Complications Following Expander/Implant-Based Breast Reconstruction Utilizing Acellular Dermal Matrix

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148.1 Introduction

The use of AlloDerm (LifeCell, Branchburg, NJ), an acellular dermal matrix (ADM), in breast reconstruction to facilitate complete coverage of the implant/expander gained popularity in 2005 [1]. The introduction of this biomaterial has made it possible to provide complete tissue expander coverage without dissection of the serratus anterior or rectus abdominis muscle/fascia. In addition, it has been shown that when using ADM, the intraoperative tissue expander fill volume was increased and the total number of expansions needed was decreased [2]. However, ADM use does not come without complications; increased rates of infection and seroma formation have been linked with ADM use [3–5].

Almost a decade following the adoption of ADM in expander/implant breast reconstruction

it is still unclear whether the benefits of its use presents an increased risk of infection and/or seroma formation. The results of most individual studies are oftentimes difficult to interpret. This chapter attempts to clarify complication rates associated with the use of ADM by performing an examination of existing literature and pooling selected outcomes in the form of a meta-analysis. Selected studies were examined for rates of complications in patients undergoing ADM-assisted and conventional expander/implant breast reconstruction. A literature search was performed to select high-quality observational studies that examine the relevant data. Stroup et al. [6] consensus article regarding meta-analyses of observational studies was used in the reporting of methods and results of this study. This method has been validated previously for the reporting of observational studies in the field of plastic and reconstructive surgery [7]. Guidelines compiled specifically for meta-analyses in plastic surgery literature were also followed [8]. The contents of this chapter are an expansion of a meta-analysis previously published by the authors incorporating since published data [9].

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148.2 Search Strategy

One author (I.C.H) conducted all initial searches. PubMed was searched with the keywords, "alloderm", "biocompatible materials", "acellular

dermal matrix", "breast", "expander implant", and "infection" through February 2011. Daily updates of new papers that matched the search criteria were provided by email. In addition, reference lists were scrutinized to find any studies that may have been inadvertently excluded in

the initial search. Abstracts were initially used to select relevant articles utilizing inclusion criteria (Table 148.1). Full-text articles were retrieved and submitted to the exclusion criteria (Table 148.2). A diagram of the initial search process is presented in Fig. 148.1. Since the publication of the original article, daily email updates with articles matching the search criteria were scrutinized for inclusion in a follow-up meta-analysis. This resulted in seven additional articles that met inclusion/exclusion criteria.

Table 148.1 Inclusion criteria

Clinical human study
Post-mastectomy
Breast reconstruction
English language

Table 148.2 Exclusion criteria

Method other than tissue expander/implant breast reconstruction
No comparison between ADM group and control
Previously published data

148.3 Data Extraction

All 15 studies included in the meta-analysis evaluated the rates of complications in ADM-assisted compared to traditional implant/expander breast reconstruction following mastectomy. All data
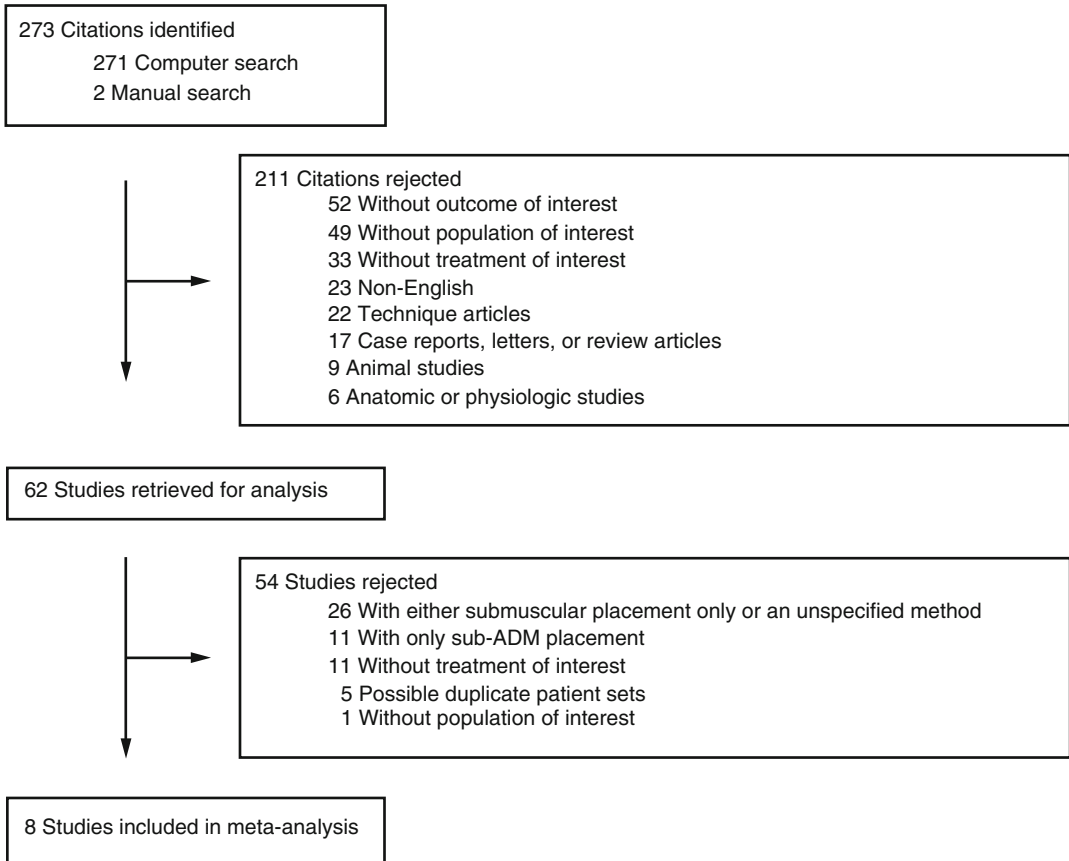
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┌─────────────────────────────────┐
│ 273 Citations identified        │
│        271 Computer search      │
│        2 Manual search          │
└─────────────────────────────────┘

