Received: 16 July 2019 | Revised: 11 September 2019 | Accepted: 13 September 2019

DOI: 10.1111/tbj.13645

ORIGINAL ARTICLE

The Breast Journal WILEY

Skin trophicity improvement by mechanotherapy for lipofilling-based breast reconstruction postradiation therapy

Kais Razzouk MD[1] | Philippe Humbert MD, PhD[2] | Bruno Borens MD[3] | Marie Gozzi[1] | Noor Al Khori MD[4] | Jennifer Pasquier PhD[1] | Arash Rafii Tabrizi MD, PhD[1,5]

[1]Nice Breast Institute, Nice Breast institute, Nice, France

[2]Centre d'Etudes et de Recherche sur le Tégument (CERT), INSERM UMR1098, SFR FED 4234 IBCT, University of Franche-Comté, Besançon, France

[3]Polyclinique Santa Maria, Nice, France

[4]Department of Diagnostic Imaging, Sidra Medicine, Doha, Qatar

[5]Weill Cornell Medicine in Qatar, Education City, Doha, Qatar

Correspondence
Kais Razzouk, Nice Breast institute, 57 bld de la Californie, 06000 Nice, France.
Email: kais.razzouk@gmail.com

Funding information
There was no specific funding for this study.

Abstract

Background: Post-mastectomy irradiation severely impairs skin trophicity resulting in poor prosthetic implant outcome. Autologous fat grafting improves skin quality allowing minimally invasive approach with prosthetic reconstruction. Here, we report our pilot experience of preoperative mechanotherapy to optimize lipofilling and subsequent prosthetic reconstruction outcome.

Methods: We retrospectively included 65 women that had breast reconstruction using autologous fat grafting and implant placement from 2012 to 2018 benefiting or not from mechanotherapy before the reconstructive procedure. Demographic and surgical outcomes were recorded.

Results: The volume of fat injected was significantly superior in the mechanotherapy group compared with the controls for the first and second lipofilling (259.3 mL vs 150.6 mL and 251.8 mL vs 154 mL, respectively). Sixteen patients among controls required a pre-expansion prosthesis compared with none in the endermology group. The prosthesis volume was smaller in the endermology group. Six patients in the endermology group had a reconstruction without prosthesis. The aesthetic score evaluated by patients was 4.8 with no statistically significant difference between the two groups.

Conclusion: Preoperative skin mechanotherapy and postoperative skin mechanotherapy increase skin compliance. It is associated with a higher volume of fat injection and lower prosthesis volume. If confirmed in a prospective study, endermology could become a standard in patients' preparation for lipofilling-based reconstruction.

KEYWORDS

breast reconstruction, irradiated skin, mecanisation, post-mastectomy

1 | INTRODUCTION

Despite the increasing prevalence of lumpectomy for early detected tumors, mastectomy remains a commonly performed procedure.[1,2] Women who undergo mastectomy may choose to have breast reconstruction either with a prosthetic implant, a flap, or a combination of both. Flap-based reconstruction is currently the standard when patients received radiation therapy. Prosthetic outcome in patients with mastectomy and radiation therapy is quite poor and associated with high morbidity rate. Indeed radiation therapy decreases epithelial tissue thickness, worsens blood circulation in dermal tissue, and inhibits regenerative ability of the skin.[3,4] Autologous fat grafting (AFG) or lipofilling has been used for aesthetic and reconstructive indications.[5-10] AFG is a minimally invasive procedure associated with low morbidity and can be used as an autologous filler but also to reverse fibrotic changes and rejuvenate irradiated skin.[9] In order to improve lipofilling outcome, external expansion devices have been developed to prepare recipient site.[11-13]

Endermology is a non-invasive mechanical massaging technique performed with a mechanical device that lifts the skin by means of suction, creates a skin fold, and mobilizes that skin fold. This therapy was introduced to treat traumatic or burn scars.[14-17]

Here, we report our experience using endermology to prepare irradiated skin for autologous fat injection. We illustrate the high efficiency and low morbidity of our minimally invasive approach combining peri-operative skin preparation with prepectoral lipofilling associated with prosthesis-based reconstruction.

2 | METHODS

2.1 | Patients

We included patients who had previously undergone a radical mastectomy followed by external radiotherapy of the chest wall. These patients chose not to undergo flap-based reconstruction or had contraindications to the procedure. Demographic, clinical data, and complications were retrieved. The study was carried out between 2012 and 2018 at the Nord Artois Breast Institute in Lambres les Douai (France) and the Santa Maria Breast Institute in Nice (France). This study was reviewed and approved by the Weill Cornell Medicine in Qatar IRB (Board reference number 19-00014).

