



The Use of a Cellular Dermal Matrix (ADM) in Pre-pectoral Implant-Based Breast Reconstruction: A Review of the Literature

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Abstract

Background/Aims: Prepectoral implant-based breast reconstruction with the use of Acellular Dermal Matrix (ADM) has re-emerged as an increasingly popular choice for post-mastectomy breast reconstruction. However, controversy remains regarding complication rates, cosmetic outcomes and patient selection.

Materials and Methods: This review examines the current literature regarding ADM and prepectoral-based breast reconstruction; highlighting technique, complication rates, cosmetic outcome, patient safety and satisfaction, appropriate patient selection, and areas for further research.

Results: This appraisal clearly demonstrates that pre-pectoral breast reconstruction is safe, feasible and has excellent short-term outcomes (cosmesis, complication rates and patient satisfaction). Main advantages include decreased animation deformity, shoulder dysfunction and chronic pain, and possibly a lower incidence of capsular contracture. Notable shortcomings include small population size and lack of long-term follow-up regarding oncological and aesthetic outcomes especially the incidence of rippling. Outcomes establish dependency on patient factors (i.e. BMI, co-morbidities, lifestyle, etc.), breast size, intra-operative flap assessment, and adjuvant radiotherapy. Recent evidence suggests that post mastectomy radiation does not represent a contraindication to this approach. Meshed ADMs seem to be superior to solid ADMs in terms of integration and cost effectiveness.

Conclusion: Short-term outcomes of pre-pectoral ADM-assisted implant-breast reconstruction are promising; however, long-term outcomes are yet to be assessed, requiring further research.

Keywords: Pre-pectoral; Mastectomy; Breast cancer; ADM; Acellular dermal matrix

Introduction

Post-mastectomy breast reconstruction has continued to increase in popularity world-wide. A variety of options are currently available; however, the most common is implant-based reconstruction (40% to 60% in the UK, and 75% in the U.S.) [1-3]. Results have continued to improve as we have seen an evolution in mastectomy techniques; and a move away from the traditional implant-based sub-muscular reconstruction to pre-pectoral (also known as muscle-sparing) reconstruction [4]. The new technique is emerging as a highly popular owing to its more minimal surgical approach. Furthermore, the use of Acellular Dermal Matrix (ADM) has revolutionized implant-based breast reconstruction. The increasing availability of ADM over the past two decades has permitted plastic surgeons to further enhance implant-based reconstruction and develop new protocols allowing for a shorter operative course and improved outcomes [5,6].

Several studies have looked at the effectiveness of pre-pectoral implants with the use of ADM, however, notable shortcomings include small population size and lack of long-term follow-up. The aim of this review is to combine the literature on the safety, efficacy and outcome of prepectoral-based implant reconstruction with the use of ADM; while highlighting areas for further research. Furthermore, we aimed to assess the importance of appropriate patient selection as a major contributor to patient safety, satisfaction, and the prevention of complications.

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Materials and Methods

The Medical Subject Headings (MeSH) terms used to search for relevant papers on PubMed included: “pre-pectoral”, “breast surgery”, “implant”, “breast reconstruction”, “reconstruction”, “reconstructive technique”, “ADM”, “a cellular dermal matrix”, and “mastectomy”. The inclusion criteria for studies which were reviewed include: papers which were recent (2015 to present), contained adult patients only, and were of research level 3 and higher. In total, thirty-two studies were tabulated and comparisons were made in relation to the study (date of publication, study size, age and co-morbidities of participants, and type of study conducted), and outcome (including post-operative complication numbers and rates, patient satisfaction, and cosmetic outcome). Studies with inherent bias or conflict of interest were excluded from comparison.

