Acta Oncologica, 2011; 50: 1045–1052

informa
healthcare

ORIGINAL ARTICLE

The clinical course of immediate breast implant reconstruction after breast cancer

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Abstract

Background. The number of women suitable for breast conserving treatment as well as immediate reconstruction after breast cancer has been increasing, and studies of complications hereafter are needed. *Material and methods*. The cohort was identified in the prospective database of the Danish Registry for Plastic Surgery of the Breast during the period 1999 to 2006; 167 women with 189 immediate breast reconstructions (40 one-stage and 149 two-stage procedures) after breast cancer without a history of radiation therapy. The women were followed for complications until November 2009. Cumulative incidence risks were computed for infection, hematoma, seroma, severe capsular contracture (modified Baker III and IV), extrusion of the implant, implant rupture, asymmetry/displacement of the implant, any complication, and reoperation. In addition, we compared the postoperative course of immediate two-stage procedures with delayed two-stage procedures. *Results*. The overall eight-year risk estimates for the immediate procedures were 76.4% for any complication, 5.3% for severe capsular contracture, 29.5% for displacement/asymmetry of the implant and 40.6% for reoperation. Significantly higher risk for reoperation was observed after immediate one-stage than after two-stage procedures. For immediate two-stage procedures acute complications such as infection, seroma and hematoma were higher in the expansion period than after the second planned surgery. Higher risks for acute complications were observed after immediate than after delayed two-stage procedures. *Conclusion*. Immediate breast implant reconstruction was found to have substantial risks of complications in non-radiated women, which should be considered in the guidance of breast cancer patients before choosing reconstructive procedure.

In Denmark and many other Western countries, immediate breast reconstruction with implants or autologous tissue is becoming more widely used among women undergoing prophylactic mastectomy or among women with in situ or early stage breast cancer [1]. In women with breast cancer, it is important to obtain detailed information about the postoperative clinical course and potential complications associated with immediate reconstruction. Recent studies have not reported a higher incidence of recurrent breast cancer after immediate or delayed breast reconstruction [2,3]. Moreover, women undergoing immediate breast reconstruction have not been found to have delay in adjuvant treatment when compared with women with no reconstruction [4,5].

In Denmark, a nation-wide breast cancer screening program [6] has led to an increase in the number of women suitable for breast conserving treatment as well as immediate reconstruction, since tumours

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(Received 13 March 2011; accepted 8 April 2011)

ISSN 0284-186X print/ISSN 1651-226X online
DOI: 10.3109/0284186X.2011.581690

are being diagnosed at an earlier stage. Using data from the Danish Registry for Plastic Surgery of the Breast, we examined the occurrence of local complications among 167 Danish women without a history of radiation therapy who underwent immediate breast implant reconstruction after mastectomy because of breast cancer between 1999 and 2006. The outcomes were described for both one- and two-stage immediate reconstruction procedures during a follow-up period up to 10.1 years. In addition, we compared the postoperative course of immediate two-stage procedures with similar delayed procedures [7].

Material and methods

Sources of data and study population

Details of the structure and unique resources of the Danish Registry for Plastic Surgery of the Breast have been described previously [8,9]. Briefly, the Registry, established in May 1999, prospectively collects pre-, peri-, and postoperative data for women undergoing cosmetic or reconstructive breast surgery at public hospitals or private clinics of plastic surgery throughout Denmark. After giving written informed consent, women participating in the registration complete a self-administered questionnaire on medical and reproductive history and lifestyle factors. At surgery, the surgeons register date, indication and type of operation, surgical technique, and implant characteristics. At each follow-up visit, the surgeon registers surgical and clinical outcomes, including details on any complication and need for treatment. All data are registered at the patient level by use of the personal identification number, a unique 10-digit number assigned at birth to all Danish citizens encoding information on date of birth and sex. Clinical adverse outcomes recorded in the Registry are infection (both superficial and periprosthetic), wound rupture, hematoma, seroma, skin wrinkling, implant folding, displacement and asymmetry, capsular contracture (modified Baker grade II, III, or IV [10]), sensitivity changes, diagnosed implant rupture, extrusion of the implant and persistent pain in the breast. Reoperations are defined as operations not included in the planned reconstructive procedure, where the implant capsule space is accessed.

A total of 1418 breast implant reconstruction procedures were registered in the Danish Registry for Plastic Surgery of the Breast during the period May 1999 through December 2006 (Figure 1). All public hospital departments performing breast reconstruction (n = 9) during the inclusion period contributed to the registration. Registered information on clinical outcomes following breast reconstruction was supplemented by a thorough medical record review for all but five procedures of the total reconstruction cohort (Figure 1). From the medical records information on any missed events of postoperative complications and reoperations was collected. Further, from the medical records, we retrieved additional information on the method of reconstructive procedure (immediate or delayed) and indication (breast cancer or prophylactic mastectomy). One- and two-stage procedures were defined according to the primary implantation; permanent implant or temporary expander. Only women who received temporary expanders were included in the two-stage group.