        ┌──────────────────────────────────────────────────────────────┐
        │ 211 Citations rejected                                       │
        │        52 Without outcome of interest                        │
        │        49 Without population of interest                      │
   ───▶ │        33 Without treatment of interest                      │
        │        23 Non-English                                         │
        │        22 Technique articles                                 │
        │        17 Case reports, letters, or review articles          │
        │        9 Animal studies                                      │
        │        6 Anatomic or physiologic studies                     │
        └──────────────────────────────────────────────────────────────┘

┌────────────────────────────────────┐
│ 62 Studies retrieved for analysis  │
└────────────────────────────────────┘

        ┌─────────────────────────────────────────────────────────────────────────┐
        │ 54 Studies rejected                                                     │
        │        26 With either submuscular placement only or an unspecified method│
   ───▶ │        11 With only sub-ADM placement                                   │
        │        11 Without treatment of interest                                  │
        │        5 Possible duplicate patient sets                                 │
        │        1 Without population of interest                                  │
        └─────────────────────────────────────────────────────────────────────────┘

┌────────────────────────────────────┐
│ 8 Studies included in meta-analysis│
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Fig. 148.1 Study acquisition

was extracted directly from each study. Two researchers evaluated and independently extracted data from each study using a standardized form. The researchers were not blinded to the study being examined as this has been shown to be unnecessary [10].

148.4 Statistical Analysis

Statistical analysis was performed utilizing Review Manager ((RevMan) [Computer program]. Version 5.2. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration

2012). A fixed effect model and the Mantel–Haenszel test were utilized to provide pooled odds ratios for the variables under examination.

148.5 Results

Thirteen observational studies and one prospective randomized trial were found to fit the inclusion and exclusion criteria [2–4, 11–21]. One study [5] reported only explantation rates and was only included in that analysis. Table 148.3 provides a summary of the characteristics of each study.

Table 148.3 Characteristics of each study included

Source		No. of breasts	Mean age (year)	Mean body mass index	Infections (%)	Seromas (%)	Hematomas (%)	Explantation (%)
Antony et al.	ADM	153	44.5[a]	23.8	5 (3.3)	11 (7.2)	3 (2.0)	9 (5.8)
	Control	2910	48.1[a]	26.3	38 (1.3)	47 (1.6)	26 (0.9)	55 (1.9)
Chun et al.	ADM	269	47	25.5	24 (8.9)	38 (14.1)	6 (2.2)	16 (5.9)
	Control	146	46.2	23.8	3 (2.1)	4 (2.7)	2 (1.4)	1 (0.7)
Collis et al.	ADM	106	53	NA	NA	NA	NA	6 (5.7)
	Control	68	53	NA	NA	NA	NA	3 (4.4)
Hanna et al.	ADM	38	47.3	28.5	5 (13.2)	6 (15.8)	3 (7.9)	5 (13.2)
	Control	62	54.7	27.4	2 (3.2)	6 (9.7)	2 (3.2)	2 (3.2)
Lanier et al.	ADM	52	51	29.8	15 (28.9)	8 (15.4)	0 (0)	10 (19.2)
	Control	75	50	24.7	9 (12)	5 (6.7)	0 (0)	4 (5.3)
Liu et al.	ADM	266	NA	24.9	18 (6.7)	19 (7.1)	1 (0.4)	13 (4.8)
	Control	204	NA	24.8	5 (2.4)	8 (3.9)	0 (0)	5 (204)
McCarthy et al.	ADM	56	49[a]	NA	3 (5.4)	1 (1.8)	1 (1.8)	1 (1.18)
	Control	50	53[a]	NA	1 (2)	3 (6)	1 (2)	0 (0)
Nahabedian	ADM	100	46	NA	5 (5)	NA	NA	2 (2.0)
	Control	376	NA	NA	22 (5.85)	NA	NA	20 (5.3)
Parks et al.	ADM	346	50.6	26.7	NA	103 (29.9)	NA	40 (11.6)
	Control	165	51.9	26.4	NA	26 (15.7)	NA	14 (8.4)
Peled et al.	ADM	100	48.2	24.6	20 (20)	4 (4)	3 (3)	7 (7)
	Control	90	44.6	23.1	25 (27.8)	4 (4.4)	3 (3.3)	16 (17.8)
Preminger et al.	ADM	45	NA	NA	3 (6.7)	3 (6.7)	1 (2.2)	NA
	Control	45	NA	NA	1 (2.2)	2 (4.4)	0 (0)	NA
Sbitany et al.	ADM	92	48.6	26.4	4 (4.3)	3 (3.3)	NA	4 (4.3)
	Control	84	51.7	28.2	3 (3.6)	3 (3.6)	NA	3 (3.6)
Vardanian et al.	ADM	208	49	23	2 (1)	NA	NA	NA
	Control	129	47	23	3 (2.3)	NA	NA	NA
Weichman et al.	ADM	442	51.08	24.58	60 (13.6)	8 (1.8)	2 (0.5)	34 (7.7)
	Control	186	49.09	23.94	14 (7.5)	6 (3.2)	2 (1.1)	5 (2.7)

Percentages calculated based on total reconstructions
ADM acellular dermal matrix, *BMI* body mass index, *NA* not available
[a]Median

148.6 Included Studies

Antony et al. [13] retrospective comparative study examines immediate 2-stage tissue expander breast reconstruction over a 4 year period at a single institution. In this period, there were 153 breasts included in the ADM group and 2910 breasts included in the control group. The control group was defined as a traditional musculofascial method. Descriptive characteristics are provided in Table 148.4. Notably, the mean BMI for the non-ADM group was lower than the ADM group and the rate of preoperative radiation therapy was higher in the ADM group. No formal comparison between ADM and control groups was performed. Outcomes examined included seroma, cellulitis, hematoma, and premature explantation of the expander. Overall, there was an increased incidence of complications noted in the ADM group. Age, BMI, and axillary dissection were determined to be independent risk factors for development of one or more complications.

