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Evaluation of the efficacy of lipotransfer to manage radiation-induced fibrosis and volume defects in head and neck oncology

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Abstract

Background: Multimodality treatment for head and neck cancer leads to substantial functional and esthetic impairment mainly manifested as radiation-induced skin fibrosis (RIF) in combination with volumetric defects and reduction in neck mobility. This study assessed the impact of lipotransfer as part of secondary surgical procedure(s) in patients treated for head and neck malignancies.

Methods: Retrospective analysis was performed between 2005 and 2016. All patients with a history of head and neck malignancy, multimodal treatment including at least surgery or radiotherapy, and at least 2-year disease-free survival were included. Thirty-eight patients (22 men, 16 women) matched the inclusion criteria.

Results: Thirty seven (97%) reported esthetic and functional improvements in their RIF and volumetric defect at follow-up of 32 months. Major improvement in esthetic and functional outcome was reported by 24 (63%) patients and surgeons and minor by 13 patients and surgeons (34%) without causing any complications. Lipotransfer was also found to significantly improve patient's psychological health postoperatively as showed by significant improvements in Derriford Appearance Scale (DAS24), Short Form Health Survey (SF-36), and University of Washington Quality of Life Questionnaire (UW-QOL V4) scores ($P < .001$).

Conclusions: Lipotransfer is effective for volume restoration and treating scar and RIF from head and neck defects.

KEYWORDS

fat grafting, head and neck oncology, lipotransfer, radiation-induced fibrosis, volume defects

1 | INTRODUCTION

Advanced head and neck cancer is typically treated using surgical resection with the inclusion of adjuvant chemotherapy and radiotherapy in most instances.[1] Surgical correction of contour deformities involves reconstruction using pedicle and free flaps.[2] Adjuvant radiotherapy and/or chemotherapy accentuates postoperative fibrosis leading to excessive scar formation with debilitating esthetic and functional outcomes. The restoration of ongoing contour deformities and scar-induced fibrosis remains an ongoing surgical challenge.

Michelle F. Griffin and Jelovac Drago contributed equally to this study.

Radiation therapy is the mainstay of multiple therapeutic regimes for malignant diseases. However, despite its anticancer effects, there are multiple side effects on the normal surrounding host tissue.[1-5] One of the most debilitating and esthetically impairing side effects is radiation-induced skin fibrosis (RIF). RIF is a severe, progressive, and late complication of radiotherapy with a complex pathophysiology mechanism.[3-5] In most tissues, it is characterized by loss of parenchymal cells and excessive formation of fibrous tissue. For decades, it was considered in the literature that the RIF is difficult to manage and has very limited treatment options.[3-7] The condition can occur in many ways including skin induration, loss of skin elasticity, neck immobility, and retraction to severe restrictions in joint movement.[3-5] The current available treatments for RIF are limited and demanding including pharmacotherapy, hyperbaric oxygen therapy, and laser therapy.[3-5] Due to the limited available treatments for reversing RIF, it remains a reconstructive challenge for the surgical field.[3-5]

Autologous fat transfer or lipotransfer for the restoration of soft tissue defects and scar reversal is a commonly utilized reconstructive and cosmetic surgical technique.[8-10] Lipotransfer is considered a useful tool for enhancing the residual contour deformities following free flap reconstruction. However, since Coleman et al in 2006 identified that the lipoaspirate may have regenerative properties, lipotransfer has been explored clinically for the reversal of multiple fibrotic conditions.[8-15] Lipotransfer has also populating the regenerative medicine literature as it has shown to contain an adult stem cell population, known as adipose derived stem cells (ADSCs).[16-18] These adult derived stem cells have the ability to self populate and differentiate into multiple cell types including the bone, cartilage, and adipose tissue. Although the mechanism by which the lipotransfer reverses the fibrosis is unclear, current research is focusing on establishing the effect of the ADSCs within the lipotransfer on several fibrotic conditions.[19-23]

Despite, the multiple references that lipotransfer may reverse fibrosis and provide volume restoration, only a few recent studies have evaluated their use in the reversal of fibrosis and volume loss following head and neck reconstruction. This study retrospectively reports on the effectiveness of lipotransfer for the treatment of RIF and volume restoration following head and neck cancer in thirty-eight patients.

