-3.17, $P = 0.41$) was not significant. The study showed that the ultra-conservative fertility-sparing approach is more effective than the standard approach in terms of reproductive outcomes, but presents a higher oncological risk[55].

It is clear that "biological" status of the patients inside the groups, pre-menopausal, post-menopausal or women in the reproductive age, who desire to preserve fertility should influence the decision regarding choice of conservative or radical surgical management.

Lymphadenectomy

The one parameter that most of the centres agreed on is that lymphadenectomy is not done as part of any surgical management for BOTs. Lymph node involvement is seldom[42,46,56] and does not seem to adversely affect prognosis[22]. Hence systematic pelvic and para-aortic lymph node dissection is not recommended in BOTs. Moreover, it is not clear whether these lymph node implantations represent real metastases or, *in situ* transformed secondary mullerian epithelia[25,57]. Concerning the performing of lymph node resection, at least 20% of the patients with FIGO stage Ⅰ have to be upgraded as belonging to FIGO stage Ⅲc, but the prognostic relevance is unimportant[48,58].

Studies have shown that the intraoperative blood loss was significantly more and the hospital stay was significantly longer in patients who underwent complete lymph node dissection. However, overall and disease-free survival spans were found to be statistically similar between patients who had or did not have lymphadenectomy. Hence retroperitoneal evaluation can be spared in women with BOTs[23,59].

Follow up

The survey shows variability of this aspect of the practice in the UK. The majority of the centres had a follow up protocol for all patients in place, but the protocols varied in different centres. Follow up protocols varied in duration between being patient initiated, clinical visits every 3, 5, 10 and 20 years and up to for life in patients who had fertility sparing surgery. The frequency of follow up visits and modality varied as well depending on the time of surgery, type of surgery and histological type and features of the tumor and patient age. The majority of centres would send a reminder letter with a new appointment if the patient missed her appointment and some centres would in addition send a letter to the GP for persistent non attenders.

It is not surprising to find variability in follow up protocols, as there are no robust criteria to identify patients at high risk of recurrence or progression[60,61]. However, it should be the consensus that conservative surgery warrants closer follow up. Histological features of the tumor should also be considered in follow up and not just whether the patient had fertility sparing surgery. In view of the controversy about the significance of micro-invasion, intramucosal carcinoma, lymph node deposits, type of implants, it would seem appropriate that such features dictate long term follow up regardless of tumor stage.

The common modes of diagnosis of recurrences are imaging, clinical symptoms and CA 125 elevation[62]. The results of our survey show that most centres use physical examination and serum CA 125 for follow up. In some patients transvaginal ultrasound is used in addition, particularly in patients who had fertility sparing surgery. Other centres use only one or different combinations of these modalities.

CA 125 at primary diagnosis correlates with tumor stage and tends to be increased in the presence of ascites, endometriosis or peritoneal implants. Moreover, CA 125 at primary diagnosis appears to have prognostic value for recurrence[63].

In one study serum tumor marker levels of CA 125, CA19-9, CEA, and CA15-3 were determined by radioimmunoassay in women with serous and mucinous BOTs, and respectively 48.2% and 41.8% had at least one abnormal value[64]. In another study the positive rate of

CA 125, CA 19-9, CA 15-3, and CEA in serous tumor were 57.9%, 7.9%, 7.9% and 15.8%, respectively. These figures were 31.8%, 40.9%, 27.3% and 40.9% in mucinous tumor. The positive rate of CA 125 in the serous group was statistically significantly higher than that in the mucinous group, while the positive rates for CA 19-9 and CEA in mucinous histology was significantly higher than those in serous tumors[65]. This suggests that it may be reasonable to include CA19-9 and CEA rather than or in addition to CA 125 in the follow up of patients with mucinous BOTs.

