

Physical Characteristics of SurgiMend Meshed Biological ADM in Immediate Prepectoral Implant Breast Reconstruction

Gerald Gui, FRCS*

Marcus Gui†

Adrian Gui‡

Marios Konstantinos Tasoulis,
MD, PhD, FEBS, CEBS, MFSTEd,
FRCS*§

Summary: With increasing acceptance of prepectoral implant breast reconstruction, there has been a requirement for biological acellular dermal matrices with conformational properties, high tensile strength, and rapid integration. SurgiMendPRS Meshed is a biological acellular dermal matrix derived from fetal calf with these specific characteristics for prepectoral implant breast reconstruction. The aim of this study was to test the performance of this mesh by recreating its surgical use ex-vivo using a variety of implants in an effort to define its physical properties. The mesh is usually attached with a number of interrupted sutures to the implant periphery, the variable being at the inferior border, where it can be attached as a snug fit at the level of the inframammary crease (“tent” technique) or sewn behind the implant, cradling the lower pole (“hammock” technique). The results show mesh elasticity to stretch with increasing implant weight. When used as a “hammock,” greater stretch was demonstrated compared with the “tent” technique, allowing greater degrees of ptosis to be achieved. The suture points demonstrated lines of tension that progress evenly over the anterior implant surface. The mesh performed better when used at maximum stretch, but should not be forcibly stretched over an implant as the lines of stress show uneven distribution of lines of tension. These data provide a structural basis on optimum clinical use of this acellular dermal matrix in prepectoral implant breast reconstruction. (*Plast Reconstr Surg Glob Open* 2022;10:e4369; doi: [10.1097/GOX.0000000000004369](https://doi.org/10.1097/GOX.0000000000004369); Published online 8 June 2022.)

INTRODUCTION

Implant breast reconstruction is the most common method used to recreate a breast mound after mastectomy.¹ Since the introduction of biological acellular dermal matrices (ADM), there has been a shift toward direct-to-implant breast reconstruction, and the current trend is prepectoral placement.² This led to ADM requirements with conformational properties, high tensile strength, and rapid integration. SurgiMend Meshed (SurgiMendPRS Meshed, Integra LifeSciences) was introduced for this purpose, and was granted a CE mark in Europe in 2017. It is derived from fetal calf skin, consisting

of type III collagen, meshed in a 2:1 ratio, packaged as a sterile 20×10 cm freeze-dried sheet, which needs to be rehydrated before use. When fully stretched, the dimensions become 22×18 cm and each mesh rhomboid typically has equal sides of 7 mm, with a diameter between opposing angles of 5 mm.

There have been no publications linking physical characteristics of biological ADMs with clinical application. The mesh is empirically orientated craniocaudally (vertically) such that the expected lines of tension are aligned with the gravitational pull of the implant in the upright patient position. A disadvantage of this orientation is that the width of the stretched ADM may not fit over larger implants.

The aims of this ex-vivo study were as follows:

1. Assess the effect of implant weight on the degree of ADM stretch when used as a “tent” or “hammock;”

Disclosure: G.G. is on Speakers Bureau for Integra Life Sciences and serves as ad hoc Consultant for Johnson & Johnson. The other authors have nothing to disclose. This study did not receive any funding.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

From the *Royal Marsden NHS Foundation Trust, London, UK; †Latymer Upper School, London, UK; ‡Emanuel School, London, UK; and §Division of Breast Cancer Research, The Institute of Cancer Research, London, UK.

Received for publication April 4, 2022; accepted April 20, 2022.

Copyright © 2022 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: [10.1097/GOX.0000000000004369](https://doi.org/10.1097/GOX.0000000000004369)

2. Identify lines of tension in relation to suture placement;
3. Evaluate differences in elastic stretch and tension lines between vertical and horizontal mesh orientation.

METHODS

SurgiMend Meshed was used with 245 cm³, 445 cm³, and 490 cm³ anatomical implants (Polytech, Germany and Mentor, USA). Each mesh was stretched with three sustained pulls following rehydration in normal saline for one minute at room temperature. Adhesive Velcro tape (Velcro SA, Barcelona, Spain) was attached to a flat board that allowed the working base to be stable when flat (to mimic implant position during surgery) and at 90 degrees (the upright patient). Prolene sutures (3/0; Ethicon, Lidingo, Sweden) were used to attach the mesh to the Velcro sheet. Sutures^{2,3} were applied to each of the superior, medial, inferior, and lateral edges. The inferior edge was shaped to fit the implant as a “tent” or a “hammock,” as previously described.³ As a “tent,” the mesh was trimmed to fit the lower implant border, and as a “hammock,” the suture line was posterior to the implant, allowing for the mesh to cradle the lower pole.

The vertical displacement of the implant was measured by a ruler fixed to the board, zeroed from the lowermost point of the implant in the supine position. (See figure 1, Supplemental Digital Content 1, which displays ex-vivo experimental system to recreate the prepectoral pocket of the surgical patient. A flat board working surface was raised to 90 degrees to mimic the upright position of the implant. Measurements were made with the ruler mounted in a fixed position by Velcro. <http://links.lww.com/PRSGO/C54>.)