2 | MATERIALS AND METHODS

2.1 | Surgical technique

The adipose tissue from the patient's abdomen was harvested according to the surgical technique described by Sydney Coleman in 2002.[8] Using a 15 cm × 3 mm disposable cannula (Blink Medical, UK) connected to a 10 cc Luer lock syringe, the adipose was harvested from the superficial layer of the subcutaneous fat of the abdomen. Following aspiration, the fat was centrifuged at 3000 rpm for 3 minutes with a central rotor centrifuge. The upper fraction (oil and cellular debris) and lower fraction (fluids and blood) was then discarded. The adipose tissue and progenitor cells from the middle layer were then transferred into 1 mL Luer-Lock syringes connected to a 12 cm × 1.5 mm blunt disposable cannula (Blink Medical). Lipoaspirate was then injected into the recipient site using the Coleman technique using an injecting cannula through a small skin incision (2 mm). The lipoaspirate was injected slowly using multiple passages with withdrawal of the cannula in a retrograde fashion. This study was sponsored by University College London and ethically approved by the REC London Dulwich, REC reference: 16/LO/1603.

2.2 | Patient identification

The inclusion criteria for lipotransfer in patients were: (a) history of advanced head and neck malignancy, (b) multimodal treatment including at least radiotherapy or a combination of surgery and radiotherapy or surgery and chemotherapy, and (c) at least 2-year disease-free survival. Using our in house electronic system at University College London Hospital, London, all patients who had undergone lipotransfer following head and neck irradiation between the years of 2005 and 2016 were identified retrospectively. The following details were extracted from the patient records: (a) patient demographics including age, sex, comorbidities, and medication history; (b) details regarding the type of cancer and previous treatment modalities; (c) lipotransfer operative procedures; (d) overall survival rate and disease-specific survival; and (e) lipotransfer follow-up.

2.3 | Postoperative outcomes following lipotransfer

2.3.1 | Assessment of physical improvement of lipotransfer

The surgeon and patient rated the physical improvement postlipotransfer as either an improvement or no improvement. Improvements were further graded as minor or major. Improvements were considered in terms of their improvement on volume restoration and reversal of scar or RIF.

2.3.2 | Psychological impact of lipotransfer

Patients were sent postquestionnaires following their lipotransfer procedure used to improve their cancer resection volume defect or RIF to investigate the psychological and emotional impact of the lipotransfer intervention compared with their preoperative state. The questionnaires were sent during the last follow-up after their lipotransfer procedure. The assessment included Short Form Health Survey (SF-36), Patient Outcomes of Surgery—head and neck (POS-head/neck), University of Washington Quality of Life Questionnaire (UW-QOL V4), Visual Analog Scales (VAS), and Derriford Appearance Scale. SF-36 is a validated overall indicator of overall health. It is a 10-item questionnaire. The different sections include questions on vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health. The SF-36 has eight scaled scores, which are weighted sums of the questions in each section. Scores range from 0 to 100. Lower scores indicate more disability and higher score less disability. The POS-head/neck score is validated psychometric evaluation of a patient-based outcome measure in plastic surgery for head/neck skin lesions.[24] Preoperative assessment includes six questions relating to physiological functioning and cosmetic appearance prior to treatment. Postoperatively includes nine questions forming two scales, including the same six questions preoperatively, plus a satisfaction scale consisting of three questions. Lower scores indicate low overall health status and higher score better health. Although the questionnaire is used typically to examine the impact of treatment for skin lesions, it was useful in this study to assess the patients' response to the lipotransfer in terms of cosmetic impact and their satisfaction with the treatment. The UW-QOL V4 is a validated tool that provides quality of life data on the physical, functional, and emotional quality of life of the patients with head and neck cancer.[25] It consists of 12 questions covering physical and emotional factors. The 12 questions investigate how the treatment affects their pain, appearance, activity, recreation, swallowing, chewing, speech, shoulder function, taste, salvia production, mood, and anxiety. Low scores indicate low overall health status and higher score better health. The three VAS from 0 to 10 were also used for subjective ratings of noticeability of disfigurement. These scales measure the noticeability of patients' disfigurement perceived to themselves and others. The scales scores are from 0 to 10, with higher rankings showing higher level of noticeability. The three scores are added together to give a final score.[26,27] DAS24 was also used to examine the frequency of avoidant or maladaptive behaviors due to their appearance concern.[28] The DAS24 questionnaire also assesses the negative emotions including fear, social anxiety, and shame the patient may experience due to their facial defect. Higher scores demonstrated higher levels of distress and concern.