In one study the most frequent diagnostic method for invasive recurrences was blood CA 125 elevation and the majority of noninvasive recurrences were diagnosed by imaging by ultrasound[66]. It is believed that CA 125 monitoring may have a role in early detection of recurrence in patients with aggressive disease[36]. Some authors believe that CA 125 does not improve any positive or negative predictive value of the examination[56]. On the basis of the current literature, vaginal ultrasound and possibly additional Doppler ultrasound as well represent the best diagnostic tool for the detection of BOTs[62,67].

It may be a recommendation to have both modalities of serum tumor markers and transvaginal ultrasound, as each is more sensitive to a different type of recurrence. In patients with mucinous tumor, it seems reasonable to include CEA and CA 19-9 in follow up.

Management of relapsed disease

Patients with recurrent disease have a statistically significantly worse survival: 5- and 10-year survival rates are 90.0% and 80.0% compared with 98.9% and 94.4% for those without (P = 0.0208), respectively[28]. Second cytoreductive surgery is recommended for patients with recurrent disease[8]. The survey showed that most centres (45.5%) treat relapsed disease by surgery only. In some centres chemotherapy is also used alone or before or after surgery especially if there is invasive disease. Fewer centres use chemotherapy in the adjuvant setting. In both situations the used regimen was carboplatin ± taxol.

The role of chemotherapy in the management of BOTs in the adjuvant setting or in treatment of relapsed disease is not confirmed and adjuvant systemic chemotherapy is nowadays not generally indicated[9-12]. Faluyi *et al*[68] reviewed seven randomised controlled trials (RCTs) that evaluated adjuvant therapy (chemotherapy, pelvic external irradiation or intra-peritoneal radioactive isotope therapy) after radical surgery. Overall and recurrence-free survival were similar between both arms of these trials, except that one trial (n = 66) showed a significantly lower survival (P = 0.03) in women who received chemotherapy (thio-TEPA). The authors concluded that they found no evidence to support the use of any specific type of adjuvant therapy for BOTs[68].

So far, there has been no phase Ⅲ trials performed that explored the role of systemic therapy for patients with BOTs. Generally, platinum-based chemotherapy regimens were administered in phase Ⅱ trials[58,69,70]. Some studies showed that adjuvant treatment was of no benefit[71] and did not seem to influence progression free survival[72]. Occasional responses to chemotherapy have been reported in advanced BOTs but no study has shown improved survival[8]. Some studies show that adjuvant postoperative therapy is not indicated in Stage- I diploid tumors, but favoured in "high-risk" patients with tumor residual, microinvasion or invasive implants[8,41].

To date the value of the currently available chemotherapeutic agents used in ovarian cancer is not established in treatment of BOTs[11]. The search for new systemic chemotherapy regimens is essential and perhaps attention should be paid to the local intraabdominal administration of drugs[73].

MDT discussion

The results of the survey are very reassuring as they showed that all but one centre do refer the cases for discussion in the central MDT meeting and even the one centre that does not refer all cases seems to refer any cases other than stage I A tumors that have no alarming clinical and histological features. Discussion of all cases of BOTs by the specialist MDT is essential and histology review by expert gynaecological pathologists is important. In our experience some cases on review are found to be benign. Although borderline features are present in the tumor, these may be present in less than 10% of the tumor, which should then be best regarded as a benign tumor according to the current consensus. Also some tumors diagnosed as BOT, may actually show features that justify managing them as carcinomas. Specific features as the presence of intramucosal carcinoma, microinvasion and the nature of peritoneal implants are also essential parameters to assess as previously discussed.

From the surgical point of view discussion of the surgery the patient had in relation to histological features is essential to make an informed decision whether the patient needs further surgery, adjuvant therapy and the appropriate follow up protocol for every case. So it is advocated that BOTs are discussed in the context of the MDT meeting for appropriate clinical decision making relevant to the treatment of each individual patient. This will also facilitate the collection of accurate data for cancer registries and provide feedback for those caring for the patients.