2.2 | Skin mobilization with endermology

All 32 women in the control group underwent a reconstruction combining lipofilling and prosthesis placement. All 33 patients in the endermology group were treated by endermology on recipient site before AFG and were operated between 2014 and 2018. Mechanotherapy was delivered with a CelluM6 (LPG, Figure 1) machine by trained physical therapists (Video S1). The following endermology protocol was used:

(i) Preoperative on recipient zone starting 4 weeks before surgery, 2/week: Alliance 50 12-14 hz RC 60/80 Vb 0,6-Vr with PAF 50% then 100% or TR30 roll 12-14 hz-RC 80 depending of the skin status. Each session lasted 45 minutes.

(ii) Postoperative recipient zone starting 21 days after surgery, TR30 roll minutes 10 hz RC30 aspi1 for 4 weeks. Each session lasted 45 minutes.

The patients underwent similar preoperative endermology treatment between the different lipofilling sessions.

2.3 | Reconstruction process

The first step of the reconstruction consisted of a chest wall lipofilling and was carried out in an outpatient setting at least 3 months after the end of radiotherapy. The fat was aspirated using a 3 mm liposuction cannula, connected to a 600-mL Redon vial, and connected to a liposuction device. The fat was then centrifuged 30 seconds at 3000 RPM and injected through multiple passages in different planes. Injections were performed using a 10 mm syringe and a 1.6 mm cannula. Based on the improvement of the recipient site, we decided to proceed with one of the following options:

New session of fat grafting if the recipient site was not thick and mobile enough to allow implant placement.
Placement of a silicone implant if trophicity, thickness, and mobility of the skin were suitable. When required a pre-expansion implant was used.

After the second session of lipofilling, based on the skin evaluation we opted for one of the following options:

Finalizing the reconstruction with a third session of lipofilling.
Placement of a silicone implant.

The implant was always placed in a prepectoral position avoiding pectoralis major dissection.

FIGURE 1 Screenshot taken during a patient's treatment with a CelluM6

2.4 | Statistical analysis

All quantitative data were expressed as mean ± standard error of the mean (SEM). A Shapiro-Wilk normality test, with a $P = .05$ rejection value, was used to test normal distribution of data prior to further analysis. All pairwise multiple comparisons were performed by one-way ANOVA followed by Holm-Sidak post hoc tests for data with normal distribution or by Kruskal-Wallis analysis of variance on ranks followed by Tukey post hoc tests, in case of failed normality test. Paired comparisons were performed by Student's *t* tests. Statistical significance was accepted for $P < .05$ (*).

3 | RESULTS

A total of 65 patients were included in this study (Table 1). All patients in the control group benefited from a silicone implant, 84.6% of them directly after the first lipofilling and the remaining 15.6% received two lipofilling sessions before completing the reconstruction. Among patients benefiting from endermology, 30.3% completed the reconstruction after the first lipofilling, 18.1% of patients completed reconstruction after the second session of lipofilling and 48.4% of the patients required three lipofillings, 37.5% (6/16) of patients among this group did not require prosthesis placement to complete the reconstruction. About 50% of patients in the control group had a pre-expansion prosthesis. The volume of fat injected in the endermology group was significantly higher than the volume of fat injected in the control group for the first and second lipofilling (259.3 mL vs 150.6 mL and 251.8 mL vs 154 mL, respectively). The patient from the endermology group had significantly smaller prosthesis (346.2 mL vs 403.5 mL). The overall follow-up was 22 months (6-48 months).

We had one prosthesis explantation in the control group (immediate postoperative infection). Three patients form the control group had nodular cystic fat necrosis compare with one in the endermology group. One patient in the control group displayed skin necrosis. The average score assessing the aesthetic result by patients was 4.8 with no difference between the two groups (*P*-value >.05).