Chun et al. [3] retrospective comparative study examines immediate breast reconstruction utilizing tissue expanders or implants over a 6 year period at a single institution. During this period, there were 269 breasts included in the ADM group and 146 breasts in the control group. The control group was defined as expanders/implants with total submuscular coverage or partial submuscular coverage with corresponding partial subcutaneous coverage. Within this group, 68 latissimus dorsi and 1 pedicled transverse rectus abdominis muscle flaps were included because they utilized a tissue expander or an implant. Descriptive characteristics are provided in Table 148.5. Notably, there was a

Table 148.4 Characteristics of Antony et al.

	ADM	Control
Median age	44.5	48.1
Mean BMI	23.8	26.3
Adjuvant/neoadjuvant chemotherapy (%)	45.8	50.1
Preoperative radiation (%)	15.6	11.1
Postoperative radiation (%)	9.4	11.4

ADM acellular dermal matrix, *BMI* body mass index

Table 148.5 Characteristics of Chun et al.

	ADM	Control
Mean age	47	46.2
Mean BMI	25.5	23.8
Preoperative chemotherapy (%)	14.9	8.2
Postoperative chemotherapy (%)	19	30.8
Preoperative radiation (%)	8.7	5.2
Postoperative radiation (%)	8.6	6.5
Mean mastectomy specimen weight (g)	577.2	389.9

ADM acellular dermal matrix, *BMI* body mass index

significant (p=0.002) difference between the BMI of the two groups and the mastectomy specimen (p<0.001) weight of each group. Outcomes examined included hematoma, seroma, necrosis, intraoperative fill volume, and infection. Infection was broken down into minor (successfully treated with outpatient antibiotics) and major infections (required admission), both of which were combined to determine the rate of infection. Overall there was an increased rate of complications in the ADM group. BMI and the use of ADM were determined to be significant risk factors for the development of infection and seroma.

Collis et al. [15] retrospective review examined immediate 2-stage expander/implant breast reconstruction performed over a 4.5 year period at a single institution. During this period there were 106 breasts included in the ADM group and 68 breasts included in the control group. The ADM utilized in this study was of human origin, and not strictly Alloderm. The control group was only defined as those undergoing 2-stage reconstructions without the use of ADM. No mention is made of complete submuscular coverage. The only descriptive characteristics provided were mean age (53 in both groups) and that 100 % of each group was an immediate reconstruction. Outcomes examined included tissue expander dynamics, skin necrosis, seroma, expander malposition, and infection requiring explantation. It was found that a significantly higher intraoperative fill volume was achieved in the ADM group, but that this group was also associated with a higher rate of overall complications. There was no significant difference noted between the groups with regard to explantation.

Table 148.6 Characteristics of Hanna et al.

	ADM	Control
Mean age[a]	47.3	54.7
Mean BMI	28.5	27.4
Obesity (BMI>30) %	22.5	18.1
Hypertension %[a]	16.1	40.9
Smokers %	12.9	25
Diabetics %	16.1	18.1
Steroids %	3.2	4.5
Radiation therapy %	19.3	13.6
Chemotherapy %	35.5	52.2

ADM acellular dermal matrix, *BMI* body mass index
[a]Significant difference noted between groups (p<0.05)

Table 148.7 Characteristics of Lanier et al.

	ADM	Control
Mean age	51	50
Mean BMI	29.8	24.7
Preoperative chemotherapy (%)	11.5	20
Postoperative chemotherapy (%)	51.9	45.3
Preoperative radiation (%)	5.8	9.3
Postoperative radiation (%)	5.8	10.7
Mean mastectomy specimen weight (g)	646	984

ADM acellular dermal matrix, *BMI* body mass index

Table 148.8 Characteristics of Liu et al.

	ADM	Control
Mean BMI	24.9	24.8
Radiation (%)	9.8	10.4
Mean mastectomy specimen weight (g)	526.4	456.9

ADM acellular dermal matrix, *BMI* body mass index

Hanna et al. [16] retrospective review examined 2-stage expander/implant breast reconstructions performed by 2 senior authors over a 4 year period at a single institution. During this period, there were 38 breasts included in the ADM group and 62 breasts included in the control group. The control group was defined as complete submuscular coverage beneath the pectoralis superiorly and the serratus anterior inferiorly. Eleven delayed reconstructions were included in this study. Descriptive characteristics are provided in Table 148.6. Outcomes examined included seroma, hematoma, cellulitis (defined as a minor infection), skin necrosis, wound separation, major infection, infection requiring intravenous antibiotics, and explantation. For the purposes of the meta-analysis infections requiring IV antibiotics were used for the infection variable. No statistical differences were noted between the ADM and control groups with regards to complications. Tissue expander dynamics were also reported, however were not included in the meta-analysis due to the authors' protocol of not inflating the expander intraoperatively in the control group. It was thought that including this would skew the results of the meta-analysis of that variable. An evaluation of patient satisfaction was performed between the 2 groups with no significant difference found.

Lanier et al. [4] retrospective comparative study examines immediate 2-stage tissue expander breast reconstruction over a 3 year period at a single institution. During this period, 52 breasts were included in the ADM group and 75 breasts in the control group. The control group was defined as the creation of a sub-pectoral pocket and a lateral pocket utilizing serratus anterior muscle. Descriptive characteristics are provided in Table 148.7. All characteristics were compared to find significant differences among groups. Significant differences were noted in BMI (p<0.001) and mean breast tissue removed (p=0.005) between groups. Outcomes examined included seroma, hematoma, necrosis requiring revision, capsular contracture, intraoperative fill volume, and cellulitis or infection. Overall there was an increased rate of complications in the ADM group.

