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Microsurgical autologous breast reconstruction in the midst of a pandemic: A single-unit COVID-19 experience

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KEYWORDS

COVID-19;
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Summary *Introduction:* COVID-19 has disrupted the provision of breast reconstructive services throughout the UK. Autologous free flap breast reconstruction was restarted in our unit on 3 June 2020. We aimed to compare the unit's performance of microsurgical autologous breast reconstruction in the "post-COVID" period compared with the exact time period in the preceding year.

Methods: We retrospectively reviewed prospectively collected data in the "pre-COVID" (from 3 June 2019 to 31 December 2019) and "post-COVID" period (from 3 June 2020 to 31 December 2020). Patient demographics included age, body mass index, co-morbidities, Anaesthesiologists (ASA) grade and smoking status. Surgical factors included neoadjuvant chemotherapy, previous chest wall radiotherapy, unilateral or bilateral reconstruction, reconstruction timing, number of pedicles, contralateral symmetrisation and other procedures.

dependant variables were ischaemic time, operative time, mastectomy weight, flap weight, length of stay, return to theatre and complication rates. The number of trainers and trainees present in theatre was recorded and analysed.

Results: Fewer DIEP flaps were performed in the "post-COVID" period (45 vs. 29). No significant difference was observed in mastectomy resection weight, but flap weight was significantly increased. No significant difference was found in ischaemic time as well.

The postoperative length of stay was significantly reduced. No significant difference was found in rates of return to theatre, unplanned admission, infection, haematoma, seroma or wound dehiscence. No cases of venous thromboembolism or flap failures were recorded.

The mean number of trainers and trainees, and the trainee-to-trainer ratio was not found to be significantly different between cohorts.

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Conclusion: Although fewer cases were performed, autologous breast reconstruction was safely delivered throughout the COVID-19 pandemic in the first wave without affecting training.

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Introduction

The novel coronavirus disease-2019 (COVID-19) has thrown a spanner in the works in the continuity of provision of breast reconstructive services throughout the United Kingdom (UK). This was on the background of early literature from Wuhan, China¹⁻⁴ and New York, United States of America (USA),⁵⁻⁷ suggesting that cancer patients may be at increased risk of contracting COVID-19. Further early data also suggested a cancer patient may experience a more severe disease course with a greater risk of intensive care admissions, mechanical ventilation and death if they contracted COVID-19³⁻⁵. In addition, international data from the COVIDSurg Collaborative found the 30-day mortality in elective surgery patients diagnosed perioperatively with COVID-19 may be as high as 19.1%.⁸

Consequently, the Clinical Guide to Surgical Prioritisation during the Coronavirus Pandemic jointly published by the Federation of Surgical specialty Associations states that breast reconstruction is priority level 4 surgery, implying that it can be delayed for over three months.⁹

After reviewing the available evidence, Jallali et al. concluded that there is a paucity of high-quality prospective data and therefore insufficient evidence to deny patients the benefits of immediate reconstruction.¹⁰

After widespread consultation with stakeholders both locally and nationally, regional guidelines for selecting patients and postoperative management of patients undergoing microsurgical breast reconstruction were produced. Consequently, as of 3 June 2020 autologous free flap breast reconstruction was restarted in the Norfolk and Norwich University Hospital.¹¹ Since then, we had also published our experience with managing a patient diagnosed with COVID-19 in the postoperative period, including dressings, drains and management of seroma of the right breast. In this case, steps were taken to minimise risk to patient and staff.¹²

The aim of this study was to compare the unit's performance of microsurgical autologous breast reconstruction in the "post-COVID" period compared with the exact time period in the preceding year in order to objectively assess the impact of COVID-19 on microsurgical autologous breast reconstruction.

Methods

This was a retrospective review of prospectively collected data in two separate cohorts. Cohort 1 or the "pre-COVID" cohort was defined as patients who underwent free DIEP flap procedures between 3 June 2019 and 31 December 2019. Cohort 2 or the "post-COVID" cohort was defined as patients who underwent free DIEP flap procedures in the same time period in the year 2020.