In Denmark, the standard procedure in immediate breast implant reconstruction is primarily creation of a full submuscular pocket (below pectoralis major, serratus anterior and upper part of rectus abdominis). However, in some patients this is not feasible and a smaller part of the implant will be subcutaneous. During the study period there was no use of non-autologous material such as dermal matrix. A reconstructive procedure usually involves regularly follow-up visits within the first one to two years including reconstruction of the papilla and subsequent tattoo of the mammilla-area.

For the present study, we identified 528 immediate breast implant reconstruction procedures registered during the inclusion period, 1999–2006 (Figure 1). We excluded 277 procedures following prophylactic mastectomy and 62 procedures with a history of radiation therapy, leaving 189 immediate breast reconstructive procedures with breast cancer in 167 women in the study; 40 one-stage and 149 two-stage procedures. In a previous study, we identified 353 delayed two-stage breast reconstructions in 331 women with breast cancer without radiation therapy [7] (Figure 1).

Information on vital status by November 2009 was obtained from the Central Person Register for all women.

Statistical analyses

Descriptive statistics were computed to describe the implant characteristics for all immediate breast reconstruction procedures.

First, we performed analyses of clinical outcome for all the immediate procedures. In these analyses, the follow-up period started on the date of primary breast implantation and ended on the date of implant exchange due to complications, first event of interest (for the individual outcomes), death, or end of study (November 1, 2009), whichever came first. For the two-stage procedures, any