Liu et al. [14] retrospective comparative study examines immediate 2-stage tissue expander breast reconstruction over a 5 year period at a single institution. During this period, 266 breasts were included in the ADM group and 204 breasts in the control group. The control group was defined as either total or partial submuscular placement of the expander. Descriptive characteristics are provided in Table 148.8. Significant differences were noted in mean breast tissue removed (p=0.0184). Outcomes included infection, implant removal, skin flap necrosis, seromas, intraoperative fill volume, and hematomas. Overall, complications were higher in the ADM group.

Table 148.9 Characteristics of McCarthy et al.

	ADM	Control
Median age	49	53
Neoadjuvant chemotherapy %	6	6
Adjuvant chemotherapy %	25	30

ADM acellular dermal matrix

Table 148.10 Characteristics of Parks et al.

	ADM	Control
Mean age	50.6	51.9
Mean BMI	26.7	26.4
Diabetic %	6.7	6.6
Smoker %	10.7	10.3
Radiation %	7.8	22.4
Chemotherapy %	40.1	47.2

ADM acellular dermal matrix, *BMI* body mass index

McCarthy et al. [17] multicenter, blinded, randomized controlled trial examined immediate expander/implant reconstruction over a 4 year period at 2 institutions. During this time period 56 breasts were randomized to the ADM group and 50 breasts were randomized to the control group. The control group was defined as submuscular coverage utilizing serratus muscle/fascia and rectus abdominis fascia. Descriptive characteristics are provided in Table 148.9. Outcomes examined included visual analog scale rating throughout expansion, BREAST-Q Physical Wellbeing: Chest and Upper Body Scale scores throughout expansion, narcotic use, tissue expander dynamics, and perioperative complications (hematoma, seroma, infection, premature removal of tissue expander). No difference was found between groups with regards to perioperative and expansion-phase pain, physical wellbeing scores, narcotic use, intraoperative expander fill volume, or perioperative complications. There were significantly fewer percutaneous expansions in the ADM group. This was an incredibly well-designed study that was terminated early due to an interim review that revealed a very small likelihood of discovering a difference between the groups with continued patient enrollment.

Nahabedian [11] retrospective comparative study examines breast reconstruction utilizing prosthetic devices over a period of 11 years. Specifically, this study examined the rates of complications with and without chemotherapy and/or radiation. During this period, 100 breasts were included in the ADM group and 376 breasts were included in the control group. The control group was defined as device placement beneath the pectoralis major and lower mastectomy skin flap. Few descriptive characteristics were included regarding the patients. Outcomes examined included infection, implant removal, and ADM removal. Overall, there was no difference in the rate of complications between groups.

Parks et al. [18] retrospective review examined immediate 2-stage expander/implant breast reconstruction performed over a 10 year period at a single institution. During this period there were 346 breasts in the ADM group and 165 breasts in the control group. There is no description of the control group surgical procedure, but mention is made regarding non-uniformity of surgical technique amongst surgeons. Also of note, all non-ADM reconstructions were performed in the first 4 years followed by all ADM reconstructions in the following 6 years. Descriptive characteristics are provided in Table 148.10. Outcomes examined included tissue expander dynamics, seroma, mastectomy skin necrosis, and loss of tissue expander. A significantly increased rate of seromas was found in the ADM group. Prior radiation, increased intraoperative percentage of tissue expander fill volume, mastectomy flap necrosis, and seroma were all identified as risk factors for tissue expander loss.

Peled et al. [19] prospective cohort study examined immediate 2-stage expander-implant breast reconstruction performed by a single surgeon over a 5 year period at a single institution. During this time period there were 100 breasts in the ADM group and 90 breasts in the control group. The control group was defined as a dual-plane position of the expander without muscular coverage of the inferior pole. The non-ADM group was performed over the course of the first year, and the ADM group was performed over the course of years 2–3 of the study. A 3rd group was included in this study in which ADM was used selectively based on mastectomy skin flap thickness. This group was excluded from the meta-analysis because it failed to separate recon-

Table 148.11 Characteristics of Peled et al.

	ADM	Control
Mean age	48.2	44.6
Mean BMI	24.6	23.1
Diabetics %	6.2	1.6
Smokers %	3.1	3.2
Prior radiation %	9	4.4
Postoperative radiation %	14	23.3
Neoadjuvant chemotherapy %	36	44.4
Adjuvant chemotherapy %	21	23.3
Therapeutic mastectomy %	55	66.7
Prophylactic mastectomy %	45	33.3
Sentinel lymph node biopsy only %	43	45.6
Axillary lymph node biopsy %	19	26.7

ADM acellular dermal matrix, *BMI* body mass index

Table 148.12 Characteristics of Sbitany et al.

	ADM	Control
Mean age	48.6	51.7
Mean BMI	26.4	28.2
Postoperative radiation (%)	12	6

ADM acellular dermal matrix, *BMI* body mass index

structions utilizing ADM. Descriptive characteristics are provided in Table 148.11. Outcomes examined included infection, unplanned return to operating room, skin flap necrosis, expander-implant exposure or loss, seroma, hematoma, and nipple necrosis. It is difficult to interpret the results of this study due to the inclusion of a 3rd cohort of patients, but it appears that infections, return to operating room, and expander loss were decreased in the ADM group. The analysis of the 3rd cohort is important however, in that it implies an individualized approach to selection of ADM use in breast reconstruction.

Preminger et al. [12] matched, retrospective cohort study examines immediate tissue expander implant breast reconstruction over a 2 year period. Matching criteria included median expander size, history of radiation, and indication for mastectomy. Matched cohorts of 45 breasts each were prepared. The control group was defined as creation of a subpectoral pocket with elevation of the serratus anterior and superior rectus abdominis muscle/fascia. Few descriptive characteristics were included regarding the patients, but due to the matched cohort nature of the study it can be assumed that there are likely few differences between groups. Outcomes examined included seroma, hematoma, intraoperative fill volume and cellulitis. For the purposes of the meta-analysis, the rate of cellulitis was used as the rate of infection. Overall, there was no difference in the rate of complications between groups.

