Journal of Plastic, Reconstructive & Aesthetic Surgery (2007) 60, 1127–1135

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

REVIEW

Breast cancer following augmentation mammoplasty – a review of its impact on prognosis and management

S.A. McIntosh, K. Horgan*

Department of Surgery, Leeds General Infirmary, Great George Street, Leeds LS1 3EX, UK

Received 5 July 2006; accepted 20 March 2007

KEYWORDS
Breast augmentation;
Breast cancer;
Prognosis;
Mastectomy;
Breast conserving surgery;
Sentinel lymph node biopsy

Summary The incidence of breast cancer in women with implants is increasing and will continue to do so for the foreseeable future due to the marked increase in breast implant insertion in recent years. Undoubtedly many of these women will wish to know whether the presence of implants worsens the prognosis of their breast cancer. Furthermore, the clinical management of such patients may be difficult, as aesthetic results are likely to be a major concern for women who have already undergone cosmetic surgery to the breast. There is no consensus on surgical approach to this scenario. This article reviews the literature on the prognosis of breast cancer patients with a history of augmentation mammoplasty and examines the available data regarding their surgical treatment.

Breast cancer prognosis in augmented patients

On the basis of the fact that breast implants reduce the sensitivity of mammography and could therefore delay the diagnosis of breast cancer, the inference could be made that breast cancer in women with a history of augmentation mammoplasty has a worse prognosis than in the non-augmented patient. Published data are conflicting on this subject. Hoshaw et al.,[1] in a comprehensive review of the relationship between breast implants and cancer, concluded that women with implants were diagnosed at a similar stage in the disease process as women without implants. However, this conclusion is based on the evaluation of a number of small studies, many of which are essentially expanded case reports with no control group, and used comparisons with the general population with breast cancer, which is not a suitable group for comparison.

Tumour prognostic characteristics; size, nodal involvement, grade

Miglioretti et al.[2] found that women with breast implants were more likely than women without implants to present

* Corresponding author. Tel.: +44 (0)113 3923325; fax: +44 (0)113 3928150.
E-mail address: kieran.horgan@leedsth.nhs.uk (K. Horgan).

1748-6815/$ - see front matter © 2007 Published by Elsevier Ltd on behalf of British Association of Plastic, Reconstructive and Aesthetic Surgeons.
doi:10.1016/j.bjps.2007.03.017

with symptomatic disease (47 versus 35%). Despite this finding, women both with and without augmentation had cancers of a similar size, stage, nodal status and oestrogen receptor status. Tumours in the augmented population were of a lower grade than in the non-augmented population, although this difference did not reach statistical significance. The authors suggest that these findings may mean that it is easier to palpate abnormalities in the augmented breast, either because women with breast implants have a smaller volume of native breast tissue,[3] or because it is easier to feel an abnormality against the firm background of an implant.[4,5] However, there are possible confounding factors. Women with a history of augmentation mammoplasty may be more breast aware or more likely to perform self-examination than women without breast implants, and may also originate from a different socioeconomic class. In addition, and as Miglioretti et al. point out, up to 35% of data (up to 10% for disease stage, 4% for nodal status, 12% for tumour size and 18% for tumour grade) concerning tumour characteristics are missing from their study (albeit in similar proportions from both the augmented and non-augmented population groups), which introduces a potential source of bias.

Carlson et al.[6] retrospectively reviewed 37 patients with breast implants and cancer, and found that 92% had invasive disease and 46% of these had axillary nodal metastases. Liebman and Kruse[7] reported a series of 11 patients, eight of whom had infiltrating ductal carcinoma, and four of whom had nodal metastases. Although the authors of both these studies comment that these findings are in keeping with breast cancer statistics in the general population, there is no control group for the purposes of direct comparison. Clearly the incidence of axillary nodal disease will vary according to the size and grade of the primary tumour — this is a well-documented finding. The Surveillance, Epidemiology and End Results (SEER) data published by Carter et al.[8] in 1989 give an overall nodal positivity rate of 45%. These data are roughly contemporaneous with the studies of both Carlson et al.[6] and Liebman and Kruse,[7] and predate the introduction of national breast screening programmes. This comparison would therefore seem reasonable.

Cahan et al.[9] reviewed the cases of 22 women with breast cancer who had previously undergone breast augmentation. These patients were all diagnosed between 1977 and 1992, and were compared with a group of 611 women with breast cancer but without implants who were treated in the same time period. Comparison was also made with the SEER data. This study found that the augmented patient group were younger than non-augmented patients (mean age 48 years versus 58 years). However, there was no significant difference in mean tumour size, incidence of in situ disease or nodal status between the two groups. Indeed, tumours in patients with implants tended to be smaller than in non-augmented women, although this difference did not reach statistical significance. The time frame of this study implies that displacement views were not used, and also means that the majority of patients preceded the introduction of breast screening programmes, although these details are not discussed. The age difference between the two groups, which is not corrected for, means that the groups are not truly comparable.

An epidemiological study from Denmark[10] reviewed the Danish Breast Cancer Registry, and identified 1135 women who had undergone breast augmentation. Within this population, eight patients had gone on to develop breast cancer. At the time of diagnosis, four patients had localised disease, while a further four had regional nodal metastases. These findings led the authors to conclude that there was 'little difference in the stage of diagnosis of breast cancer when compared with Danish women as a whole'.