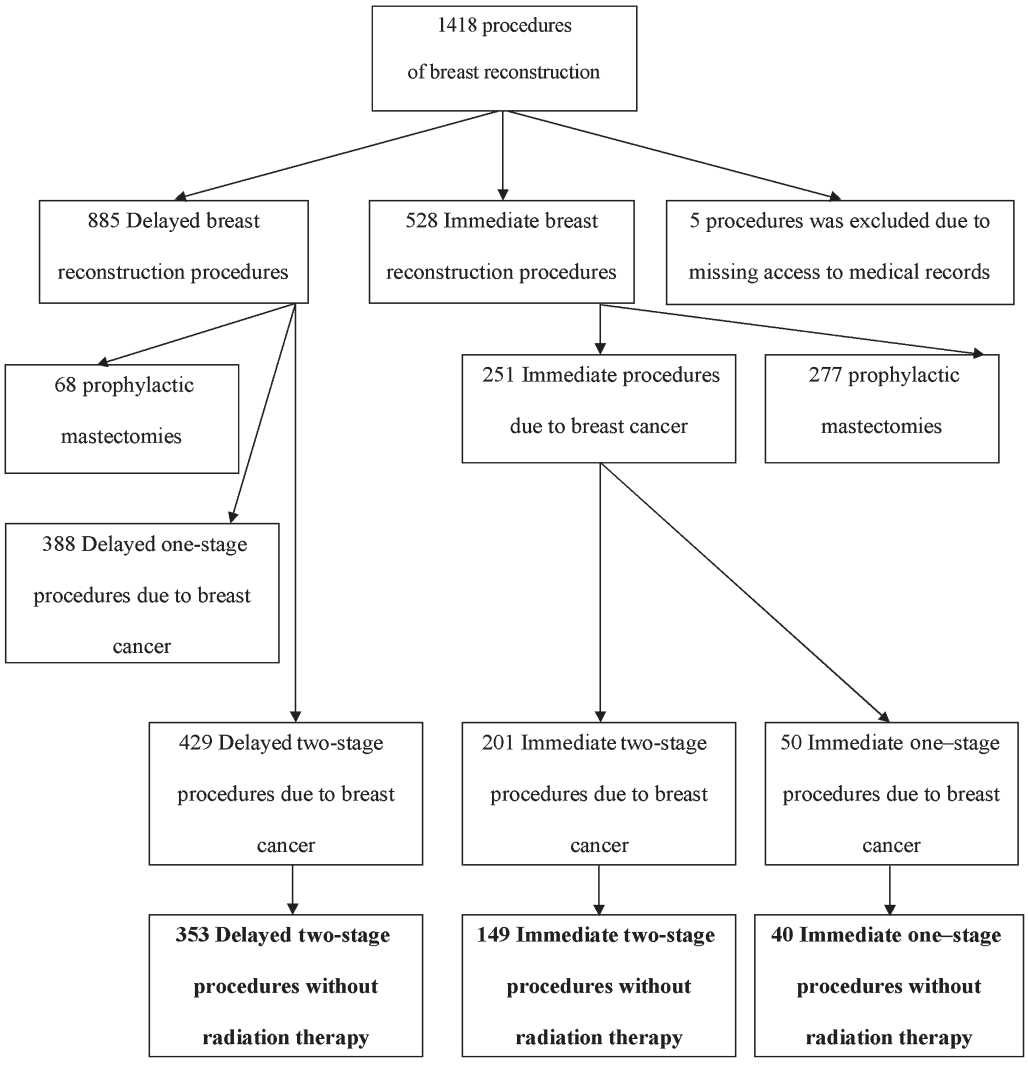

Figure 1. Breast implant reconstructions registered in the Danish Registry for Plastic Surgery of the Breast in the period 1999–2006.

occurrence of complications could be either during the expansion period or after the second surgery. The exchange of the expander to a permanent implant was part of the planned reconstructive procedure and therefore not included as a reoperation in these analyses. Second, we performed analyses for the immediate two-stage procedures divided into the two periods of follow-up; first the expander period, and then the period after the second surgery, in which the expander was exchanged with a permanent implant. In the analyses of the expander period, the follow-up period started on the date of the primary implantation and ended on the date of exchange of the expander to a permanent implant, the first event of interest (for the individual outcomes), exchange or removal of the expander due to complications, the end of the study (November 1, 2009) or death, whichever came first. In the analyses after the second surgery, the follow-up period started on the date for the second surgery and ended on the date of exchange of the implant due to complications, the first event of interest (for the individual outcomes), the end of the study (November 1, 2009) or death, whichever came first.

Estimation of the cumulative incidence of selected adverse outcomes; that is the risk of experiencing an adverse outcome before a given point in time, was performed taking into account the presence of competing risk events [11,12]. The selected outcomes were; any complication, infection (superficial and periprosthetic combined), hematoma, seroma, severe capsular contracture (modified Baker III and IV), extrusion of the implant, rupture and displacement/asymmetry of the implant, as well as for reoperation. "Any complication" included all unintended postoperative adverse events ranging from minor events not requiring treatment to surgery-requiring complications, however, the vast majority being comprised by the above mentioned outcomes. For complications (any or specific complications), reoperations and

death were considered competing risks, for reoperations, only death was considered a competing risk. Cumulative incidence estimates with 95% confidence intervals (CI) were calculated by the use of the SAS macro Greenwood [13], and were computed for the selected outcomes. Estimated cumulative incidence curves for immediate one- and two-stage procedures were compared using a test described by Pepe and Mori [14]. This test was computed using the SAS-macro described by Pintilie [15].

Finally, we computed cumulative incidence curves for the selected outcomes among immediate and delayed two-stage procedures, exploring differences in the risk of the outcomes between these two types of breast implant reconstruction. A similar comparison for one-stage procedures, immediate and delayed, was not performed due to small numbers.

All statistical analyses were performed on implant level with the use of SAS version 9.1 (SAS Institute, Inc.; Cary, NC).

Results

Descriptive data

For the immediate procedures overall, the mean age of the women at breast reconstruction was 47.7 years (range, 24 to 75 years) and the total average follow-up time after the operation was 3.9 years (range, 0 to 10.1 years). For the immediate two-stage procedures the average time between insertion of an expander and replacement with a permanent implant was 7.6 months (range, 3.0 to 18.2 months) (data not shown). All immediate breast reconstructions were performed with submuscularly placed, textured implants and at expander implantation all were performed with the use of drainage and 93% with systemic antibiotics (data not shown). Among the two-stage procedures, second surgery was performed in 125 of 149 breasts prior to censoring or end of study; of the remaining 24 expanders, 12 were removed, three were exchanged by new expanders, four were reoperated and left in situ and five were not exchanged (two due to death) (data not shown). The vast majority of implants were categorised as very cohesive (4th generation) (Table I).

Table I. Characteristics of permanent implants; primary implantation for the one-stage and exchange operation for the two-stage procedures (Implant level).

	One-stage procedures (n = 40)		
	Double lumen expandable[&]	Saline, expandable[§]	Cohesive silicone
McGhan (n = 12)	8 (67%)		4 (33%)
Mentor (n = 17)	8 (47%)	6 (35%)	3 (18%)
Eurosilicone (n = 10)			10 (100%)
Missing (n = 1)			
	Two-stage procedures, permanent implant (n = 125)		
	Cohesive, type I[£]	Cohesive, type II[*]	Cohesive, type III[#]
McGhan (n = 37)		1 (3%)	36 (97%)
Mentor (n = 81)	4 (5%)	1 (1%)	76 (94%)
Eurosilicone (n = 1)		1 (100%)	
Missing (n = 6)			

[&]Saline in inner chamber, silicone in outer.
[§]Saline implants used as expandable implants were of the type Siltex Contour Profile Spectrum.
[£]Cohesive, type I corresponds to McGhan style 110 Responsive Gel, Mentor Silicone Gel Breast Implants Cohesive I.
[*]Cohesive, type II corresponds to McGhan style 410 Soft Touch, Mentor Silicone Gel Breast Implants Cohesive II and Eurosilicone Cristalline Aptex Paragel E.S. 101N.
[#]Cohesive, type III corresponds to McGhan style 410 Cohesive Gel and Mentor Silicone Gel Breast Implants Cohesive III.