2.4 | Statistical analysis

Intercomparisons were analyzed statistically using paired *t* test with nonparametric Wilcoxon test (Prism6 Software). The average and SD was calculated. Graphs are presented with SEM (SE of the mean). Significance was described as $P < .05$. Graphpad was used for graphically representing data.

3 | RESULTS

3.1 | Demographics of the patients

Over the period, 38 patients were identified as having lipotransfer following head and neck ablative surgery and reconstruction. Fifty-three patients underwent lipotransfer in that period of time. However, only 38 patients, 22 men (58%), 16 women (42%), with an average age 51 ± 16.38 (SD) years matched the inclusion criteria as 15 did not have multimodal treatment or a 2-year disease-free survival. Of the 38 patients in the cohort, 1 patient was an active smoker.

3.2 | Details regarding the type of cancer and previous treatment modalities

The primary tumor sites were varied and included the mandible (45% primary bone neoplasm), floor of the month (7.9%), buccal mucosa (2.6%), maxillary mucosa or maxillary antrum (10.5%), nose, cheek, nasolabial fold, or zygomatic region (13.2%), and the submandiblar or parotid gland (10.5%). The mandible represented the commonest site for the primary cancer. The underlying pathology was also varied, with the majority being squamous cell carcinoma (SCC) or adenocarcinoma (46.2%) and sarcoma (43.6%). Other pathologies included lymphoma (2.6%) and pleomorphic adenoma (5.1%). Treatment modalities to treat the tumors included oncological treatment and reconstruction for either soft tissue defect alone or composite defects (Table 1). Regarding the time of reconstruction, all almost all patients (32 of 33) underwent simultaneous ablative and reconstructive surgery. Furthermore, more than half of the patients (20 of 33) with mandibular defects underwent composite free flap reconstruction. Seventeen out of 20 were treated

TABLE 1 Treatment modalities used in this study to treat the tumors of the patients in this cohort

Treatment modality	Groups	Number of patients	%
Specific oncological treatment	Surgery alone	4	10.5
	RT + surgery	17	44.7
	CHT + surgery	10	26.3
	RT + CHT + surgery	7	18.4
Reconstruction	Composite[a]	24	61.5
	Soft tissue	9	23.1

Abbreviations: CHT, chemotherapy; MRND, modified radical neck dissection; RT, radiotherapy.
[a]Composite; soft and bone tissue reconstruction.

with composite fibula free fibula flap, whereas the remaining with Scapula and deep circumflex iliac artery flap. One patient underwent dual flap reconstruction with fibula and radial forearm flap. Defect-oriented approach in reconstruction with appropriate selection of free flaps was used to manage the patients in the cohort.

3.3 | Details of the lipotransfer procedures

The average follow-up of the lipotransfer was 31.53 ± 15.52 (SD) months. The esthetical units of the face and neck have been divided into two following units: face and neck. In order to exactly clarify the recipient site, we defined subunits with regards to the indication: the cheek, mandibular contour, zygomatic region, and neck (Table 2). The majority of lipotransfer was injected into the neck and cheek. Coleman graft was performed as single procedures in 17 (43.6%) and as multiple procedures in 21 patients (55.3%), with the majority requiring between 1 and 2 procedures. An average of 12.52 ± 4.63 (SD) mL was used for lipotransfer injection following an average of 40 ± 4.63 (SD) mL of harvest. Lipotransfer was started an average of 38 ± 4.73 (SD) months post–last radiation or chemotherapy or surgery. There were no complications from the lipotransfer procedure with no infections, wound breakdowns, or hematomas reported.