Results

Advantages

This appraisal clearly demonstrates that pre-pectoral breast reconstruction is safe, feasible and has excellent short-term outcomes (complication rates, cosmesis and patient satisfaction) [1]. The main advantages of a muscle-sparing technique include avoiding animation deformity, being faster and less invasive, preventing shoulder dysfunction, resulting in less post-operative pain, as well as a lower incidence of capsular contracture [1,3]. Additionally, the costs and complications associated with tissue expanders and a second surgery are eliminated [5]. However, this needs to be weighed against the heightened costs associated with complete implant coverage with ADM and possible future fat-transfer procedures.

It is important to note that the pre-pectoral procedure is not suitable for all patients. Selection for the pre-pectoral technique is dependent on patient factors (i.e. body mass index, lifestyle), breast size, flap assessment, and adjuvant radiotherapy [3,7,8]. A well-perfused mastectomy flap is a prerequisite for this procedure in all patients and skin perfusion should be objectively assessed utilizing a tissue perfusion system [9].

Disadvantages

We found significant heterogeneity when reviewing the studies; several contain insufficient patient numbers (either due to lack of enrollment or loss during follow-up), many are retrospective in nature, and lack long-term follow-up which compromises the quality of the evidence. Further limitations include lack of standardised technique, patient selection criteria, variety in types of ADM used, and inconsistent use of pre- and post-op Quality of Life (QoL) and cosmetic validated scoring systems (i.e. BREAST-Q score). The quality is also minimized in the studies where external assessors were not used to critique the aesthetic outcomes.

Discussion

There is a clear need to conduct larger, long-term, prospective studies; with particular attention to appropriate patient selection, complication rates (including oncological outcomes), cosmesis including the incidence of rippling and patient satisfaction. Further research into cost-effectiveness analysis aimed at improving service quality and provision would be highly beneficial. Below, we have described the major influences behind the largely positive findings with PPM and ADM use.

Rationale behind pre-pectoral implant placement

Foremost, the decision to place the implant above the pectoralis muscle is a far less traumatic procedure which circumvents muscle dissection; therefore, significantly decreasing associated nerve damage, haematoma formation, inflammation, and muscle contraction [10]. It is important to note that muscle contraction was found to be an independent risk of implant displacement, malposition and need for subsequent revision. Furthermore, PPM is linked to minimal acute post-operative pain (and almost complete elimination of chronic pain), decreased need for narcotics, faster recovery times, absence of animation deformity and improved, more natural appearing breasts [5,10]. Furthermore, patients have been shown to gain full range of motion much earlier (PPM increasingly being performed as a day-case procedure) in the acute postoperative period. This early use of the upper extremities translates to less patient discomfort, earlier mobility, reducing complications associated with prolonged immobility (i.e. VTE, bed sores, muscle disuse) and resulting in an easier return to baseline function [10].

Patient selection

Although prepectoral breast reconstruction has become increasingly popular, it is not suitable for all patients; and risk-benefit analysis must be carefully considered on a patient-specific basis. However, a majority of research is in agreement regarding desired patient characteristics; including: non-smokers, BMI <35 and >18.5, no history of prior radiotherapy (10-fold increased risk of implant loss), no cardiovascular risk factors or co-morbidities (i.e. HTN, MI, Diabetes, etc), no immunosuppressant medication, and favorable predicted long-term oncological outcome (i.e. excised carcinoma in situ; and lack of metastatic disease) [8,11,12]. Patients with deeply located tumours attached to the underlying pectoralis major muscle should be excluded and considered for the subpectoral approach. Due to the multifold criteria for consideration, the choice of skin incision, thickness of mastectomy flap, access to axillary dissection, should be carefully planned prior to reconstruction [8,12].

Decreased complication rate

The use of ADM in a pre-pectoral approach has become a preferred surgical variable; largely due to more control of the periprosthetic space, providing additional tissue support, and the less anatomically disruptive method inducing less immunological response [13,14]. A growing body of research has identified major factors affecting complication rates; including adequacy of mastectomy skin flap thickness and vascularity, and the aforementioned patient factors affecting both (i.e. BMI, cardiovascular disease, breast size (small breasts in lean patients often provide insufficient flap thickness resulting in skin ischaemia or obvious rippling, etc.) [13].