Clark et al.[5] compared 33 women with augmentation and breast cancer with 1735 breast cancer patients without augmentation. The authors noted a similar incidence of in situ disease in the two groups (18% in augmented patients versus 15% in non-augmented patients). There was no difference in the size of mammographically-detected tumours between the two groups. Palpable tumours, however, were significantly smaller in women with implants. In addition, the incidence of nodal disease was significantly lower in women with implants and palpable lesions (22 versus 58%). This is to be expected given the smaller average size of these tumours. The majority of women in this study were symptomatic; the implications cannot therefore be extended to the screened population as a whole. Furthermore, no attempt was made to control or adjust for age difference in this study. In Clark et al.'s study, patients with augmented breasts were significantly younger than the control group (mean age 43 years versus 59 years). Both of these factors introduce a potential source of bias.

Birdsell et al.[11] evaluated 41 women with breast implants diagnosed with breast cancer between 1973 and 1990, and compared these with a control group of 13 246 women with breast cancer but without implants. Information on the method of tumour detection was missing in a proportion of cases. However, given that the study was carried out prior to the inception of breast screening programmes, it would seem reasonable to infer that the majority of patients were symptomatic. The authors found a higher incidence of in situ disease in patients with implants compared to women without implants (12 versus 3.5%). Tumours in augmented women were significantly smaller, where 66% of these patients had a tumour less than 2 cm in diameter, compared with 34% of the non-augmented patients. Similar proportions of women in each group were found to have nodal disease (around 30%). No statistically significant difference in 5 and 10 year survival was identified between the groups. Once again, augmented patients were significantly younger than non-augmented patients. The authors performed additional analysis, matching one patient with an implant and cancer to five patients with no implant but with cancer. Patients were matched for year of diagnosis and age at diagnosis. No significant survival difference was demonstrated. The improved prognostic features in these patients were attributed to increased awareness and regular self-examination in the augmented patient population.

Survival analysis

Deapen et al.[12] monitored the incidence of breast cancer in a cohort of 3182 women who underwent breast augmentation between 1959 and 1981, and identified 37 women with

either in situ or invasive disease. The incidence of in situ disease was 14%, and the authors comment that the distribution of disease was very similar to that among non-augmented patients in a comparable age group. Survival data were compared with that expected amongst the general breast cancer population, using data from the SEER Programme. The overall survival rate for patients with breast augmentation was 88%, compared with an expected 84% 5 year survival.

Hölmich et al.[13] identified 23 cases of breast cancer following augmentation in 2955 Danish women who were diagnosed between 1973 and 1977. Controls were selected from the Danish Breast Cancer Cooperative Group Registry; 11 controls without augmentation were matched for each woman with augmentation and breast cancer. Controls were matched for age and year of breast cancer diagnosis, but were otherwise randomly selected. Analysis showed no significant difference in tumour histology, grade, oestrogen receptor status or incidence of axillary nodal disease between augmented patients and the control group. There was no difference in overall survival (86% versus 78% in control group). There was also no difference between the groups in the use of adjuvant treatments.

Some conflicting data to the previously described reports are available, from the studies of Silverstein et al.[14–16] and Schirber et al.[17] Schirber et al.[17] presented a series of nine patients with previous breast augmentation and breast cancer, and argued that these patients had more advanced disease at presentation than women seen following mammographically-diagnosed neoplasia. No control group was used in this study, nor were any comparisons made with existing data.

Schirber et al.[17] argued that their findings support Silverstein et al.'s original series of 20 patients.[14] This study suggested that augmented patients had a greater proportion of invasive tumours and nodal disease than non-augmented patients. Again, because of the time frame of this particular series, the majority of patients were symptomatic rather than screen-detected. The implications of this are that they are more likely to be larger, later stage tumours with worse prognostic factors.

More mature data from the same study[16] showed that the incidence of nodal metastases had fallen, with 47% of the 35 patients in the updated series having positive nodes, more closely matching the general population with breast cancer. These data were further updated in 1992,[15] with a total of 42 patients now in the study group. When tumour size and nodal positivity were compared with non-augmented women in the Los Angeles County Cancer Surveillance Programme, the proportions of patients in each population with invasive disease and positive axillary nodes were very similar, leading the authors to conclude that breast cancer stage at diagnosis is similar in women with breast implants to that in women without implants.

Brinton et al.[18] conducted a population-based survey of women with breast implants and women who had undergone other types of plastic surgery (not involving silicone implants). This was a retrospective cohort study, in which 13,488 women who had undergone augmentation and 3936 comparison women were surveyed by postal questionnaire. In the implant group, 23 patients died from breast cancer and a further 116 cases self-reported as having the disease. In the 78 cases where medical verification of invasive breast cancer was obtained, augmented patients were less likely to have in situ (15 versus 28%) or localised disease (41 versus 53%) and more likely to have regional or distant disease (35 versus 17%) than women without implants, although none of these differences reached statistical significance. Medical records were not obtained for a substantial number of the women who self-reported to have breast cancer, and therefore the exclusion of these patients may have biased the findings. Breast cancer mortality was not significantly different between the implant and control populations.