Clinical outcomes

Of 189 immediate procedures, 144 procedures (76%) were followed by a complication and 74 (39%) were followed by a reoperation during the follow-up period (Tables II and III). Overall, 10 women (6%) with 12 procedures died, two of whom died before experiencing any complication or reoperation.

The overall risk for any complication after immediate breast reconstruction was 52.4% within the first year increasing to 76.4% within eight years (Table II). Immediate complications, i.e. infection, hematoma and seroma, occurred primarily within the first postoperative year, with risk estimates of 19.0%, 11.1% and 12.2%, respectively (Table II). Of the infections 76% were treated with antibiotics and no surgery, 21% were treated with explantation and 3% were registered with "other treatment". We observed higher risk for seroma after two-stage than after one-stage procedures ($p = 0.051$), whereas the risk for extrusion of the implant was higher after one-stage than after two-stage procedures ($p = 0.023$) (data not shown). No apparent differences were observed between one- and two-stage procedures for the remaining individual outcomes included in Table II, but numbers were small due to the limited size of the one-stage group (data not shown). Within eight years, the overall risk for severe capsular contracture was 5.3%, and that for asymmetry or displacement of the implant was 29.5% (Table II).

Overall, the estimated risk for reoperation within the first postoperative year was 23.3%, increasing to 40.6% within eight years (Table III). A higher risk for reoperation was observed after one-stage than after two-stage procedures ($p = 0.002$) (Table III).

Among the immediate two-stage procedures, we observed most of the acute complications during the

Table II. Cumulative incidence of complications adjusted for competing risks according to time since operation for all immediate implant reconstructions (Implant level, n = 189).

Outcome	N£	1 Year Risk (95% CI)	2 Year Risk (95% CI)	5 Year Risk (95% CI)	8 Year Risk (95% CI)
Any complication**	144	52.4 (48.7;56.0)	67.2 (63.8;70.6)	75.7 (72.6;78.8)	76.4 (73.3;79.5)
Infection¤	38	19.0 (16.2;21.9)	19.6 (16.7;22.5)	20.1 (17.2;23.0)	20.1 (17.2;23.0)
Hematoma	23	11.1 (8.8;13.4)	12.2 (9.8;14.6)	12.2 (9.8;14.6)	12.2 (9.8;14.6)
Seroma	23	12.2 (9.8;14.5)	12.2 (9.8;14.5)	12.2 (9.8;14.5)	12.2 (9.8;14.5)
Capsular Contracture#	10	2.1 (1.1;3.2)	4.2 (2.8;5.7)	5.3 (3.7;7.0)	5.3 (3.7;7.0)
Extrusion of the implant	11	5.8 (4.1;7.5)	5.8 (4.1;7.5)	5.8 (4.1;7.5)	5.8 (4.1;7.5)
Rupture@	3	1.6 (0.7;2.5)	1.6 (0.7;2.5)	1.6 (0.7;2.5)	1.6 (0.7;2.5)
Displacement/asymmetry	55	14.8 (12.2;17.4)	23.8 (20.7;26.9)	28.7 (25.4;32.0)	29.5 (26.1;32.9)

£N is number of events and accounts for all events in the given category.
**Any complication included all registered unintended postoperative adverse events ranging from minor events not requiring treatment to surgery-requiring complications.
¤Including clinical suspicion of both superficial- and periprosthetic infections.
#Capsular contracture includes severe contractures (modified Baker III-IV).
@Rupture is suspicion of implant rupture based on clinical findings.

expansion period, with considerably higher risk estimates for infection, hematoma and seroma after the implantation of the expander compared with following the second surgery. The risk for reoperation after implantation of the expander was 13.5% within six months, and 28.1% within eight years after the second surgery (Table IV).

When comparing overall risk for the various complications between immediate and delayed two-stage procedures (Table V), we observed higher risks for hematoma and seroma after immediate than after delayed reconstruction procedures (p = 0.044 and p = 0.017, respectively). The risk for infection was also higher, although non-significantly after the immediate procedures. No differences were observed in risk for other adverse outcomes, including capsular contracture, asymmetry or displacement of the implant, or reoperation.