Sbitany et al. [2] retrospective comparative study examines tissue expander implant breast reconstruction over a 4 year period. During this period 92 breasts were included in the ADM group and 84 breasts were included in the control group. The control was defined as placement in a subpectoral pocket with elevation of the serratus anterior laterally. Descriptive characteristics are provided in Table 148.12. No significant differences were found between these characteristics. Outcomes examined included seroma, cellulitis, intraoperative fill volume, and infection requiring expander removal. For the purpose of this meta-analysis the rate of cellulitis was used as the rate of infection. Overall, there was no difference in the rate of complications between groups. During the reporting of complications, the authors used the number of patients instead of the number of reconstructions. The decision was made to utilize these values in terms of the number of reconstructions for the purpose of this meta-analysis to avoid discrepancies in reporting.

Vardanian et al. [20] retrospective review examined 2-stage expander/implant breast reconstruction performed over a 9 year period at a single institution. During this period there were 208 breasts in the ADM group and 129 breasts in the control group. The control group was defined as either total or partial submuscular coverage, with a majority of the reconstruction being performed with partial submuscular coverage. Descriptive characteristics are provided in Table 148.13. Of note, 21 reconstructions were performed for indications other than breast cancer, including BRCA mutation, silicone mastitis, and congenital breast asymmetry. Outcomes examined included capsular contracture, inframammary fold problems, bottoming out, rippling, mechanical shift, wound infection, seroma/hematoma, dehiscence, and skin problems. Because seroma and hematoma were tabulated in the same category they were unable to be included within each respective

meta-analysis. It was found that a significantly decreased number of capsular contractures, inframammary fold problems, episodes of bottoming out, rippling, and mechanical shift were associated with the use of ADM. No differences were noted with regard to wound infection, seroma/

Table 148.13 Characteristics of Vardanian et al.

	ADM	Control
Mean age	49	47
Mean BMI	23	23
Smokers %	3	3.4

ADM acellular dermal matrix, *BMI* body mass index

Table 148.14 Characteristics of Weichman et al.

	ADM	Control
Mean age	51.08	49.09
Mean BMI	24.58	23.94
Smoker %	7.4	7.9
Sentinel lymph node biopsy %	30.1	32.2
Axillary lymph node biopsy %	21.9	17.2
Methylene blue used %	36.9	41.9
Neoadjuvant radiation %	7.8	8.7
Neoadjuvant chemotherapy %	14.2	16.7
Adjuvant radiation %	6.4	7.9
Adjuvant chemotherapy %	31.3	28.6
Prophylactic mastectomy %	44.3	36

ADM acellular dermal matrix, *BMI* body mass index

hematoma, dehiscence, or skin problems between groups.

Weichman et al. [21] retrospective review examined immediate 2-stage expander/implant breast reconstruction performed over a 3 year period at a single institution. During this period there were 442 patients in the ADM group and 186 breasts in the control group. The control group was defined as total submuscular coverage with use of a serratus flap and rectus fascia as needed. Descriptive characteristics are provided in Table 148.14. Outcomes examined included tissue expander dynamics, mastectomy flap necrosis, infection, seroma, hematoma, and explantation. It was found that a significantly higher intraoperative fill volume was achieved in the ADM group. The ADM group had significantly higher rates of mastectomy flap necrosis, infection and explantation.

148.7 Meta-analysis of Studies

A forest plot of the odds ratio of infection across all studies is provided in Fig. 148.2, a funnel plot is provided in Fig. 148.3. The meta-analysis reports an increased in rate of infections for the ADM-assisted group (odds ratio of 1.71; 95 %
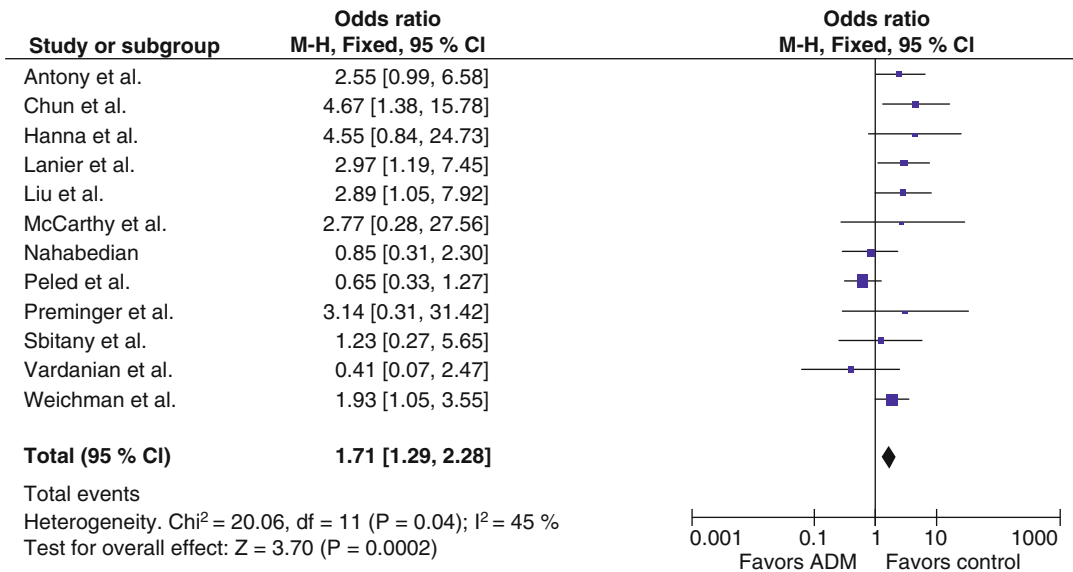