Skinner et al.[3] found 99 breast cancers in augmented women by reviewing a prospectively maintained breast cancer database between 1980 and 1999. In this time period, 2857 cancers were seen in women without implants. Patients with implants were significantly younger than those without (46 years versus 54 years), and were more likely to have palpable tumours (83 versus 59%) and invasive disease (82 versus 72%). Augmented patients were also significantly more likely to have nodal metastatic disease (48 versus 36%). Palpable tumours in women with implants tended to be smaller than in women without, although this difference did not reach statistical significance. No difference was seen in overall tumour stage between the groups. However, these two groups were not comparable, as the women with implants were significantly younger. A separate subgroup analysis was therefore carried out in women aged 50 years or younger, and in this group women with implants remained more likely to present with palpable lesions.

There are factors in this study which would bias the augmented group towards having a greater incidence of palpable tumours. Routine annual screening mammography was recommended in 1992 by the American Cancer Society for women over the age of 50 years.[19] In 1997, this recommendation was updated in favour of commencing screening at the age of 40 years.[20] Because the augmented patients in Skinner et al.'s study are younger than the controls, they would have been subject to a different screening regime, thus making them more likely to have palpable lesions than the older women without implants who were more likely to have been screened. This would also account for the fact that women with implants were more likely to have invasive disease. When women older than 50 years were excluded, the difference in rates of invasive disease was no longer significant. In addition, as the authors point out, the referral practice in their centre may bias the findings, as the incidence of in situ disease in their non-augmented patient population was relatively high at 28% (compared with previous studies showing an incidence of in situ disease of 6–12% of all cancers diagnosed, which is roughly equivalent in the augmented and non-augmented population[11,21]).

Jakub et al.[22] report a retrospective series of 78 breast cancers in women with implants, and compare these patients with a series of 4110 non-augmented women with breast cancer treated contemporaneously at the same institution. Nodal metastases were seen in 38% of augmented women, with no difference in nodal status between augmented patients and controls. Furthermore, patients with implants were significantly more likely to have a tumour less than 1 cm. Spear et al.[23] report a series of 21 patients

with previous augmentation, 29% of whom were node positive. Although both these series would seem to support the hypothesis that women with previous augmentation do not have a worse prognosis per se, there are caveats to this conclusion. No data are available on womens' participation in breast screening programmes in either of these studies. Furthermore, they are retrospective, non-randomised studies and so allowance must be made for confounding factors such as the potential for increased breast awareness and self-examination in the augmented women.

It is clear that many of these studies are small, often retrospective case series, and caution must be exercised when interpreting the results. However, the larger studies, and particularly those with appropriate control groups would support the hypothesis that women with a history of breast augmentation who develop breast cancer have neither more advanced disease at diagnosis nor a worse prognosis than women without implants.[2,3,5,11,18] Those studies which include control groups for the purposes of comparison are summarised in Table 1.

Management of breast cancer following augmentation mammoplasty

Over time, the management of breast cancer has gradually become more conservative, as studies have shown that breast conservation surgery and radiotherapy can achieve local disease control and overall survival results comparable with mastectomy.[24–31] It is only recently, however, that the management of breast cancer in women with breast implants has become an issue of concern for surgeons. This problem will become an increasingly common one, as greater numbers of women undergo augmentation mammoplasty, and as this population ages and the incidence of cancer within it increases.

The literature on breast conservation surgery in women with breast implants is limited, and much of the published data are contradictory. Breast radiotherapy is routinely given following breast conserving surgery, as it has been shown to reduce local recurrence rates and achieve similar disease control to mastectomy.[28,29] However, published data regarding the use of radiotherapy following prosthesis-based breast reconstruction after mastectomy would suggest that there is a significant incidence of complications associated with this treatment approach, a topic which has been comprehensively reviewed elsewhere.[32]

The physics of irradiation in the presence of a prosthetic breast implant has been assessed in several studies, and much of the available data are from women who have had radiotherapy following prosthetic breast reconstruction. It has not been shown that implants of any type result in the attenuation of X-rays, and there is no evidence to suggest that the presence of an implant impairs the delivery of radiation to the surrounding tissues.[33–37] On this basis, it could be argued that there is no evidence to suggest that either local disease control or survival will be adversely affected by the presence of an implant.

Table 1 Published studies comparing prognostic factors and survival between augmented and non-augmented women

First author	Reference	Number of patients	Incidence of palpable tumours	Difference in size?	Difference in tumour grade?	Incidence of nodal disease	Incidence of *in situ* disease	Overall survival
Miglioretti	2	137	Higher in augmented patients (47 v 35%)	N.D.	N.D.	N.D.	N.D	N.D.
Skinner	3	99	Higher in augmented patients (83 v 59%)	N.D.	N.D.	Higher in augmented patients (48 v 36%)	Lower in augmented patients (18 v 28%)	N.D.
Clark	5	33	—	Smaller tumours in augmented patients (82 v 63% < 20 mm)	—	Lower in augmented patients (19 v 41%)	N.D.	—
Cahan	9	22	—	N.D.	—	N.D.	N.D.	—
Birdsell	11	41	—	Smaller tumours in augmented patients (66 v 34% < 20 mm)	—	N.D.	Higher in augmented patients (12 v 3%)	N.D.
Deapen	12	37	—	—	—	N.D.	N.D.	N.D.
Hölmich	13	23	—	N.D.	N.D.	N.D.	—	N.D.
Brinton	18	136	—	—	—	N.D.	N.D.	N.D.
Jakub	22	78	—	N.D.	—	N.D.	N.D.	—
Spear	23	21	—	N.D.	—	N.D.	—	—

N.D. No significant difference between augmented and non-augmented patients.
— Data not available for these parameters.