Patient demographics that were studied were age, body mass index (BMI), co-morbidities, American Society of

Anaesthesiologists (ASA) grade and smoking status. Surgical factors included neoadjuvant chemotherapy, previous chest wall radiotherapy, unilateral or bilateral reconstruction, immediate or delayed reconstruction, unipedicled or bipedicled flaps, contralateral symmetrisation surgery and other additional procedures.

Intraoperative dependant variables investigated are ischaemic time, operative time, mastectomy weight and flap weight. Postoperative dependant variables included length of stay, return to theatre and complication rates.

In order to assess training, the number of trainers, defined as Plastic Surgery Consultants, and trainees, defined as Plastic Surgery Fellows or Registrars, present in theatre for the case were also recorded for analysis.

Statistical analysis

All statistical analyses were performed using Microsoft Excel (Microsoft, USA). Means for all continuous and categorical data were reported with standard deviation (SD). Parametric continuous variables were compared statistically using the two-tailed non-paired *t*-test. Categorical variables were statistically analysed using the Pearson's chi-squared test. Statistical significance was defined as *p*-value of < 0.05.

Results

Patient demographics

In total, 46 patients were in "pre-COVID" (Cohort 1) and 29 patients were "post-COVID" (Cohort 2). Mean ages for cohorts 1 and 2 were 50.7 years (SD 10.2 years) and 51.7 years (SD 10.8 years), respectively. Mean BMIs were 25.8 (SD 3.1) and 27.3 (SD 3.6), respectively. Mean ASA grades were 1.8 (SD 0.5) and 1.7 (SD 0.5), respectively. All the aforementioned independent factors were not statistically different (Table 1). About two-thirds of both cohorts were non-smokers, whereas the rest were ex-smokers (Cohort 1: *n* = 28 non-smokers and 14 ex-smokers vs. Cohort 2: *n* = 19 non-smokers and 10 ex-smokers, *p* = 0.896). This was not significantly different (Table 1).

Surgical factors

In total, 33 immediate and 12 delayed procedures were performed in the "pre-COVID" period, whereas 23 immediate and 6 delayed procedures were performed in the "post-COVID" period. Cohort 1 comprised of 23 unilateral and 13 bilateral reconstructions, whereas cohort 2 had 23 and six, respectively. In immediate reconstruction cases, mastectomy types were not significantly different between cohorts [Cohort 1: 28 skin-sparing mastectomies (SSM) and 1

Table 1 Summary of patient demographics. ASA = American Society of Anaesthesiologist score, SD = Standard deviation.

		Cohort 1 (2019) (n = 45)		Cohort 2 (2020) (n = 29)		p-value
		Mean	SD	Mean	SD	
Age		50.65	10.24	51.69	10.75	0.680
BMI		25.84	3.05	3.55	3.55	0.081
ASA		1.85	0.47	1.69	0.47	0.081
		n	%	n	%	
Smoking status	Ex-smoker	14	33.3	10	34.5	0.896
	Non-smoker	28	66.7	19	65.5	

nipple-sparing mastectomy (NSM) vs. Cohort 2: 22 SSM and 1 NSM, $p = 0.813$]. Where nodal surgery was required for staging or therapeutic purposes, sentinel lymph node biopsies (SLNB) accounted for a significantly larger proportion compared with axillary node clearances (ANC) (Cohort 1: 6 SLNB and 6 ANC vs. Cohort 2: 13 SLNB and 3 ANC, $p = 0.012$).

The proportion of bipedicted to unipedicted cases was statistically similar (Cohort 1: 41 unipedicted and 5 bipedicted vs. Cohort 2: 26 unipedicted and 3 bipedicted, $p = 0.928$). In unilateral cases, the proportion of cases requiring contralateral symmetrising surgery was also not significantly different [Cohort 1: $n = 9$ (27.2%) vs. Cohort 2: $n = 8$ (34.7%), $p = 0.927$].

Mean drains for the recipient site (breast and/or axilla) were not significantly different between cohorts (Cohort 1 = 1 drain vs. Cohort 2 = 1 drain, $p = 0.00$), however, the mean number of drains for the donor site (abdomen) was significantly reduced (Cohort 1 = 1 drain vs. Cohort 2 = 0 drains, $p = < 0.0001$).