3.4 | Physical impact of lipotransfer

Of the 38 patients in this study, 37 reported improvements following fat grafting with major improvement in 24 patients (63.2%) and minor improvement in 13 (34%) by both surgeon and patient including esthetic and functional outcome. Figure 1 demonstrates an example of one patient with a major improvement following lipotransfer. The patient who did not respond to lipotransfer was a 45-year-old women who had two treatments of lipografting following SSC of the maxillary mucosa. The comparison of patient demographics and tumor type and management on the outcome of lipografting are shown in Table 3.

TABLE 2 The injection sites of the lipotransfer in this study in unit and subunits

		Number of patients	%
Units	Cheek	21	55.3
	Neck	8	21.1
	Cheek and neck	9	23.7
Subunits	Zygomatic region	2	5.3
	Cheek	9	23.7
	Mandibular contour	1	2.6
	Neck	8	21.1
	Zygomatic region and cheek	2	5.3
	Cheek and mandibular contour	7	18.4
	Cheek and neck	2	5.3
	Mandibular contour and neck	3	7.9
	Cheek and mandibular contour and neck	3	7.9
	All subunits	1	2.6

3.5 | Psychological impact of lipotransfer

Two patients had passed away before questionnaires could be completed postlipotransfer. Thirty-six patients completed the questionnaires at an average follow-up of 33 ± 14.3 (SD) months post–fat grafting. The questionnaire results supported the clinical findings that lipotransfer improved both functional and esthetic outcomes. Within this study cohort, the SF-36 score increased postoperatively demonstrating improvements in physical and mental health of the patient cohort (Table 4). The average UW-QOL V4 and the POS head

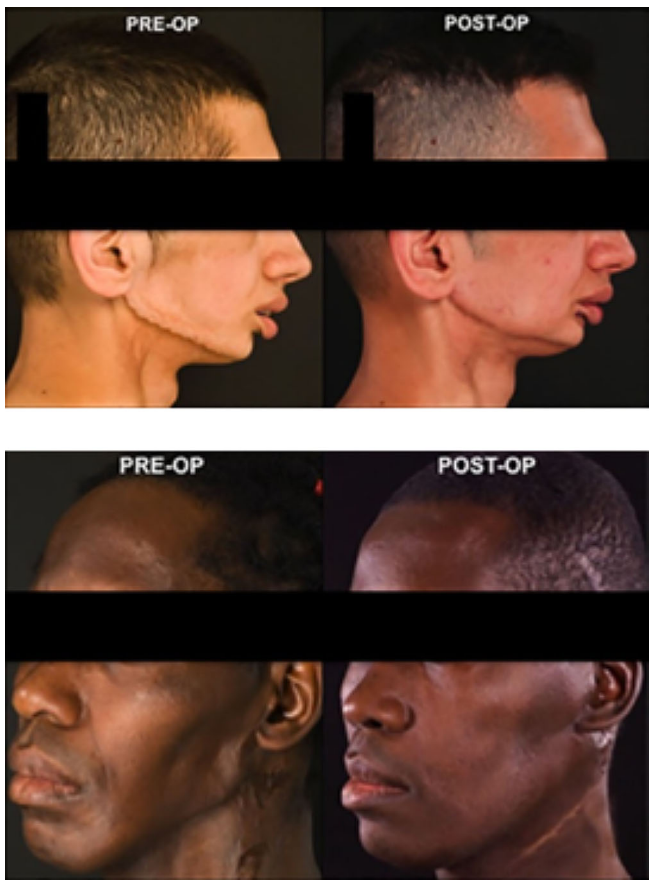

FIGURE 1 Example of patient before and after lipotransfer for radiation-induced fibrosis of the neck. Top, This patient had two episodes of fat transfer 6 months apart. Bottom, This patient had three episodes of fat transfer 6 months apart with an average of 10 mL transferred each time. The follow-up image was recorded 18 months after surgery [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Effect of patient demographics and tumor pathology on the outcome of fat grafting