The cosmetic result following irradiation of breast implants should also be borne in mind. Certainly there is little doubt that radiotherapy after prosthetic breast reconstruction can adversely affect the cosmetic outcome of reconstruction, most often by the occurrence of capsular contracture. Senkus-Konefka et al. have recently reviewed this topic.[32]

Conservation breast surgery of the augmented breast

Less evidence is available for the effects of radiotherapy following breast conservation surgery in a breast which contains an implant. There are a small number of reports which examine the outcome of such treatment. Ryu et al.[38] describe three such patients, reporting cosmetic outcomes as fair in two cases and excellent in the third. Handel et al.[39] discuss the management of 34 women with breast augmentation and breast cancer, of whom 17 were treated with breast conserving surgery. All 17 had microscopically clear margins, underwent an axillary node clearance, and were subsequently treated with whole-breast radiotherapy. Complete follow-up data were available in 15 women, and significant capsular contracture was seen in 67%. The mean Baker grade of contracture was 3.5 in these patients, compared with a mean grade of 1.3 in the non-irradiated breast. These symptoms occurred at a range of 2—40 weeks following radiotherapy, with a mean time to symptomatic capsule development of 12 weeks. Revisional surgery (either capsulotomy or capsulectomy and change of implant) was required in four patients. The authors acknowledge that this is a small series, but it would appear that the good cosmetic results reported in breast conservation patients without implants cannot be replicated in the augmented population.

The same authors subsequently reported a series of 33 augmented women treated with breast conserving surgery and radiotherapy, 52% of whom were noted to have significant worsening of capsular contracture.[40] The average Baker grade was 3.08 after radiotherapy, and eight patients required revisional surgery. This consisted of capsulectomy and implant exchange in five cases, implant removal alone in one, and unilateral implant removal and autologous tissue reconstruction in two cases.

In neither of these studies are long-term survival or recurrence data given, and it is therefore not possible to comment on the oncological appropriateness of breast conserving surgery in women with previous augmentation mammoplasty. Guenther et al.[41] evaluated results in 20 women with silicone implants who underwent breast conserving surgery and radiotherapy. As might be expected, these were women with small tumours; the mean tumour size was 14.3 mm, and 75% of tumours were T1 lesions. Radiation was given to a total maximum of 7100 cGy (6400 cGy after 1985), with a boost dose to the tumour site. Cosmesis was rated using a four-point scoring system, ranging from poor to excellent. At median follow up of 3.8 years, no local recurrences were seen, although distant recurrence was reported in two cases. Cosmetic outcome was rated as excellent or good in 17 cases (85%). A fair outcome was reported in a further two cases, and a poor result in a single patient. This was the only patient who subsequently required revision, with capsulectomy and removal of both implants.

Mark et al.[42] reported a series of patients with breast implants who had breast conserving surgery and radiotherapy. Twenty-one patients with implants underwent wide local excision followed by whole-breast radiotherapy, to an average dose of 5021 cGy to the breast and a boost dose to the tumour bed in 16 cases. At median follow up of 22 months, 19 patients (86%) were disease free, with one patient alive with local recurrence and a further two patients dead of systemic disease. Capsular contracture was seen in 12 cases (57%), with 10 women self-reporting the cosmetic outcome as poor, and the remaining two as fair. The nine women with no contracture reported their cosmetic outcome as being good to excellent. There was no correlation between implant position or type or radiation dose and capsular contracture.

Karanas et al.[43] reported on the management of 58 women with breast cancer in the presence of breast implants. In this retrospective review, 30 patients had undergone mastectomy with implant removal (52%), and 28 patients (48%) had breast conservation with subsequent radiotherapy. The average tumour size was smaller in women who underwent breast conservation (mean size 2.1 cm versus 2.23 cm overall), and the implant was removed in four patients and retained in 22 (with implant fate unknown in two patients). Of these 22 patients with a retained implant, three refused radiotherapy, and 58% of the others developed implant-related complications. These comprised infection, intractable pain, poor cosmesis, contracture, erosion, intractable seroma and implant rupture, and surgical treatment was required in three of the 19 cases. At 28 months follow up, local recurrence was seen in seven of the 28 who had had breast conservation (25%). By this stage 11 of the 28 (39%) had gone on to completion mastectomy, due either to implant complications or to local recurrence on persistently positive surgical margins.

Published studies to date regarding breast conserving surgery in patients with previous augmentation mammoplasty tend to be small, non-randomised retrospective studies, comprising heterogeneous patient groups. In addition, the cosmetic outcomes of surgery are difficult to assess, as they are subjective, and many different scoring systems are used for this purpose. In many of these studies, it is unclear whether measures of cosmetic outcomes are reported by patients, or by blinded independent observers. There seems little doubt, however, that radiotherapy after breast conservation in women with implants has an adverse cosmetic impact, with the above studies reporting capsular contracture rates between 35 and 67%,[39,40,42,44] and re-operation rates in these patients reported as ranging from 5 to 25%.[39—41,44] With respect to oncological considerations, the short follow-up periods and small patient numbers make it practically impossible to draw any meaningful conclusions about the oncological safety of breast conserving surgery in these patients.