4 | DISCUSSION

Here, we propose that external mechanotherapy treatment could impact the quality of cutaneous and subcutaneous tissue resulting in improved surgical and cosmetic outcome. The higher volume of fat injected and our ability to perform up to three lipofillings and use smaller prosthesis are supportive of the role of mechanical preparation of the skin. Patients without endermology treatment displayed signs of low skin trophicity such as vessel dilatation, thin skin, and capsular retraction (Figure 2A) while patients with endermology treatment displayed

TABLE 1 Demographic and clinical characteristics of the cohort

Characteristic	Group control n = 32	Group endermo n = 33	*P*-value
Age, y	50.6 (9.7)	56.3 (9.5)	.02*
Delay before first lipofilling	16.7 (13.7)	15.5 (16.2)	.74
Lipofilling fat volume (1st injection), mL	150.6 (58.5)	259.3 (69.9)	<.001*
Lipofilling fat volume (2nd injection), mL	154 (35.7) 5/32	251.8 (44.4) 22/33	.008*
Lipofilling fat volume (3rd injection), mL	0 (0)	245.6 (60.3) 16/33	<.001*
Delay before Prosthesis placement (mo)	3 (1.1)	5.5 (2.3)	<.001*
Prosthesis Volume (1 lipofilling), mL	403.5 (102.9)	346.23 (66.5)	<.01
Prosthesis Volume (2 lipofilling), mL	433 (93)	380 (85.6)	>.05
Pre-expansion prosthesis	16	0	<.001*
Delay between pre-expansion and final Prosthesis placement (mo)	3.7 (1.9)	NA	
Lipofilling alone	0	6	
Complication rate, %	12.5	3	ND
Explant rate (N)	1	0	ND
Oil Cysts (N)	3	1	ND

* indicates the values that are significantly different, *P*-value < .05

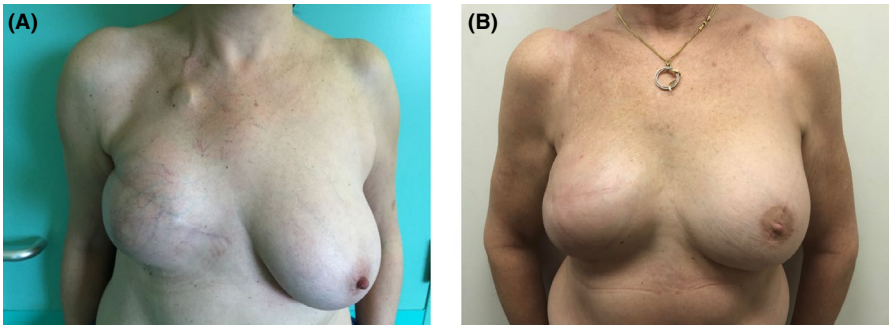

FIGURE 2 Effect of endermology treatment on skin trophicity after reconstruction. A, Patient with one lipofilling session and breast reconstruction without endermology displaying signs of low skin trophicity such as vessel dilatation, thin skin, and capsular retraction. B, Patient with one lipofilling session and breast reconstruction with endermology displaying improved skin trophicity

improved skin trophicity (Figure 2B) possibly leading to better long-term outcome of the lipofilling process.

Prosthetic-based reconstruction is usually contraindicated in patients with chest wall radiation therapy after mastectomy. The tissues are less compliant with skin retraction on the chest wall resulting in high risk of scaring defect or skin necrosis. AFG could be an important adjunct to prepectoral reconstruction, expanding the thickness and enhancing the quality of mastectomy skin flaps. In a recent meta-analysis of 1011 lipofilling-based breast reconstructions in 834 patients, 2.84-4.66 sessions were required to complete reconstruction. The number of fat grafting sessions to complete breast reconstruction was significantly higher for irradiated compared with nonirradiated patients (4.27 vs 2.84 [$P < .05$]). The complication rate was related to radiation therapy with 5.4% in the irradiated group compared with 1.1% in the nonirradiated group (considering only necrosis and ulceration). This is a significant shift from the high rate of complications associated with prosthetic reconstruction without lipofilling.[18] Trophic skin is associated with lower fat resorption rate, better outcome, and less morbidity. Preparation of the recipient site could therefore be essential before breast reconstruction. One could hypothesize that mechanical treatment such as external expansion or endermology might impact the biology of the irradiated tissue and hence initiate an appropriate regenerative niche. Identifying variables that may affect adipocytes and ASCs engraftment could improve further adipocyte survival at recipient site and hence the vascular network and skin trophicity.[19]

There are limitations in this pilot study such as the low number of patients, its retrospective setup, and a short-term follow-up. We do think that a prospective trial should be performed to (a) rigorously evaluate the short- and long-term benefits of endermology in AFG-based reconstruction, (b) establish the endermology protocols, and (c) decipher the biological changes subsequent to the mechanical stimulation of skin cells.

If confirmed in a prospective translational study, a rigorous protocol could be set up to use the regenerative ability of mechanotherapy on irradiated skin. This would allow AFG to become a gold standard for patients requiring minimally invasive reconstruction.