Study or subgroup	Odds ratio M-H, Fixed, 95 % CI
Antony et al.	2.55 [0.99, 6.58]
Chun et al.	4.67 [1.38, 15.78]
Hanna et al.	4.55 [0.84, 24.73]
Lanier et al.	2.97 [1.19, 7.45]
Liu et al.	2.89 [1.05, 7.92]
McCarthy et al.	2.77 [0.28, 27.56]
Nahabedian	0.85 [0.31, 2.30]
Peled et al.	0.65 [0.33, 1.27]
Preminger et al.	3.14 [0.31, 31.42]
Sbitany et al.	1.23 [0.27, 5.65]
Vardanian et al.	0.41 [0.07, 2.47]
Weichman et al.	1.93 [1.05, 3.55]
Total (95 % CI)	**1.71 [1.29, 2.28]**

Total events
Heterogeneity. Chi^2 = 20.06, df = 11 (P = 0.04); I^2 = 45 %
Test for overall effect: Z = 3.70 (P = 0.0002)

Fig. 148.2 Forest plot of rate of infections between groups. *ADM* acellular dermal matrix

confidence interval, 1.29–2.28). A forest plot of the odds ratio of seroma formation across the 11 studies reporting this statistic is provided in Fig. 148.4, a funnel plot is provided in Fig. 148.5. There was over a twofold increase in the incidence of seromas in the ADM-assisted group (odds ratio of 2.14; 95 % confidence interval, 1.61–2.84). A forest plot of the odds ratio of hematoma formation across the nine studies reporting this outcome is provided in Fig. 148.6, a funnel plot is provided in Fig. 148.7. There was no significant difference in the rate of hematoma formation between groups. A forest plot of the odds ratio of tissue expander explantation across

the 13 studies reporting this outcome is provided in Fig. 148.8, a funnel plot is provided in Fig. 148.9. The meta-analysis reports an increased rate of explantations for the ADM-assisted group (odds ratio of 1.77; 95 % confidence interval, 1.32–2.36). A forest plot of the mean difference of intraoperative fill volumes of the tissue expanders is provided in Fig. 148.10, a funnel plot is provided in Fig. 148.11. The meta-analysis reports a mean difference of 94.45 mL (95 % confidence interval, 84.73–104.17)

148.8 Discussion

As breast reconstruction following mastectomy utilizing ADM becomes an acceptable reconstructive option it is important to understand the risks and benefits of its use. In the case of expander/implant breast reconstruction, several variables are important to the end result and ultimately patient satisfaction. These include postoperative complications such as infections, seromas, hematomas, and the rate of expander explantation following one of these complications.

While there is much in the current literature regarding ADM use in expander/implant breast
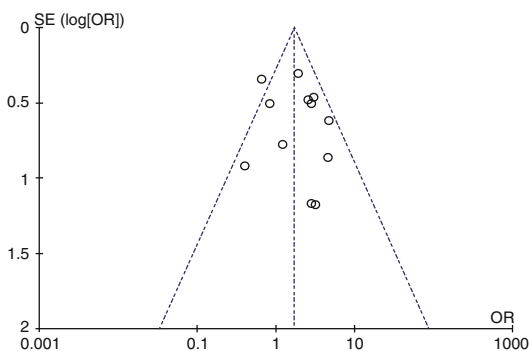

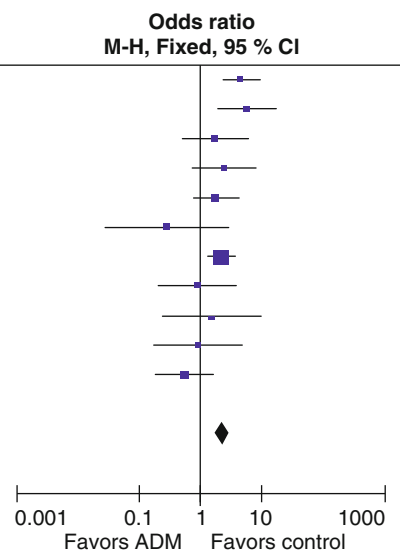**Fig. 148.3** Funnel plot of rate of infections between groups

Fig. 148.4 Forest plot of rate of seromas between groups. *ADM* acellular dermal matrix

reconstruction, the majority focuses on the rates of complications and the dynamics of expansion [1, 22–27]. Unfortunately, most of these publications are case series with no control group.

It is oftentimes difficult to evaluate the results of each individual study due to the presence of confounding factors such as body mass index (BMI), surgeon expertise (both plastic surgeon and breast surgeon), and unclear methods of study design. The 15 studies included in this analysis were dissenting regarding whether complication rates were higher in the ADM group. This presents a problem for the surgeon attempting to determine the true risks and benefits of the use of ADM. It is the goal of this meta-analysis to pool all available data to obtain a clearer picture of the risks inherent with the use of ADM in expander/implant breast reconstruction.

This meta-analysis demonstrates that ADM use in expander/implant reconstruction results in increased rates of infection, seroma, and explantation compared to a control. This is not conceptually difficult to understand given that ADM is a foreign body, despite its biologic properties. Foreign bodies incite an inflammatory reaction that may result in increased rates of infection. This does not preclude the use of ADM in breast reconstruction as the benefits may outweigh the risks reported by this study. These benefits may include decreased postoperative pain and morbidity, decreased operative time, increased initial expander fill volume, and an increased rate of expansion. This meta-analysis showed a significant difference between the ADM group and the control regarding intraoperative fill volume. This may lead to a fewer number of expansions and ultimately greater patient satisfaction.

Weaknesses of this meta-analysis include the introduction of publication bias and a slightly different definition of outcome measurements across studies. Through the meticulous literature search the authors attempted to include all published data on the topic. Unfortunately, researchers are less likely to publish unfavorable results, introducing a degree of bias. An attempt was made to generalize outcome measurements throughout each study as described in each synopsis.