The largest studies describing the outcomes of breast conservation surgery and radiotherapy in patients with previous augmentation mammoplasty are summarised in Table 2. Only studies which describe the outcomes following breast conservation surgery are included in this

Table 2 Summary of findings of main studies describing outcomes of breast conserving surgery and radiotherapy in patients with previous augmentation mammoplasty

First author	Reference number	Number of patients	Capsular contracture rate	Revisional surgery rate	% of patients with 'good/ excellent cosmesis'	Overall favourable results reported?
Handel	39	15	10/17 (67%)	4/17 (24%)	33%	No
Handel	40	33	17/33 (65%)	8/33 (24%)	—	No
Guenther	41	20		1/20 (5%)	—	Yes
Mark	42	21	12/21 (57%)	7/21 (33%)	43%	No
Karanas	43	28	3/19 (16%)	5/19 (26%)	—	No

— Data not available for these parameters.

table, as several of the published studies comprise heterogeneous groups of patients as described above, and are therefore not appropriate for comparison in this setting.

Radiotherapy after mastectomy and reconstruction

In light of these data, it may be that better cosmetic results can be achieved by mastectomy together with reconstruction of the affected breast, as described by Spear et al.[23] and Carlson et al.[45] Mastectomy will obviate the need for radiotherapy in some cases, although some patients with adverse prognostic factors will require chest wall radiotherapy to reduce local recurrence.[46,47] In patients who undergo mastectomy and immediate reconstruction with an implant or tissue expander, capsular contracture rates of 2—73% have been described.[48—59] Where immediate reconstruction has been performed with autologous tissue and followed by radiotherapy, complications such as flap necrosis, fat necrosis and flap contracture have been reported in 15—34% of patients.[60—63] It has been suggested that, where patients require post-mastectomy radiotherapy, reconstruction should be delayed until after the completion of radiotherapy. However, delayed reconstruction on the irradiated chest wall has also been shown to have significant associated complications. The use of implants in irradiated tissue has been reported to result in capsular contracture formation in 26—60% of cases.[51,54,57,59,64—66] Similarly, autologous tissue reconstruction after radiotherapy has been reported to have complication rates ranging from 3 to 34%.[67—73] In these studies, there are a wide variety of cosmetic outcomes reported; due to the range of outcome measures used it is very difficult to draw comparisons between the studies.

Little data are available regarding women with previous breast augmentation who have undergone mastectomy and reconstruction. Spear et al.[23] report a series of 21 patients who had mastectomy followed by reconstruction, with the use of a prosthesis in the majority of cases. Autologous tissue was used where patients had received adjuvant radiotherapy or where significant skin loss was to be replaced. Complications were seen in three patients (14%). Cosmetic outcomes were assessed blindly, with mean scores of 3.35 (out of a possible 4), compared with matched controls who were given a mean score of 3.0. No oncological follow-up data are available.

Carlson et al.[45] report six patients with previous breast augmentation who underwent mastectomy with immediate reconstruction. None required postoperative radiotherapy, and complications were seen in two cases. Cosmetic outcome was judged to be good to excellent in all cases, and no recurrences of breast cancer were seen at a mean follow up of 33.6 months.

Clearly, clinical decision making in this patient group can be difficult, and there is little clear evidence to guide clinicians. While breast conserving surgery may be possible, there is a significant complication rate associated with leaving an implant in situ and giving postoperative radiotherapy. In addition, given that there may be only a small volume of native breast tissue in these patients, it may be difficult to achieve adequate surgical margins while conserving the breast. Both Handel et al.[40] and Karanas et al.[43] suggest that a preferred option may be breast conservation surgery combined with explantation of the implants and mastopexy, followed by radiotherapy. However, neither group present the results of such surgery, nor are there any published accounts of such treatment to be found in the literature.

It may be that such patients are better served by mastectomy and reconstruction, with consideration given to delaying reconstruction until after the completion of treatment should post-mastectomy radiotherapy be necessary. Individualised treatment plans and informed decision making by patient and clinician are likely to provide the optimal cosmetic results; however, adequate oncological treatment should not be compromised for the sake of cosmesis.

Axillary lymphatic mapping in augmented breast cancer patients

In 2004, Gray et al.[44] described breast conserving surgery and sentinel lymph node biopsy in 19 patients with previous augmentation mammoplasty. Two patients subsequently declined radiotherapy, leaving 17 augmented breasts treated with radiotherapy. Of these, 11 were adjudged to retain favourable appearances (65%), with six breasts judged to have a capsular contracture of Baker grade 3 or 4 (35%). Implant removal was required in three cases (18%). At median follow up of three years, one local recurrence was seen (5%), and no systemic recurrence, with all patients remaining alive. Lymphatic mapping was carried out in 11 patients, with successful identification of the sentinel node in all cases, and a false negative rate of 0% (completion axillary dissection was carried out in nine patients),

leading the authors to conclude that implants do not interfere with the success of lymphatic mapping in breast cancer. Successful lymphatic mapping has also been reported following breast augmentation by the transaxillary route.[74]

Jakub et al.[22] carried out a retrospective review to evaluate the stage and prognosis of breast cancer in women with breast augmentation, and to assess the role of lymphatic mapping in these patients. Like previous studies, they found that although these patients were more likely to present with a palpable mass, this does not translate into either larger average tumour size or worse prognosis. In their review of 67 augmented women with 78 breast cancers, 37 (47%) were treated with breast conservation (as against a breast conservation rate of 64% in the non-augmented patient population). No data are available on cosmetic outcomes or the need for further surgery for either oncological or implant-related considerations. Lymphatic mapping was carried out in 49 cases, with a success rate of 100%.