The results of our survey indicate the need for more adequate staging of patients with BOTs in some centres. Oncologic safety, as well as patients' desires and expectations, have to be balanced to reach the most appropriate treatment for BOTs[40]. More importantly a follow up program should be in place, particularly patients who had fertility sparing surgery, and all patients whose tumors show histological features that may indicate the likelihood of aggressive behaviour.

Although patients with BOTs have an excellent prognosis, the small, but significant risk of progression over time to low-grade serous carcinoma emphasizes the need for prolonged follow-up in patients with BOTs[17,23]. Re-

lapses of the S-BOTS may occur up to 50 years later so continued long-term surveillance with CA 125 evaluation and physical examination and ultrasound in patients who had fertility sparing surgery should be considered for optimal patient follow-up[73,74]. The taking on board of risk factors will enable identification of patients with high-risk factors, which is essential for offering more selective treatments to prevent recurrence[60]. None of the histopathologic criteria of the primary tumor including micropapillary subtype of the S-BOT can be used yet as a prognostic marker[73].

RCTs evaluating the benefit of adjuvant therapy with optimally dosed chemotherapy and newer targeted drugs are necessary, particularly for advanced BOTs. The low mortality from BOTs should make recurrence-free survival, time to recurrence and morbidity important end points in such trials[68].

Although the survey represents the practice of 46% of the networks in the United Kingdom, we believe the results are a representative of the current practice and demonstrate the variability of management in surgical intervention and follow up in different centres, which highlights the need for a national protocol for management of BOTs that offers patients across the country the same standard of care.

RECOMMENDATIONS

There are currently no evidence based criteria for individualised patient tailored management and equally no unified international or UK national protocol for the management of BOTs. Based on the current knowledge from the literature and results of our survey of current practice in the UK, we propose the following recommendations.

Surgical management

(1) Fertility sparing surgery is adequate for young women with early stage disease, with subsequent completion surgery on family completion; and (2) Surgical staging is important to identify the presence and type of extra-ovarian implants, which can affect prognosis.

Histological assessment

(1) BOTs should be thoroughly sampled, at least 1 block per centimeter; (2) Histological reports should include comments on the presence of micro-invasion, micropapillary pattern, intramucosal carcinoma, presence and type of implants and tumor stage; and (3) Cases should be reported/reviewed by specialist gynaecological pathologists.

Follow up

(1) Patients should be followed up for at least 5 years; (2) Conservative surgery, high stage disease and invasive implants warrant closer and longer term follow up; (3) Patients should be followed up by clinical examination and CA 125 levels. CA19-9 and CEA levels should also be assessed in patients with mucinous BOTs; and (4) All women who have undergone fertility sparing should in addition have annual pelvic ultrasound for 5 years, then every 2-3 years until they have completion surgery.

MDT discussion

All cases should be referred to and discussed in the specialist gynaecological oncology MDT meeting.

Management of relapsed disease or patients presenting with advanced disease

Debulking surgery is the preferred management. Chemotherapy may be used in the presence of progressive invasive disease, though the activity of platinum-based chemotherapy in this group is quite low and patients should be considered for clinical trials. It is important to establish the behaviour and natural history of the disease in individuals, and a period of observation and monitoring before introducing chemotherapy will permit selection of those with more rapidly progressive disease, for whom chemotherapy is more appropriate.

CONCLUSION

The diagnostics and therapy of BOTs requires more educational and research activities. Molecular Studies have not yet uncovered a reliable prediction of biologic behaviour, however, there is hope that future studies of the genetics and molecular biology of these tumors will lead to useful laboratory tests[8]. Studies of BOTs at a molecular and genetic level offer potential benefits, both in terms of clarifying clinical management, and illuminating differences and similarities between this entity and invasive ovarian cancer. Sophisticated modern analytical approaches when applied to a well defined cohort of BOTs, would address issues such as the prediction of tumor progression, factors determining invasion, and markers of adverse outcome.

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