Measurements were taken 60 seconds after raising the board to 90 degrees. The ADM was then allowed to dry, to show the lines of tension as indicated by the shape of the rhomboids. After 10 hours air drying, the ADM casts provided record of the overall mesh shape and its constituent rhomboids.

For the 445 cm³ implant, experiments were repeated with the mesh orientated in the horizontal plane to compare the impact of gravity with that of vertical orientation.

RESULTS

When the ADM was fully stretched and sutured without laxity (rhomboid diameter 5 mm), the vertical

Table 1. Vertical Displacement with the SurgiMend Meshed ADM Used in Vertical (Cranio-caudal) Orientation when the Board Was Raised to 90 Degrees Comparing the “Tent” and “Hammock” Techniques, with the Mesh Sutured Fully Stretched versus Sutured to Conform to the Implant but with Deliberate Laxity

	ADM Sutured Fully Stretched		ADM Sutured Lax
	“Tent”	“Hammock”	“Tent”
Implant size	Vertical (cranio-caudal) displacement in mm		
245 cm ³	4	7	28
445 cm ³	7	12	41
490 cm ³	12	22	55

Takeaways

Question: To examine ex-vivo physical characteristics of SurgiMend Meshed ADM.

Findings: With the ADM fully stretched, vertical displacement increases with increasing implant size. This is greater with the “hammock” technique. Deliberate ADM laxity creates uncontrolled displacement. ADM orientation does not affect implant support.

Meaning: The “tent” technique should be used to create upright breasts, whilst the “hammock” technique should be employed when a greater degree of ptosis is required. Lax suturing of the ADM would not be recommended unless for specific clinical reasons. Mesh orientation does not affect implant support.

(cranio-caudal) displacement increased with increasing implant size (Table 1). When the ADM was fully stretched but sutured with deliberate laxity (rhomboid diameter 3 mm), the measured vertical displacement was greater than desired (Table 1).

After air drying for 10 hours, the ADM casts were assessed. The final position and shape of the rhomboids demonstrated lines of tensile strength flowing from the supporting sutures reflecting these points of stress (Fig. 1). These tension lines were identical whether the sutures were passed through the rhomboid loops or sutured through a single layer of the mesh edge. Bunching of the ADM resulted in bulky suture points but did not affect the appearance of the rhomboids over the anterior implant surface. (See figure 2, Supplemental Digital Content 2, which displays suturing the mesh. Incorporating several mesh loops within a single suture [on the left side

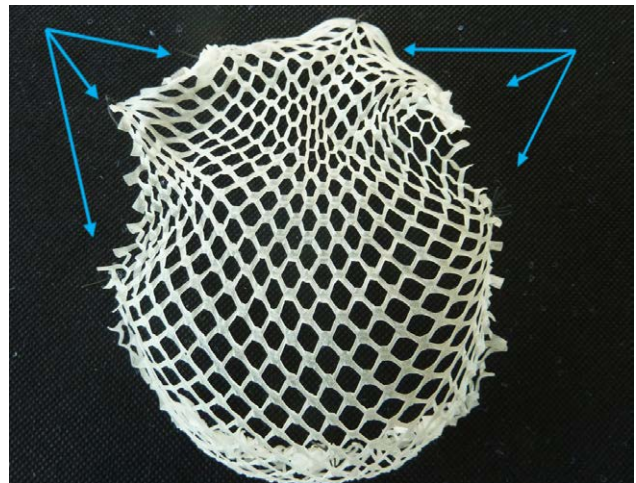


Fig. 1. Photograph of the SurgiMend Meshed ADM cast showing the effect of sutures on the lines of tensile strength as measured by the shape and area of the constituent rhomboids. With the mesh orientated in the vertical axis, the constituent rhomboids area is largest at the tensile strength on the mesh accommodates the contour to the implant anterior surface. The shape of the rhomboids can be seen fanning from the points of suture attachment (blue arrows). In the direction of stretch, the expansion of the rhomboids increase from cranial to caudal and become maximal in the lower pole.

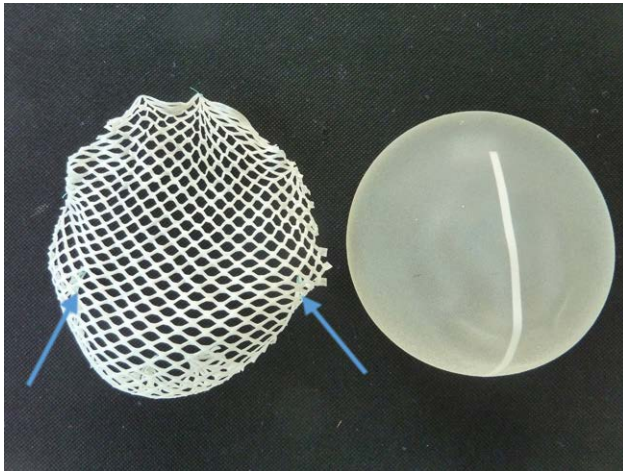


Fig. 2. Appearance of the SurgiMend Meshed ADM cast supporting a 445 cm³ implant with the direction of stretch in the vertical axis. The mesh was forced to fit the implant width: the rhomboid size progression increases craniocaudally but at the line of suture at the equator of the breast, the rhomboid diameter narrows (arrowed to indicate this feature between the arrows) before resuming progressively increasing rhomboid size to the inferior suture line.