Specific mention is warranted regarding the study performed by McCarthy et al. [17]. This study prospectively evaluated pain and patient
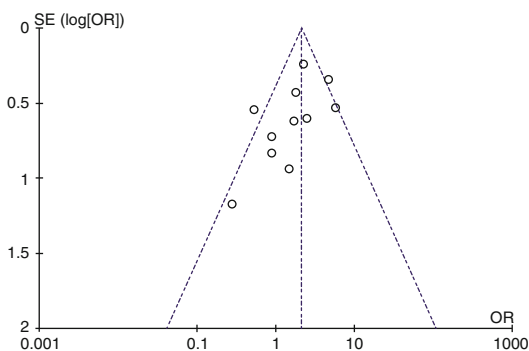

Fig. 148.5 Funnel plot of rate of seromas between groups

Study or subgroup	ADM		Control		Weight	Odds ratio M-H, Fixed, 95 % CI	Odds ratio M-H, Fixed, 95 % CI
	Events	Total	Events	Total			
Antony et al.	3	153	26	2910	17.6%	2.22 [0.66, 7.41]	
Chun et al.	6	269	2	146	17.6%	1.64 [0.33, 8.24]	
Hanna et al.	3	38	2	62	9.7%	2.57 [0.41, 16.14]	
Lanier et al.	0	52	0	75		Not estimable	
Liu et al.	1	266	0	204	3.9%	2.31 [0.09, 57.02]	
McCarthy et al.	1	56	1	50	7.2%	0.89 [0.05, 14.63]	
Peled et al.	3	100	3	90	21.2%	0.90 [0.18, 4.56]	
Preminger et al.	1	45	0	45	3.4%	3.07 [0.12, 77.32]	
Weichman et al.	2	442	2	186	19.4%	0.42 [0.06, 2.99]	
Total (95 % CI)		1421		3768	100.0 %	1.46 [0.75, 2.83]	
Total events	20		36				

Heterogeneity. $Chi^2 = 3.15$, df = 7 (P = 0.87); $I^2 = 0$ %
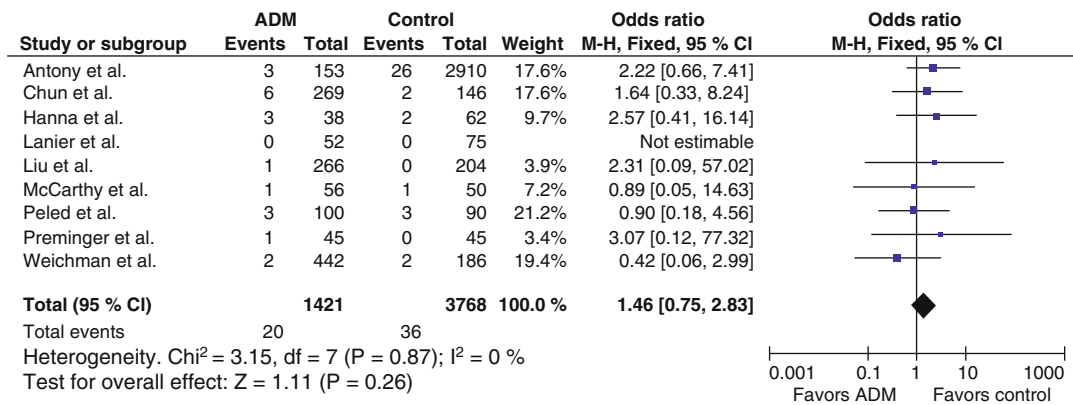Test for overall effect: Z = 1.11 (P = 0.26)

Fig. 148.6 Forest plot of rate of hematomas between groups. *ADM* acellular dermal matrix

satisfaction between groups and found no significant difference. In the ADM-assisted group there were significantly fewer percutaneous expansions, which may ultimately lead to increased patient satisfaction.

Several other studies that were not included deserve mention. Ibrahim et al. [28] examination of the National Surgical Quality Improvement Program database provides a large number of patients undergoing expander/implant breast reconstruction. It is difficult to include a study such as this in a meta-analysis due to the method of recording complications and the lack of infor-

mation regarding treatment. No difference was found in perioperative complications between those undergoing ADM-assisted reconstruction and those [presumably] undergoing traditional reconstruction. Similarly, the study performed by Pannucci et al. [29] examined a large cohort of patients from the Tracking Outcomes and Operations in Plastic Surgery database to determine rate of expander/implant loss in patients undergoing traditional and ADM-assisted breast reconstruction. This data was not included due to several limitations of the study, including the voluntary reporting nature of the database, and difficulties in determining timing of complications. Interestingly this study showed that from 2008 to 2011 there was a significant decrease in expander/implant losses, possibly explained by the learning curve associated with the use of these devices.

As in any reconstructive procedure, the surgeon must use their judgment when deciding on an operative plan. This chapter simply attempts to clear up an intensely debated issue in breast reconstruction. The answer likely lies in individual patient evaluation to determine suitability for placement of ADM. The surgeon should be aware of the possible risks associated with its use and convey this to the patient prior to surgery.
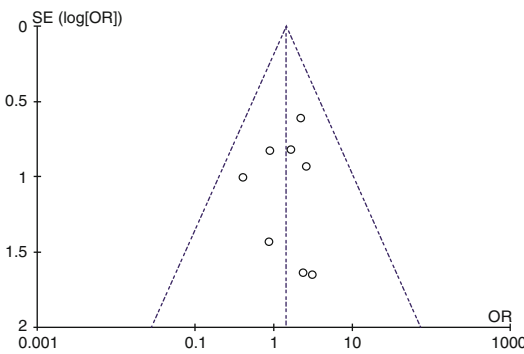