Summary

- Women with breast implants are more likely to present with a palpable invasive tumour than women without implants.
- Women with breast implants have a similar incidence of nodal metastatic disease than the non-augmented population.
- These patients do not appear to have a worse prognosis than women without implants who develop breast cancer.
- When performing breast conserving surgery, adequate margins of clearance may be difficult to obtain due to a more limited volume of native breast tissue.
- Radiotherapy will be required following breast conservation surgery, which may adversely affect the cosmetic outcome.
- Sentinel lymph node biopsy may be possible in augmented patients, although there is currently limited available data to support this.
- Consideration should be given to mastectomy and reconstruction as an alternative to breast conserving surgery.
- The need for post-mastectomy radiotherapy should be considered, and it may be advisable to delay reconstruction until after the completion of treatment.

References

1. Hoshaw SJ, Klein PJ, Clark BD, et al. Breast implants and cancer: causation, delayed detection, and survival. *Plast Reconstr Surg* 2001;**107**:1393—407.
2. Miglioretti DL, Rutter CM, Geller BM, et al. Effect of breast augmentation on the accuracy of mammography and cancer characteristics. *JAMA* 2004;**291**:442—50.
3. Skinner KA, Silberman H, Dougherty W, et al. Breast cancer after augmentation mammoplasty. *Ann Surg Oncol* 2001;**8**: 138—44.
4. Eklund GW, Busby RC, Miller SH, et al. Improved imaging of the augmented breast. *Am J Roentgenol* 1988;**151**:469—73.
5. Clark III CP, Peters GN, O'Brien KM. Cancer in the augmented breast. Diagnosis and prognosis. *Cancer* 1993;**72**:2170—4.
6. Carlson GW, Curley SA, Martin JE, et al. The detection of breast cancer after augmentation mammaplasty. *Plast Reconstr Surg* 1993;**91**:837—40.
7. Leibman AJ, Kruse B. Breast cancer: mammographic and sonographic findings after augmentation mammoplasty. *Radiology* 1990;**174**:195—8.
8. Carter CL, Allen C, Henson DE. Relation of tumor size, lymph node status, and survival in 24,740 breast cancer cases. *Cancer* 1989;**63**:181—7.
9. Cahan AC, Ashikari R, Pressman P, et al. Breast cancer after breast augmentation with silicone implants. *Ann Surg Oncol* 1995;**2**:121—5.
10. Friis S, McLaughlin JK, Mellemkjaer L, et al. Breast implants and cancer risk in Denmark. *Int J Cancer* 1997;**71**:956—8.
11. Birdsell DC, Jenkins H, Berkel H. Breast cancer diagnosis and survival in women with and without breast implants. *Plast Reconstr Surg* 1993;**92**:795—800.
12. Deapen D, Hamilton A, Bernstein L, et al. Breast cancer stage at diagnosis and survival among patients with prior breast implants. *Plast Reconstr Surg* 2000;**105**:535—40.
13. Holmich LR, Mellemkjaer L, Gunnarsdottir KA, et al. Stage of breast cancer at diagnosis among women with cosmetic breast implants. *Br J Cancer* 2003;**88**:832—8.
14. Silverstein MJ, Handel N, Gamagami P, et al. Breast cancer in women after augmentation mammoplasty. *Arch Surg* 1988; **123**:681—5.
15. Silverstein MJ, Handel N, Gamagami P, et al. Breast cancer diagnosis and prognosis in women following augmentation with silicone gel-filled prostheses. *Eur J Cancer* 1992;**28**:635—40.
16. Silverstein MJ, Gierson ED, Gamagami P, et al. Breast cancer diagnosis and prognosis in women augmented with silicone gel-filled implants. *Cancer* 1990;**66**:97—101.
17. Schirber S, Thomas WO, Finley JM, et al. Breast cancer after mammary augmentation. *South Med J* 1993;**86**:263—8.
18. Brinton LA, Lubin JH, Burich MC, et al. Breast cancer following augmentation mammoplasty (United States). *Cancer Causes Control* 2000;**11**:819—27.
19. Dodd GD. American Cancer Society guidelines on screening for breast cancer. An overview. *Cancer* 1992;**69**:1885—7.
20. Leitch AM, Dodd GD, Costanza M, et al. American Cancer Society guidelines for the early detection of breast cancer: update 1997. *CA Cancer J Clin* 1997;**47**:150—3.
21. Deapen DM, Bernstein L, Brody GS. Are breast implants anticarcinogenic? A 14-year follow-up of the Los Angeles Study. *Plast Reconstr Surg* 1997;**99**:1346—53.
22. Jakub JW, Ebert MD, Cantor A, et al. Breast cancer in patients with prior augmentation: presentation, stage, and lymphatic mapping. *Plast Reconstr Surg* 2004;**114**:1737—42.
23. Spear SL, Slack C, Howard MA. Postmastectomy reconstruction of the previously augmented breast: diagnosis, staging, methodology, and outcome. *Plast Reconstr Surg* 2001;**107**:1167—76.
24. Veronesi U, Salvadori B, Luini A, et al. Breast conservation is a safe method in patients with small cancer of the breast. Long-term results of three randomised trials on 1,973 patients. *Eur J Cancer* 1995;**31A**:1574—9.
25. Veronesi U, Saccozzi R, del Vecchio M, et al. Comparing radical mastectomy with quadrantectomy, axillary dissection, and radiotherapy in patients with small cancers of the breast. *N Engl J Med* 1981;**305**:6—11.
26. Veronesi U, Banfi A, Salvadori B, et al. Breast conservation is the treatment of choice in small breast cancer: long-term results of a randomized trial. *Eur J Cancer* 1990;**26**:668—70.
27. Veronesi U, Volterrani F, Luini A, et al. Quadrantectomy versus lumpectomy for small size breast cancer. *Eur J Cancer* 1990; **26**:671—3.
28. Veronesi U, Luini A, del Vecchio M, et al. Radiotherapy after breast-preserving surgery in women with localized cancer of the breast. *N Engl J Med* 1993;**328**:1587—91.