Discussion

We observed a substantial risk for complications and reoperations among women without a history of radiation therapy who underwent immediate breast implant reconstruction after breast cancer, during a follow-up period of up to 10.1 years. Overall estimated eight-year risks were 40.6% for reoperation and 76.4% for any complication. We observed considerably higher risk estimates for infection, hematoma and seroma after the expander implantation than after the second surgery. More acute complications were observed after immediate than after delayed two-stage procedures.

Few studies have reported on the long-term postoperative course of immediate breast reconstructions with breast implants stratified according to the period (before and after expander exchange) [16]. The majority of studies reporting on the postoperative course have either been retrospective [17–19], reporting on both delayed and immediate breast reconstructions combined [19–21], with and without flap procedures [19] or with and without radiation therapy [19,22]. The various study designs and mixture of immediate and delayed one- and two-stage reconstructions preclude direct comparisons across studies of complication patterns associated with the various procedures.

In a large prospective study of 1522 two-stage breast implant reconstructions performed from 1992–2004, of which 1176 were immediate, Cordiero and McCarthy [16,23] reported low frequencies of short-term complications both after expander placement and after the exchange procedure. The overall incidence of short-term complications after expander placement was 8.6% after immediate reconstruction compared with 3.8% after delayed reconstruction within 12 months, and 2.7% after the

Table III. Cumulative incidence of reoperation adjusted for competing risks according to time since operation (Implant level)#.

	N£	1 Year Risk (95% CI)	2 Year Risk (95% CI)	5 Year Risk (95% CI)	8 Year Risk (95% CI)
Reoperation, all (n = 189)	74	23.3 (20.2;26.4)	33.9 (30.4;37.3)	38.3 (34.7;41.8)	40.6 (36.8;44.3)
One stage (n = 40)$	23	50.0 (42.1;57.9)	57.5 (49.7;65.3)	57.5 (49.7;65.3)	57.5 (49.7;65.3)
Two stage (n = 149)$	51(19)	16.1 (13.1;19.1)	27.5 (23.9;31.2)	33.2 (29.3;37.0)	36.3 (32.0;40.7)

#Reoperations were defined as operations not included in the planned reconstructive procedure, where the implant capsule space was accessed.
£N is number of events and accounts for all events in the given category within the full study period of 10 years – for two-stage procedures the brackets indicate the part concerning the expander.
$The difference between risk of reoperation for the two procedures was statistically significant, p = 0.002.

Table IV. Cumulative incidence of complications adjusted for competing risks according to time since operation stratified by expansion period and period after second surgery (Implant level).

	Expansion period (N = 149)		Period after second surgery (N = 125)		
Outcome	N[£]	6 Months Risk (95% CI)	N[£]	1 Year Risk (95% CI)	8 Years Risk (95% CI)
Reoperation[#]	19	13.5 (10.3;16.6)	32	16.0 (12.8;19.3)	28.1 (23.5;32.7)
Any complication[**]	72	54.1 (49.0;59.3)	71	40.0 (35.6;44.4)	57.6 (53.1;62.1)
Infection[¤]	24	16.9 (13.7;20.2)	7	4.8 (2.9;6.7)	5.6 (3.5;7.7)
Hematoma	17	11.4 (8.8;14.0)	3	1.6 (0.5;2.7)	2.4 (1.0;3.8)
Seroma	19	12.8 (10.0;15.5)	2	1.6 (0.5;2.7)	1.6 (0.5;2.7)
Capsular Contracture[$]	5	1.8 (0.5;3.2)	4	2.4 (1.0;3.8)	3.2 (1.6;4.8)
Extrusion of the implant	3	2.0 (0.9;3.1)	1	0.8 (0.0;1.6)	0.8 (0.0;1.6)
Rupture[@]	2	1.9 (0.5;3.3)	1	0.8 (0.0;1.6)	0.8 (0.0;1.6)
Displacement/asymmetry	11	13.0 (8.8;17.2)	36	19.2 (15.7;22.7)	29.4 (25.2;33.6)

[£]N is number of events and accounts for all events throughout the period with the expander in place or after second surgery.
[#]Reoperations were defined as operations not included in the planned reconstructive procedure, where the implant capsule space was accessed.
[**]Any complication included all registered unintended postoperative adverse events ranging from minor events not requiring treatment to surgery-requiring complications.
[¤]Including clinical suspicion of both superficial- and periprosthetic infections. For the expander period 75% were treated with antibiotics and no surgery and 21% with explantation, after the second surgery is was 86% and 14%, respectively.
[$]Capsular contracture includes severe contractures only (modified Baker III-IV).
[@]Rupture is suspicion of implant rupture based on clinical finding.

exchange procedure (immediate and delayed pooled) [23]. In their separate report of long-term complications with a minimum follow-up time of one year, Cordiero and McCarthy [16] reported that 18% of the patients had severe capsular contracture and that 4% experienced a reoperation with exchange of the permanent implant [16]. In the present study, we found considerably higher occurrence of overall complications, maybe due to broader definitions, and reoperations for the immediate two-stage procedures in both periods. However, we found a lower risk for severe capsular contracture after the second surgery (5.3%), which may be due to the newer implant generations with textured surface in our study. Differences in surgical technique may also be of importance. The studies by Cordiero and McCarthy [16,23] were based on experiences of a single, senior surgeon, whereas our material included patients from several hospital departments and operations performed by a range of surgeons.