Different forms of ADM

Several ADMs have come into the market; these products differ in their production process and origin (allogenic and xenogenic donor sources). Therefore, they have different characteristics and behaviors in terms of easy handling, incorporation, shelf life, and costs. An optimal ADM should have collagen and extracellular matrix components and not stimulate immunogenic inflammatory response [3,12]. We have recently reported excellent results with the use of fenestrated ADMs, however head to head comparisons are needed to inform best practice. Current research into histological and ultrasound examinations have shown good integration of the matrix with the subcutaneous tissue. These objective evaluations

have been deemed fundamental to support the innovative concept of subcutaneous positioning of the breast implant [1,12,15].

Mastectomy flap perfusion

Skin vascularity is a critical component of success in any breast reconstruction surgery [7]. This is particularly true of pre-pectoral implant-based reconstruction as the implant is placed closer to the breast skin flaps, and subsequently has less vascularized soft tissue coverage. Serious complications, such as tissue necrosis, can therefore be minimized through the careful patient selection criteria previously mentioned; the use of real-time intraoperative tissue perfusion analysis (i.e. SPY system); and/or (in the absence of perfusion analysis systems) using clinical judgement to appraise tissue flap viability (i.e. capillary refill, thickness of flaps, tissue temperature, etc.); and lastly, making a decision based on these factors regarding appropriate/feasible operative technique [1,5,12,16].

Oncological outcomes

A growing body of evidence has been formed disproving the popular theory that a more conservative approach would comprise oncologic safety; further studies have shown this not to be the case [12,15]. Adjuvant radiotherapy is largely dictated by the tumour histopathology, however, there is currently limited data on toleration of adjuvant radiotherapy and the impact on meshes. A recent study demonstrated that patients undergoing subpectoral breast reconstruction who received Postmastectomy Radiotherapy (PMRT) had a capsular contracture rate three times greater with more severe contractures (Baker grade 3 or 4) than the patients receiving PMRT who underwent prepectoral breast reconstruction [17]. Further research is required in this area, as lack of evidence has resulted in many centres avoiding PPM technique in those requiring immediate post-operative radiotherapy [1,12].

Surgeons undertaking PPM may be subconsciously inclined to create thicker mastectomy flaps to improve the aesthetics, therefore future studies should include the clinical oncological outcome as a primary endpoint.

Economics & cost effectiveness

With the development of any new technique (and given the already stretched current health care environment), consideration must be given to the issues of cost and associated expense when considering the long-term implications. The main cost benefits of this muscle-sparing technique include: significantly lower associated pain and, therefore, post-operative narcotic use; decreased length of stay (by 1-2 days on average, compared to subpectoral); less post-operative expansions and revisional surgery; decreased incidence of capsular contracture; quicker return to work; improved aesthetics and patient satisfaction; earlier/enhanced range of motion, and less physical therapy required [10]. Additional consideration has to be taken regarding financial impact of using a larger sheet of ADM to fully line the breast pocket (on average 3-4 times the magnitude of those used for subpectoral breast reconstruction). Inarguably, a larger sheet of ADM has higher costs which can be reduced by fenestrating the ADM. Fenestrated ADMs increase the surface area of the mesh thus reducing costs and seem to have superior incorporation and integration compared with solid ADMs [18].

However, the costs may be potentially offset by the shorter operative times, and other aforementioned cost benefits; this is an area requiring further investigation [3,10].

Conclusion

Our review of the literature has displayed very promising initial short-term results with PPM reconstruction and the use of ADM; showing that its use is both safe and feasible.

Its main advantages are that it avoids animation deformity, prevents shoulder dysfunction, and has a lower incidence of capsular contracture. However, it may cause rippling, which can require further intervention (eg, lipomodeling), although this is not specific to the prepectoral technique. With its relatively short learning curve and promising short-term outcomes, it appears to be a promising technique. However, further research looking at the long term results is required to assess the oncological and aesthetic outcomes and long-term morbidity which it may be associated with [1,10,11].

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