		Improvements			
		Yes	No	Substantial	Minor
Age group	1-40	20	1	12	8
	40-60	10	0	8	2
	>60	7	0	4	3
Tumor type	SCC or adenocarcinoma	17	1	12	5
	Sarcoma	17	0	12	5
	Lymphoma	1	0	0	1
	Pleomorphic adenoma	2	0	0	2
Primary tumor site	Mandible	21	0	13	8
	FOM, tongue	3	0	3	0
	Buccal mucosa	1	0	1	0
	Maxillary mucosa and antrum	3	1	2	1
	Nose, cheek, nasolabial fold, zygomatic region	5	0	3	2
	Submandibular and parotid gland	4	0	2	2
Treatment modality	Surgery	4	0	2	2
	RT	16	1	11	5
	CHT	10	0	7	3
	RT + CHT	7	0	4	3
Free flap type	Fibular	18	0	11	7
	Radial	7	0	5	2
	ALT	1	0	1	0
	Scapula	1	0	1	0
	DCIA	1	0	1	0
	TDAP	1	1	0	1
	Fibular plus radial	3	0	1	2
Defect localization	Segmental mandibulectomy	20	0	12	8
	Midfacial	6	0	3	3
	Parotid	2	0	1	1
	Maxillectomy	3	1	2	1
	Intraoral	5	0	5	0
	Mandible plus midfacial	1	0	1	0
Defect type	Composite[a]	24	0	15	9
	Soft tissue	8	1	5	3
Single or multiple procedures	Single	17	0	11	6
	Multiple	20	1	13	7
Number of Coleman procedures	1	17	0	11	6
	2	12	1	7	5
	3	3	0	3	0
	4	4	0	2	2
	6	1	0	1	0

(Continues)

TABLE 3 (Continued)

		Improvements			
		Yes	No	Substantial	Minor
Sites	Face	20	1	11	9
	Neck	8	0	6	2
	Face + neck	9	0	7	2
Sites numbered	Zygomatic region	1	1	1	0
	cheek	9	0	5	4
	Mandibular contour	1	0	0	1
	Neck	8	0	6	2
	Zygomatic region and cheek	2	0	1	1
	Cheek and mandibular Contour	7	0	4	3
	Cheek and neck	2	0	2	0
	Mandibular contour and neck	3	0	2	1
	Cheek and mandibular contour and neck	3	0	2	1
	All subunits	1	0	1	0
Number of treated sites—units	1	16	1	10	6
	2	17	0	11	6
	3	3	0	2	1
	4	1	0	1	0

Abbreviations: ALT, anterolateral thigh free flap; CHT, chemotherapy; DCIA, deep circumflex iliac artery flap; FOM, floor of the month; SCC, squamous cell carcinoma; TDAP, thoracodorsal flap; RT, radiotherapy.
[a]Composite; bone + soft tissue defect.

TABLE 4 Results of patient questionnaire to assess psychological and physiological impact before and after lipotransfer

Outcome Score	Before lipofiling	After lipofiling	*P* value
POS head/neck	21.85	54.81	$P < .001$
VAS	26.4	9.4	$P < .0001$
SF-36	Physical functioning 60.86 Role limitations due to physical 60.7 Role Limitations due to emotional 60.5 Energy/fatigue 30.4 Emotional well-being 30.6 Social functioning 45.6 Pain 35.6 General health 40.4	Physical functioning 72.64 Role limitations due to physical 71.81 Role limitations due to emotional 73.72 Energy/fatigue 51.33 Emotional well-being 53.4 Social functioning 66.11 Pain 71.15 General health 54.03.	$P < .05$
DAS-24	63	41	$P < .05$
UW-QOL			
1. Physical	65	81.04	$P < .001$
2. Social emotional	28.96	68.50	$P < .001$

Abbreviations: DAS24, Derriford Appearance Scale; POS, Patient Outcomes of Surgery; SF-36, Short Form Health Survey; UW-QOL, Washington Quality of Life Questionnaire; VAS; Visual Analog Scale.

and neck showed significant improvements following lipotransfer (paired *t* test, $P < .001$; Table 4). All parameters of the UW-QOL V4 score improved postlipotransfer (Supporting Information Table S1). The greatest improvement in symptoms after lipofilling in this cohort was seen with the shoulder (24.72 pre-lipotransfer to 94.72 post-lipotransfer). Following lipotransfer, the VAS pain score significantly decreased from 26.2 to 9.4 (paired *t* test, $P < .0001$). The

DAS24 also decreased significantly postlipotransfer in this cohort (63 prelipotransfer to 41 postlipotransfer, paired *t* test, $P < 0.001$).