Table V. Cumulative incidence of complications adjusted for competing risks according to time since operation comparing two-stage immediate and two-stage delayed procedures (Implant level).

	Immediate Breast Reconstruction (N = 149)			Delayed Breast Reconstruction (N = 353)			
Outcome	N[£]	1 Year Risk (95% CI)	8 Year Risk (95% CI)	N[£]	1 Year Risk (95% CI)	8 Year Risk (95% CI	p-value
Reoperation[#]	51 (19)	16.1 (13.1;19.1)	36.3 (32.0;40.7)	107 (26)	15.9 (13.9;17.8)	30.5 (28.0;33.0)	0.410
Any complication[**]	113 (72)	51.7 (47.6;55.8)	76.2 (72.6;79.7)	233 (100)	44.5 (41.8;47.1)	67.2 (64.5;69.9)	0.021
Infection[¤]	31 (24)	19.5 (16.2;22.7)	20.8 (17.5;24.1)	51 (34)	13.6 (11.8;15.4)	14.4 (12.6;16.3)	0.099
Hematoma	20 (17)	12.1 (9.4;14.8)	13.4 (10.6;16.2)	25 (18)	7.1 (5.7;8.4)	7.1 (5.7;8.4)	0.044
Seroma	21 (19)	14.1 (11.2;16.9)	14.1 (11.2;16.9)	24 (20)	6.5 (5.2;7.8)	6.5 (5.2;7.8)	0.017
Capsular Contracture[$]	8 (5)	1.3 (0.4;2.3)	5.4 (3.6;7.3)	27 (7)	4.2 (3.2;5.3)	8.2 (6.6;9.8)	0.268
Extrusion of the implant	4 (3)	2.7 (1.4;4.0)	2.7 (1.4;4.0)	11 (10)	3.1 (2.2;4.0)	3.1 (2.2;4.0)	0.765
Rupture[@]	3 (2)	2.0 (0.9;3.2)	2.0 (0.9;3.2)	8 (7)	2.0 (1.2;2.7)	3.4 (1.8;4.9)	0.946
Displacement/asymmetry	43 (11)	13.4 (10.6;16.2)	29.5 (25.6;32.3)	113 (18)	19.0 (16.9;21.1)	32.5 (29.9;35.0)	0.363

[£]Number of events account for all events throughout the full study period after the second surgery. Numbers in brackets indicate the part concerning the expander period for two-stage procedures.
[#]Reoperations were defined as operations not included in the planned reconstructive procedure, where the implant capsule space was accessed.
[**]Any complication included all registered unintended postoperative adverse events ranging from minor events not requiring treatment to surgery-requiring complications.
[¤]Including clinical suspicion of both superficial- and periprosthetic infections. For the immediate procedures 77% were treated with antibiotics and no surgery and 19% with explantation, for the delayed procedures is was 92% and 8%, respectively.
[$]Capsular contracture includes severe contractures (modified Baker III-IV).
[@]Rupture is suspicion of implant rupture based on clinical findings.

Several studies have found higher risk for complications after immediate than after delayed breast reconstructions. In a study of 240 women with 334 reconstructive procedures, Sullivan et al. [19] reported, that capsular contracture and/or malposition of the implant was 5.2 times more likely after immediate than after delayed reconstruction. In a small French, prospective study of 26 immediate and 78 delayed breast reconstructions, Giacalone et al. [24] reported more frequent early and late complications after immediate than after delayed reconstructions. During a mean follow-up time of 4.7 years, the authors observed frequencies of 15.3% for capsular contracture and 26.9% for reoperations following immediate breast reconstruction [24]. In a US prospective study, Alderman et al. [20] reported two-year results for 326 women, of whom 65 had immediate two-stage reconstructions. They observed higher total complication frequencies after immediate (52%) than after delayed two-stage reconstructions (36%) ($p = 0.26$) as well as higher risk for major complications, defined as complications requiring reoperation, re-hospitalisation or intravenous antibiotics [46% versus 21%, respectively ($p = 0.089$)]. We observed significantly higher risk for any complications ($p = 0.021$) after immediate than after delayed procedures, primarily due to the immediate complications, whereas no differences in the risks for reoperation, capsular contracture or asymmetry or displacement of the implant were observed.