29. Fisher B, Anderson S, Redmond CK, et al. Reanalysis and results after 12 years of follow-up in a randomized clinical trial comparing total mastectomy with lumpectomy with or without irradiation in the treatment of breast cancer. *N Engl J Med* 1995;**333**:1456–61.
30. Lichter AS, Lippman ME, Danforth Jr DN, et al. Mastectomy versus breast-conserving therapy in the treatment of stage I and II carcinoma of the breast: a randomized trial at the National Cancer Institute. *J Clin Oncol* 1992;**10**:976–83.
31. Blichert-Toft M, Rose C, Andersen JA, et al. Danish randomized trial comparing breast conservation therapy with mastectomy: six years of life-table analysis. Danish Breast Cancer Cooperative Group. *J Natl Cancer Inst Monogr* 1992:19–25.
32. Senkus-Konefka E, Welnicka-Jaskiewicz M, Jaskiewicz J, et al. Radiotherapy for breast cancer in patients undergoing breast reconstruction or augmentation. *Cancer Treat Rev* 2004;**30**: 671–82.
33. Kuske RR, Schuster R, Klein E, et al. Radiotherapy and breast reconstruction: clinical results and dosimetry. *Int J Radiat Oncol Biol Phys* 1991;**21**:339–46.
34. Shedbalkar AR, Devata A, Padanilam T. A study of effects of radiation on silicone prostheses. *Plast Reconstr Surg* 1980;**65**:805–10.
35. Krishnan L, St George FJ, Mansfield CM, et al. Effect of silicone gel breast prosthesis on electron and photon dose distributions. *Med Phys* 1983;**10**:96–9.
36. Krishnan L, Krishnan EC. Electron beam irradiation after reconstruction with silicone gel implant in breast cancer. *Am J Clin Oncol* 1986;**9**:223–6.
37. McGinley PH, Powell WR, Bostwick J. Dosimetry of a silicone breast prosthesis. *Radiology* 1980;**135**:223–4.
38. Ryu J, Yahalom J, Shank B, et al. Radiation therapy after breast augmentation or reconstruction in early or recurrent breast cancer. *Cancer* 1990;**66**:844–7.
39. Handel N, Lewinsky B, Silverstein MJ, et al. Conservation therapy for breast cancer following augmentation mammaplasty. *Plast Reconstr Surg* 1991;**87**:873–8.
40. Handel N, Lewinsky B, Jensen JA, et al. Breast conservation therapy after augmentation mammaplasty: is it appropriate? *Plast Reconstr Surg* 1996;**98**:1216–24.
41. Guenther JM, Tokita KM, Giuliano AE. Breast-conserving surgery and radiation after augmentation mammoplasty. *Cancer* 1994;**73**:2613–8.
42. Mark RJ, Zimmerman RP, Greif JM. Capsular contracture after lumpectomy and radiation therapy in patients who have undergone uncomplicated bilateral augmentation mammoplasty. *Radiology* 1996;**200**:621–5.
43. Karanas YL, Leong DS, Da Lio A, et al. Surgical treatment of breast cancer in previously augmented patients. *Plast Reconstr Surg* 2003;**111**:1078–83.
44. Gray RJ, Forstner-Barthell AW, Pockaj BA, et al. Breast-conserving therapy and sentinel lymph node biopsy are feasible in cancer patients with previous implant breast augmentation. *Am J Surg* 2004;**188**:122–5.
45. Carlson GW, Moore B, Thornton JF, et al. Breast cancer after augmentation mammaplasty: treatment by skin-sparing mastectomy and immediate reconstruction. *Plast Reconstr Surg* 2001;**107**:687–92.
46. Ragaz J, Jackson SM, Le N, et al. Adjuvant radiotherapy and chemotherapy in node-positive premenopausal women with breast cancer. *N Engl J Med* 1997;**337**:956–62.
47. Overgaard M, Hansen PS, Overgaard J, et al. Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy. Danish Breast Cancer Cooperative Group 82b Trial. *N Engl J Med* 1997;**337**: 949–55.
48. Chu FC, Kaufmann TP, Dawson GA, et al. Radiation therapy of cancer in prosthetically augmented or reconstructed breasts. *Radiology* 1992;**185**:429–33.
49. Rosato RM, Dowden RV. Radiation therapy as a cause of capsular contracture. *Ann Plast Surg* 1994;**32**:342–5.
50. Victor SJ, Brown DM, Horwitz EM, et al. Treatment outcome with radiation therapy after breast augmentation or reconstruction in patients with primary breast carcinoma. *Cancer* 1998;**82**:1303–9.
51. Krueger EA, Wilkins EG, Strawderman M, et al. Complications and patient satisfaction following expander/implant breast reconstruction with and without radiotherapy. *Int J Radiat Oncol Biol Phys* 2001;**49**:713–21.