3.6 | Survival and recurrence rate

The follow-up period from the patients' initial diagnosis was 10.53 ± 9.15 (SD) years. Thirty-six (94%) patients remained disease free during the interval from their surgery, two patients (5.2%) developed recurrence, and three patients (7.8.%) died from unrelated pulmonary and cardiac-related issues. The overall survival of the cohort was 94% with a disease-specific survival of 100%. Two recurrences were in patients with SCC of the mandible with recurrences found 6 months post–fat grafting for neck fibrosis. Both recurrences were found in the mandibular area and not where the fat was injected.

4 | DISCUSSION

Facial disfigurement is considered to be one of the most distressing aspects of head and neck cancer and its treatment. These consequences in the patients with head and neck oncology could be significant as appropriate treatment require radical tumor excision with wide (safe) margins and mostly free flap reconstruction which produces a lot of scaring. The postoperative radiotherapy together with regular tissue scarring in the head and neck area has an additional impact for the development of severe RIF. In this cohort of patients, we have shown a sustainable improvement in patients' esthetic appearance and function, with all but one patient responding to the fat grafting treatment. We believe this is one of the largest reports demonstrating that lipotransfer can be used to treat radiation and scar fibrosis and volume defects of the skin in the head and neck region following cancer treatment.

One theoretical risk of using lipotransfer in a postcancer bed is recurrence. In our cohort, we observed two recurrences outside where the fat was grafted at an average follow-up of 10 years.[19] Karmali et al reported similar results. They reviewed the use of fat grafting to correct contour deformities in 119 patients post–head and neck reconstruction with average follow-up time of 3 years.[29] Eighty-one percent of the cohort had complementary radiation therapy. Although a larger cohort than this study, only 17 patients were assessed for esthetic outcomes using a five-point Likert scale.[29] All 17 patients demonstrated improvements, and the authors supported the use of lipotransfer for contour defects. In agreement with our study, the six oncologic recurrences of the 119 patients were found outside where the fat was grafted. With a similar follow-up, we can provide further clinical evidence that fat grafting is safe in patients with head and neck tumors. In agreement with Karmali et al, we found that often one or two treatments is required to correct deformities with small volume of fat with a minimal complication rate.

In this cohort of 38 patients, 23 presented with RIF and all of them responded to the lipotransfer treatment. Furthermore, we saw a dramatic increase in the shoulder function as demonstrated by the UW-QOL V4. The increase in shoulder function was due to improvement in the elasticity of the skin and may have enabled other improvement in recreation and activities of daily living. The smaller studies published to date are in line with our results. Gutiérrez Santamaría et al showed that in 12 patients, lipotransfer provided esthetic and functional improvement in 83% and 92% of patients, respectively, without any complications.[30] The patient population was similar with 12 patients developing RIF post–head and neck cancer treatment. Injections sites were similar including the neck, mentalis, lips, soft palate, trachea, mandible, cheek, and hemifacial. A similar study by Phulpin et al including 11 patients reported both an esthetic and functional improvement postlipotransfer. Of the 11 patients, 81.8% showed improvement in esthetic outcomes and 70% demonstrated improvement in functional outcomes after 2 years. Histopathological data also highlighted a decrease in irradiated morphological patterns and high vascular network density.[31] Our study also evaluated the improvement in psychological outcomes following lipotransfer, demonstrating significant improvements in all scores (Table 4). Although some of the scores, for example, DAS-24 postoperatively may have not been within the range of a normal population of approximately 30, this may be accounted for by the cohort's postoperative disease state. Furthermore, this highlights that a wide range of questionnaires are required to assess the psychological aspect of the lipotransfer treatment to fully understand the effect of the lipotransfer.