The higher complication frequencies after immediate than after delayed breast implant reconstruction could likely be influenced by the mastectomy procedure itself and the longer operative time that is needed. One might suspect a higher risk of contamination of the surgical field during the mastectomy by Staphylococcal organisms. Local complications after mastectomy alone are reported in up to 30% of cases [25].

The Danish Registry for Plastic Surgery of the Breast represents a successful ongoing prospective registry of plastic surgery of the breast in Denmark since 1999. To our knowledge, this registry is the only one of its kind worldwide. The strengths of the present investigation are the prospective study design and the population-based approach based on reports from all departments of plastic surgery in Denmark throughout the study period. This study of a population of unselected women describes the breast reconstructive procedures with breast implants performed by all plastic surgeons reporting to the Registry, as opposed to a study of a single surgeon's or clinic's practice. The multicenter approach broadens the generalisability of the study results. The reconstructive procedures and the implants have changed little during the study period, thus ensuring a relatively homogeneous study population of women with immediate breast implant reconstruction. The main limitation of the Registry is that some underestimation of complications attributable to the passive long-term surveillance cannot be avoided especially for long-term adverse event such as capsular contacture [9]. To minimise underreporting of complications and reoperations, we conducted a thorough medical record review of all women in the study population, thereby obtaining additional information on the postoperative course. These comprehensive follow-up initiatives, and the fact that women with breast reconstruction following breast cancer are under close medical surveillance for several years, suggest that the vast majority of severe and surgery-requiring complications were registered, and we feel confident in the completeness of registration for reoperation in this cohort of breast cancer patients.

In the present study, we computed risk estimates adjusted for competing risks. The date of first reporting of the individual complications was chosen as the date of occurrence, although this was probably only accurate for acute complications. For most complications, notably those occurring after a longer period since implantation, such as capsular contracture, some delay in the diagnosis and reporting is likely, and the incidence estimates will thus be displaced in time. Further, we did not take any potential confounding variables into consideration in this descriptive report of the complication risk pattern following immediate breast reconstruction in women with breast cancer.

In conclusion, mastectomy following breast cancer with immediate breast implant reconstruction in a group of non-irradiated women was found to be associated with substantial risks for complications. Specifically, the risk of acute complications, such as infection, hematoma and seroma, was considerably higher after immediate than after delayed implant reconstruction. Information about potential complications should be considered carefully in the guidance of patients before choosing reconstructive procedure.

Acknowledgements

The authors want to thank Randi Karlsen, project nurse at the DPB for invaluable and dedicated work. We are very grateful to all the surgeons and clinic staff at the public and private clinics who contribute to the continuously central registration. We also want to thank all the participating women for allowing the use of their data and for taking the time to fill in the questionnaires. The Danish Registry for Plastic Surgery of the Breast is partly funded by Mentor Corp, Santa Barbara, USA, and was partly funded by International Epidemiology Institute, Rockville,

Maryland, USA, which in turn received funding from Allergan, Inc. up until the end of 2009. Neither Mentor Corp. nor Allergan, Inc. was involved in any aspect of the study design, data collection, data analysis, data interpretation, writing or review of the manuscript. None of the authors have any conflicts of interest regarding the present study. Dr. McLaughlin has served as a consultant to the Inamed Corporation (now part of Allergan, Inc.) during their application to the FDA for premarket approval of silicone implants.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Kronowitz SJ, Robb GL. Radiation therapy and breast reconstruction: A critical review of the literature. Plast Reconstr Surg 2009;124:395–408.

[2] Hölmich LR, During M, Henriksen TF, Krag C, Tange UB, Kjøller K, et al. Delayed breast reconstruction with implants after invasive breast cancer does not impair prognosis. Ann Plast Surg 2008;61:11–8.

[3] Bezuhly M, Temple C, Sigurdson LJ, Davis RB, Flowerdew G, Cook EF, Jr. Immediate postmastectomy reconstruction is associated with improved breast cancer-specific survival: Evidence and new challenges from the Surveillance, Epidemiology, and End Results database. Cancer 2009; 115:4648–54.

[4] Gouy S, Rouzier R, Missana MC, Atallah D, Youssef O, Barreau-Pouhaer L. Immediate reconstruction after neoadjuvant chemotherapy: Effect on adjuvant treatment starting and survival. Ann Surg Oncol 2005;12:161–6.

[5] Wilson CR, Brown IM, Weiller-Mithoff E, George WD, Doughty JC. Immediate breast reconstruction does not lead to a delay in the delivery of adjuvant chemotherapy. Eur J Surg Oncol 2004;30:624–7.