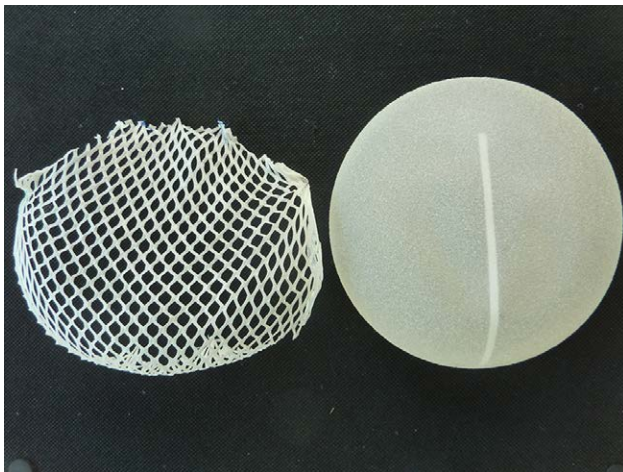


Fig. 3. Appearance of the SurgiMend Meshed ADM cast supporting a 445 cm³ implant, with the direction of stretch in the transverse axis. The mesh comfortably covers the implant in the transverse orientation, demonstrating progressive and even constituent rhomboid progression across the implant surface with no distortion.

of the implant] leaves a “bunched up” heap [blue arrows to indicate], compared with the appearance of careful point suturing through the mesh substance or a single loop [on the right side of the implant—yellow arrows]. <http://links.lww.com/PRSGO/C55>.)

Using the 445 cm³ implant, no difference in vertical displacement was seen if the ADM was orientated vertically or transversely. Using the “tent” technique, vertical ADM orientation resulted in vertical displacement of 7 mm compared with 6 mm with transverse orientation. Corresponding measurements using the “hammock” technique were 13 mm and 12 mm, respectively. The vertically orientated ADM for this implant size needed to be slightly

overstretched to fit the width of the implant, resulting in distortion in the lines of tension caused by the suture lines (Fig. 2) compared with the horizontal orientation (Fig. 3).

DISCUSSION

To our knowledge, this is the first study to provide ex-vivo data on the physical properties of SurgiMend Meshed ADM. With the mesh at full stretch used as a “tent,” there was less vertical displacement than when used as a “hammock.” The “tent” technique should therefore be used to create upright breasts, whereas the “hammock” technique should be used when a greater degree of ptosis is required. When the ADM was sutured lax, vertical displacement was uncontrolled, and therefore this would not be recommended unless there are specific clinical reasons.

Suturing through a single rhomboid loop or through the mesh edge itself produced equivalent results. Suturing the mesh as a “bunched up” entity leaves uneven mounds. In addition, trying to fit the ADM under tension over larger implants causes distortion, pulling on the suture points in an undesired manner, thus disrupting lines of tensile strength over the implant surface.

Vertical or horizontal orientation of the mesh provided equivalent implant support either as a “tent” or as a “hammock.” However, transverse orientation of the mesh allowed coverage of larger implants, with less distortion of the lines of tensile strength.

This ex-vivo study has a number of limitations. Each experiment was conducted once, at room temperature, whereas clinical use of ADM is at body temperature. Moreover, the ex-vivo situation does not reflect biological interactions, including tissue integration. Another limitation is that dehydration in air required measurements to be taken within a few minutes with unreliable effects of dehydration and humidity beyond.

CONCLUSION

These results provide a physical basis on which the clinical application of SurgiMend Meshed ADM can be used with greater confidence.

Marios Konstantinos Tasoulis, MD, PhD, FEBS, CEBS, MFSTEd, FRCS

Breast Surgery Unit
The Royal Marsden NHS Foundation Trust
Fulham Road
London SW3 6JJ, UK
E-mail: marios.tasoulis@rmh.nhs.uk

REFERENCES

1. Leff DR, Bottle A, Mayer E, et al. Trends in immediate postmastectomy breast reconstruction in the United Kingdom. *Plast Reconstr Surg Glob Open*. 2015;3:e507.
2. Tasoulis MK, Iqbal FM, Cawthorn S, et al. Subcutaneous implant breast reconstruction: time to reconsider? *Eur J Surg Oncol*. 2017;43:1636–1646.
3. Gui G, Tsang FJ. ‘Meshed-enhanced hammock’ or ‘tent’: a new patient centred pre-pectoral one-stage immediate breast reconstruction technique for varying ptosis. *Ann Plast Reconstr Surg*. 2019;3:1026.