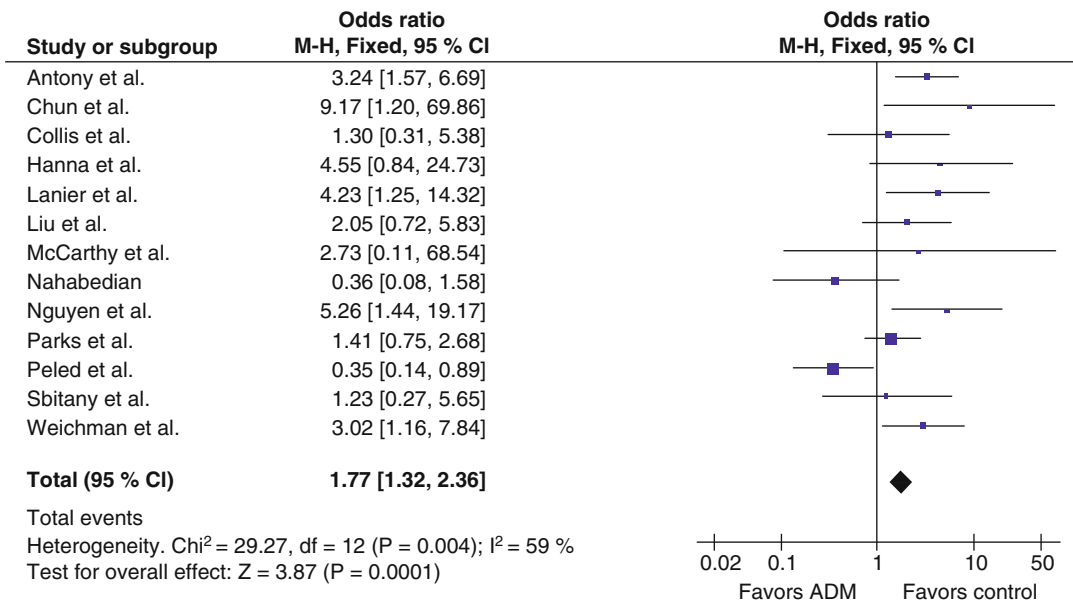**Fig. 148.7** Funnel plot of rate of hematomas between groups

Fig. 148.8 Forest plot of rate of explantations between groups. *ADM* acellular dermal matrix
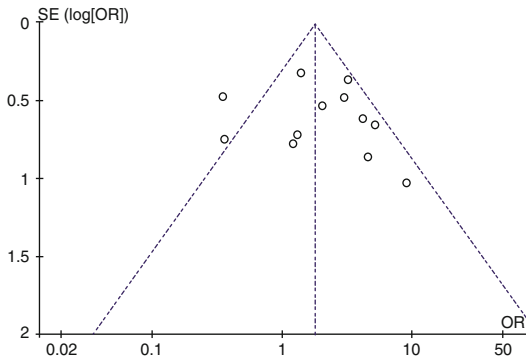
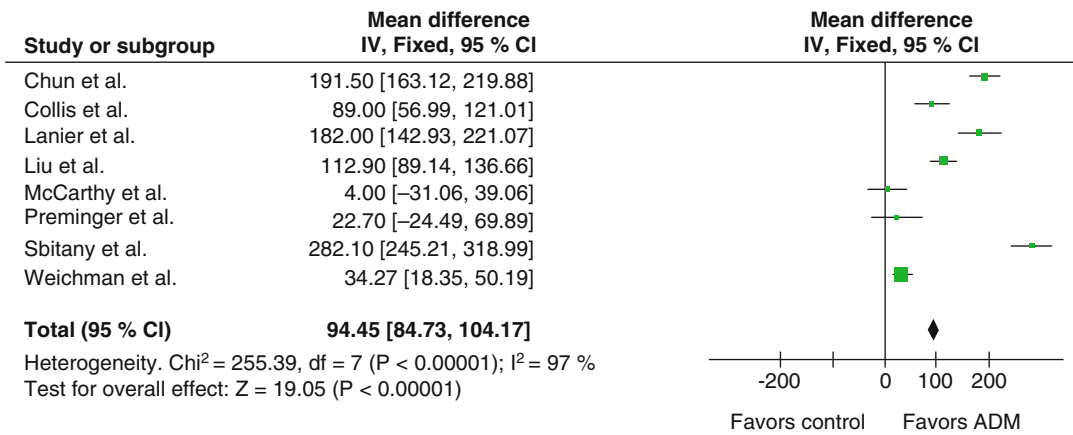**Fig. 148.9** Funnel plot of rate of explantations between groups

Study or subgroup	Mean difference IV, Fixed, 95 % CI	Mean difference IV, Fixed, 95 % CI
Chun et al.	191.50 [163.12, 219.88]	
Collis et al.	89.00 [56.99, 121.01]	
Lanier et al.	182.00 [142.93, 221.07]	
Liu et al.	112.90 [89.14, 136.66]	
McCarthy et al.	4.00 [–31.06, 39.06]	
Preminger et al.	22.70 [–24.49, 69.89]	
Sbitany et al.	282.10 [245.21, 318.99]	
Weichman et al.	34.27 [18.35, 50.19]	
Total (95 % CI)	**94.45 [84.73, 104.17]**	

Heterogeneity. Chi^2 = 255.39, df = 7 (P < 0.00001); I^2 = 97 %
Test for overall effect: Z = 19.05 (P < 0.00001)

Favors control   Favors ADM

Fig. 148.10 Forest plot of mean intraoperative tissue expander fill volume. Mean standard deviation from other studies was used if no standard deviation was provided in the paper. *ADM* acellular dermal matrix
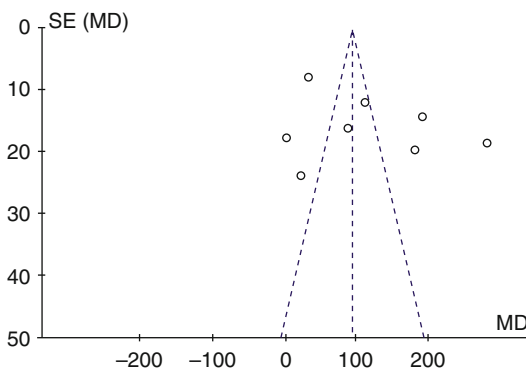

Fig. 148.11 Funnel plot of mean intraoperative tissue expander fill volume between groups

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