Lastly, Rigotti et al similarly reported in 20 patients that lipotransfer was effective in reversing the effects of radiation side effects following breast surgery.[32] The cohort consisted of patients with fibrosis following radiotherapy to the breast, chest, and supraclavicular region. Ultrasound of the targeted tissue exhibited progressive regeneration, including neovessel formation and improved hydration. Clinical outcomes showed a dramatic improvement and remission of symptoms in all patients after lipotransfer. Rigotti et al reported a linear relationship between clinical improvement and the number of injections used.[32] The authors claimed that the healing of the tissue microangiopathy increased as a function of the total number of stem cells.[32] In our series, we observed no correlation between the number of injections and the effectiveness of the surgery. The difference between the studies could be due to the differences in the patient population evaluated. Our study focused on RIF following head and neck cancer, whereas Rigotti et al was evaluating patients following breast surgery.

The Coleman technique for lipotransfer utilized in this report is a well-established reconstructive and cosmetic technique to restore soft tissue deformities and contours. Optimizing every step in lipotransfer is important to prevent potential complications such as bruising, swelling, and hematoma formation.[33] The fat harvesting and fat processing are key steps in the lipotransfer that can affect the quality of the outcome.[33-35] As described by Coleman et al, we advocate centrifugation of 3000 rpm for 3 minutes to isolate the fat.[10] Due the entire lipotransfer process being completed within the operating room and an already established surgical technique, lipotransfer could easily become an established technique for RIF. In agreement with other studies, using lipotransfer for head and neck reconstruction, we reported no complications, providing further evidence for the use of this technique.

Preclinical studies to explain our findings are limited. Several studies are investigating the effect of ADSCs within the lipoaspirate on dermal fibrosis. Luan et al demonstrated using an in vitro model that supplementing fat grafts with additional ADSCs may also augment the regenerative effect on radiation-damaged skin.[36] Cell-assisted lipotransfer was used to enhance fat graft volume retention when placed beneath the irradiated scalps of immunocompromised mice.[36] Histological analysis revealed that the fat graft survived and had improved structural qualities and vascularity.[36] Furthermore, there was rehabilitation of the radiation-induced soft tissue with improved dermal thickness, collagen content, skin vascularity, and biomechanical properties.[36] ADSCs have also shown to improve the wound healing following RIF in a mini-pig model.[37] However, despite the convincing preclinical studies demonstrating reversal of fibrosis using lipotransfer, the mechanism by which it works is still unclear. We have recently performed a systemic review demonstrating the lack of evidence to ascertain the way in which lipotransfer reverses RIF.[19] Hypotheses to date are several. The three main current streams of exploration include modulation of transforming growth factor beta-1, improvement in angiogenesis, and alteration of the patient's immune response.[19]

This study has its limitations. This study was a retrospective unblinded nonrandomized trial. The questionnaires were collected retrospectively as provided to the patient cohort following their lipotransfer after their cancer resection, which may introduce recall bias. Furthermore, the questionnaires used were not specific for analyzing lipotransfer but assess the patients overall psychological and emotional state during their head and neck cancer. However, as a wide range of validated patient reported outcome measures were used in the study, which showed improvement in the psychological impact of the cohort, these data can be used as a foundation for understanding the impact of lipotransfer for head and neck defects and RIF. In addition, the surgeon and patient improvement scale was limited due to being retrospectively collected. Future studies should use a scale to ascertain the degree of improvement by the lipotransfer procedures. Future work will now include performing a randomized control trial to evaluate our technique compared with patients untreated with lipotransfer to ascertain the true efficacy of the technique to overcome these limitations. Moreover, histological analysis will be carried out during this work to elucidate the mechanisms by which lipotransfer can reverse fibrosis. Our outcome measures in this study were patient focused, which demonstrated significant increases in patient activities and well-being. Future work should now aim to establish more robust noninvasive methodology to assess the effects of lipotransfer following RIF to understand the mechanism by which it works.

5 | CONCLUSION

We have effectively shown that lipotransfer is an effective treatment for fibrosis and volume restoration post–head and neck reconstruction. Our technique is reproducible, safe, and provides both esthetic and functional improvements. This procedure could be considered in all patients with head and neck cancer who are at least 2 years disease free after oncological treatment (free flaps and radiotherapy) with signs of RIF or scar-induced fibrosis. Further refinement of the technique is possible following the exploration of the mechanisms by which lipotransfer reverses radiotherapy and scar-induced fibrosis.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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