ORCID

Jennifer Pasquier https://orcid.org/0000-0002-2465-7942

REFERENCES

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018;68:394-424.
2. Ferlay J, Colombet M, Soerjomataram I, et al. Cancer incidence and mortality patterns in Europe: estimates for 40 countries and 25 major cancers in 2018. *Eur J Cancer*. 2018;103:356-387.
3. Uda H, Tomioka YK, Sugawara Y, Sarukawa S, Sunaga A. Shaping of the unaffected breast with brava-assisted autologous fat grafting to obtain symmetry after breast reconstruction. *Aesthet Surg J*. 2015;35:565-573.
4. Hymes SR, Strom EA, Fife C. Radiation dermatitis: clinical presentation, pathophysiology, and treatment 2006. *J Am Acad Dermatol*. 2006;54:28-46.
5. Gir P, Brown SA, Oni G, Kashefi N, Mojallal A, Rohrich RJ. Fat grafting: evidence-based review on autologous fat harvesting, processing, reinjection, and storage. *Plast Reconstr Surg*. 2012;130:249-258.
6. Del Vecchio D, Rohrich RJ. A classification of clinical fat grafting: different problems, different solutions. *Plast Reconstr Surg*. 2012;130:511-522.
7. Strong AL, Cederna PS, Rubin JP, Coleman SR, Levi B. The Current state of fat grafting: a review of harvesting, processing, and injection techniques. *Plast Reconstr Surg*. 2015;136:897-912.
8. Petit JY, Lohsiriwat V, Clough KB, et al. The oncologic outcome and immediate surgical complications of lipofilling in breast cancer patients: a multicenter study–Milan-Paris-Lyon experience of 646 lipofilling procedures. *Plast Reconstr Surg*. 2011;128:341-346.
9. Doren EL, Parikh RP, Laronga C, et al. Sequelae of fat grafting post-mastectomy: an algorithm for management of fat necrosis. *Eplasty*. 2012;12:e53.
10. Kronowitz SJ, Mandujano CC, Liu J, et al. Lipofilling of the breast does not increase the risk of recurrence of breast cancer: a matched controlled study. *Plast Reconstr Surg*. 2016;137:385-393.
11. Khouri RK Jr, Khouri RE, Lujan-Hernandez JR, Khouri KR, Lancerotto L, Orgill DP. Diffusion and perfusion: the keys to fat grafting. *Plast Reconstr Surg Glob Open*. 2014;2:e220.
12. Khouri RK, Khouri RK Jr, Rigotti G, et al. Aesthetic applications of brava-assisted megavolume fat grafting to the breasts: a 9-year, 476-patient, multicenter experience. *Plast Reconstr Surg*. 2014;133(4):796-807; discussion 8–9.
13. Mestak O, Mestak J, Bohac M, Edriss A, Sukop A. Breast reconstruction after a bilateral mastectomy using the BRAVA expansion system and fat grafting. *Plast Reconstr Surg Glob Open*. 2013;1:e71.
14. Humbert P, Fanian F, Lihoreau T, et al. Mecano-Stimulation of the skin improves sagging score and induces beneficial functional modification of the fibroblasts: clinical, biological, and histological evaluations. *Clin Interv Aging*. 2015;10:387-403.
15. Bourgeois JF, Gourgou S, Kramar A, Lagarde JM, Guillot B. A randomized, prospective study using the LPG technique in treating radiation-induced skin fibrosis: clinical and profilometric analysis. *Skin Res Technol*. 2008;14:71-76.
16. Lhoest F, Grandjean FX, Heymans O. [Mondor's disease: a complication after breast surgery]. *Ann Chir Plast Esthet*. 2005;50:197-201.
17. Moseley AL, Esplin M, Piller NB, Douglass J. Endermologie (with and without compression bandaging)–a new treatment option for secondary arm lymphedema. *Lymphology*. 2007;40:129-137.
18. Bellini E, Grieco MP, Raposio E. The science behind autologous fat grafting. *Ann Med Surg (Lond)*. 2017;24:65-73.
19. Delay E, Guerid S. The role of fat grafting in breast reconstruction. *Clin Plast Surg*. 2015;42:315-323.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Razzouk K, Humbert P, Borens B, et al. Skin trophicity improvement by mechanotherapy for lipofilling-based breast reconstruction postradiation therapy. *Breast J*. 2019;00:1–4. https://doi.org/10.1111/tbj.13645