[6] National Board of Health [Internet]. Cancer incidence in Denmark 2008. Copenhagen, Denmark: National Board of Health; 2010. [cited 2011 Mar 3]. Danish. Available from: http://www.sst.dk/publ/tidsskrifter/nyetal/pdf/2008/14_08.pdf

[7] Hvilsom GB, Hölmich LR, Steding-Jessen M, Frederiksen K, Henriksen TF, Lipworth L, et al. Delayed Breast Implant Reconstruction: A 10-year prospective study; unpublished observations.

[8] Henriksen TF, Hölmich LR, Friis S, McLaughlin JK, Fryzek JP, Høyer AP, et al. The Danish Registry for Plastic Surgery of the Breast: Establishment of a nationwide registry for prospective follow-up, quality assessment, and investigation of breast surgery. Plast Reconstr Surg 2003;111:2182–9.

[9] Hvilsom G, Hölmich L, Henriksen T, Lipworth L, McLaughlin J, Friis S. Local complications after cosmetic breast augmentation: Results from the Danish Registry for Plastic Surgery of the breast. Plast Reconstr Surg 2009; 124:919–25.

[10] Spear SL, Baker JL, Jr. Classification of capsular contracture after prosthetic breast reconstruction. Plast Reconstr Surg 1995;96:1119–23.

[11] Satagopan JM, Ben-Porat L, Berwick M, Robson M, Kutler D, Auerbach AD. A note on competing risks in survival data analysis. Br J Cancer 2004;91:1229–35.

[12] Kalbfleisch JD, Prentice RL. The statistical analysis of failure time data. 2nd ed. Hoboken, NJ: John Wiley & Sons, Inc.; 2002.

[13] Grenwood SAS macro. 2010. [cited 2011 Mar 3]. Available from: http://lib.stat.cmu.edu/general/Markov.sas

[14] Pepe MS, Mori M. Kaplan-Meier, marginal or conditional probability curves in summarizing competing risks failure time data? Stat Med 1993;12:737–51.

[15] Pitilie M. Comparing competing risk between two groups. 2010. 14-4-2010. [cited 2011 Mar 3] Available from: http://www.uhnres.utoronto.ca/labs/hill/datasets/Pintilie/Rfunctions/compCIF.txt

[16] Cordeiro PG, McCarthy CM. A single surgeon's 12-year experience with tissue expander/implant breast reconstruction: Part II. An analysis of long-term complications, aesthetic outcomes, and patient satisfaction. Plast Reconstr Surg 2006;118:832–9.

[17] Francis SH, Ruberg RL, Stevenson KB, Beck CE, Ruppert AS, Harper JT, et al. Independent risk factors for infection in tissue expander breast reconstruction. Plast Reconstr Surg 2009;124:1790–6.

[18] Cordeiro PG, Pusic AL, Disa JJ, McCormick B, VanZee K. Irradiation after immediate tissue expander/implant breast reconstruction: Outcomes, complications, aesthetic results, and satisfaction among 156 patients. Plast Reconstr Surg 2004;113:877–81.

[19] Sullivan SR, Fletcher DR, Isom CD, Isik FF. True incidence of all complications following immediate and delayed breast reconstruction. Plast Reconstr Surg 2008;122: 19–28.

[20] Alderman AK, Wilkins EG, Kim HM, Lowery JC. Complications in postmastectomy breast reconstruction: Two-year results of the Michigan Breast Reconstruction Outcome Study. Plast Reconstr Surg 2002;109:2265–74.

[21] Handel N, Cordray T, Gutierrez J, Jensen JA. A long-term study of outcomes, complications, and patient satisfaction with breast implants. Plast Reconstr Surg 2006;117: 757–67.

[22] Delgado JF, Garcia-Guilarte RF, Palazuelo MR, Mendez JI, Perez CC. Immediate breast reconstruction with direct, anatomic, gel-cohesive, extra-projection prosthesis: 400 cases. Plast Reconstr Surg 2010;125:1599–605.

[23] Cordeiro PG, McCarthy CM. A single surgeon's 12-year experience with tissue expander/implant breast reconstruction: Part I. A prospective analysis of early complications. Plast Reconstr Surg 2006;118:825–31.

[24] Giacalone PL, Rathat G, Daures JP, Benos P, Azria D, Rouleau C. New concept for immediate breast reconstruction for invasive cancers: Feasibility, oncological safety and esthetic outcome of post-neoadjuvant therapy immediate breast reconstruction versus delayed breast reconstruction: A prospective pilot study. Breast Cancer Res Treat 2010;122:439–51.

[25] Vitug AF, Newman LA. Complications in breast surgery. Surg Clin North Am 2007;87:431–51.