52. Tallet AV, Salem N, Moutardier V, et al. Radiotherapy and immediate two-stage breast reconstruction with a tissue expander and implant: complications and esthetic results. *Int J Radiat Oncol Biol Phys* 2003;**57**:136–42.
53. von Smitten K, Sundell B. The impact of adjuvant radiotherapy and cytotoxic chemotherapy on the outcome of immediate breast reconstruction by tissue expansion after mastectomy for breast cancer. *Eur J Surg Oncol* 1992;**18**:119–23.
54. Evans GR, Schusterman MA, Kroll SS, et al. Reconstruction and the radiated breast: is there a role for implants? *Plast Reconstr Surg* 1995;**96**:1111–5.
55. Ramon Y, Ullmann Y, Moscona R, et al. Aesthetic results and patient satisfaction with immediate breast reconstruction using tissue expansion: a follow-up study. *Plast Reconstr Surg* 1997;**99**:686–91.
56. Spear SL, Majidian A. Immediate breast reconstruction in two stages using textured, integrated-valve tissue expanders and breast implants: a retrospective review of 171 consecutive breast reconstructions from 1989 to 1996. *Plast Reconstr Surg* 1998;**101**:53–63.
57. Spear SL, Onyewu C. Staged breast reconstruction with saline-filled implants in the irradiated breast: recent trends and therapeutic implications. *Plast Reconstr Surg* 2000;**105**:930–42.
58. Ringberg A, Tengrup I, Aspegren K, et al. Immediate breast reconstruction after mastectomy for cancer. *Eur J Surg Oncol* 1999;**25**:470–6.
59. Contant CM, van Geel AN, van der HB, et al. Morbidity of immediate breast reconstruction (IBR) after mastectomy by a subpectorally placed silicone prosthesis: the adverse effect of radiotherapy. *Eur J Surg Oncol* 2000;**26**:344–50.
60. Williams JK, Carlson GW, Bostwick III J, et al. The effects of radiation treatment after TRAM flap breast reconstruction. *Plast Reconstr Surg* 1997;**100**:1153–60.
61. Zimmerman RP, Mark RJ, Kim AI, et al. Radiation tolerance of transverse rectus abdominis myocutaneous-free flaps used in immediate breast reconstruction. *Am J Clin Oncol* 1998;**21**:381–5.
62. Tran NV, Evans GR, Kroll SS, et al. Postoperative adjuvant irradiation: effects on tranverse rectus abdominis muscle flap breast reconstruction. *Plast Reconstr Surg* 2000;**106**:313–7.
63. Rogers NE, Allen RJ. Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap. *Plast Reconstr Surg* 2002;**109**:1919–24.
64. Dickson MG, Sharpe DT. The complications of tissue expansion in breast reconstruction: a review of 75 cases. *Br J Plast Surg* 1987;**40**:629–35.
65. Olenius M, Jurell G. Breast reconstruction using tissue expansion. *Scand J Plast Reconstr Surg Hand Surg* 1992;**26**:83–90.
66. Kraemer O, Andersen M, Siim E. Breast reconstruction and tissue expansion in irradiated versus not irradiated women after mastectomy. *Scand J Plast Reconstr Surg Hand Surg* 1996;**30**:201–6.
67. Hartrampf Jr CR, Bennett GK. Autogenous tissue reconstruction in the mastectomy patient. A critical review of 300 patients. *Ann Surg* 1987;**205**:508–19.
68. Salmon RJ, Razaboni R, Soussaline M. The use of the latissimus dorsi musculocutaneous flap following recurrence of cancer in irradiated breasts. *Br J Plast Surg* 1988;**41**:41–4.
69. Jacobsen WM, Meland NB, Woods JE. Autologous breast reconstruction with use of transverse rectus abdominis musculocutaneous flap: Mayo clinic experience with 147 cases. *Mayo Clin Proc* 1994;**69**:635–40.

70. Kroll SS, Schusterman MA, Reece GP, et al. Breast reconstruction with myocutaneous flaps in previously irradiated patients. *Plast Reconstr Surg* 1994;**93**:460—9.
71. Kroll SS, Coffey Jr JA, Winn RJ, et al. A comparison of factors affecting aesthetic outcomes of TRAM flap breast reconstructions. *Plast Reconstr Surg* 1995;**96**:860—4.
72. Williams JK, Bostwick III J, Bried JT, et al. TRAM flap breast reconstruction after radiation treatment. *Ann Surg* 1995;**221**:756—64.
73. Tran NV, Chang DW, Gupta A, et al. Comparison of immediate and delayed free TRAM flap breast reconstruction in patients receiving postmastectomy radiation therapy. *Plast Reconstr Surg* 2001;**108**:78—82.
74. Munhoz AM, Aldrighi C, Buschpiegel C, et al. The feasibility of sentinel lymph node detection in patients with previous transaxillary implant breast augmentation: preliminary results. *Aesthetic Plast Surg* 2005;**29**:163—8.