No significant difference was found in mastectomy resection weights, but flap weights were significantly increased from Cohort 1 to Cohort 2. The ischaemic time between cohorts was statistically similar. The operative time for unilateral breast reconstruction cases was significantly reduced in Cohort 2, but there was no significant change for bilateral breast reconstruction cases.

All statistical findings are summarised in [Table 2](#).

Postoperative course

Due to the newly introduced criteria, the postoperative length of stay has been significantly reduced [Cohort 1: 5.1 days (SD 1.4) vs. Cohort 2: 3.0 (SD 1.2), $p < 0.0001$]. In Cohort 2, three patients (10.3%) were recatheterised postoperatively. Of these, two patients required recatheterisation to facilitate fluid monitoring for a general anaesthetic on return to theatre, and one patient had urinary retention. The latter patient had a successful trial without a catheter 2 days later.

No significant changes were observed in rates of return to theatre, unplanned admission, infection, haematoma, seroma or wound dehiscence. In both cohorts, no cases of venous thromboembolism or flap failures were recorded. The statistical findings are reported in [Table 3](#).

Training

The mean number of trainers (Cohort 1 = 1.5 vs. Cohort 2 = 1.8, $p = 0.075$), the mean number of trainees (Cohort

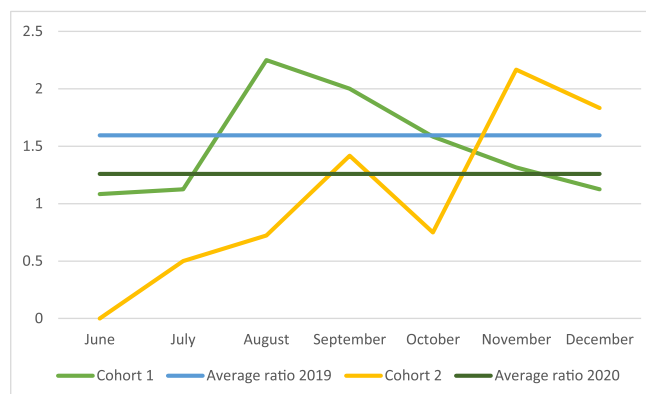


Figure 1 Temporal trend of average trainee-to-trainer ratio between cohorts. Light green line = Monthly average of Cohort 1; Blue line = Average of Cohort 1 throughout study period; Yellow line = Monthly average of Cohort 2; Dark green = Average of Cohort 2 throughout study period.

1 = 2.0 vs. Cohort 2 = 1.7, $p = 0.129$), and the trainee-to-trainer ratio was not found to be significantly different between cohorts [Cohort 1 = 1.6 (SD 0.9) vs. Cohort 2 = 1.3 (SD 1.0), $p = 0.549$] ([Table 4](#)).

[Figure 1](#) shows temporal trends of mean trainee-to-trainer ratios. Although initially low, there is an increasing trend toward “pre-COVID” trainee-to-trainer ratios.

Discussion

Autologous breast reconstruction during COVID-19

This study found that there was no significant difference in the complication rate during the “pre-COVID” and “post-COVID” cohorts, indicating that the safety of delivery of care throughout the patient journey is assured through the measures that were taken to minimise COVID-19 risk to patients. The data suggests that the current changes in practice are feasible for in our unit when microsurgical autologous breast reconstruction resumes after the next COVID-19 wave.

Pre-resection SLNB constitutes the practice of some of the breast surgeons that perform the mastectomy during the immediate reconstruction cases. As theatre space has become sparse during the height of the first wave, SLNBs were not performed preoperatively as often compared with the “pre-COVID” period. This may explain the significantly

Table 2 Summary of surgical factors. Statistically significant *p*-values are in red and bold. SSM = Skin-sparing mastectomy, NSM = Nipple-sparing mastectomy, SLNB = Sentinel lymph node biopsy, ANC = Axillary node clearance, DIEP = Deep inferior epigastric artery perforatory flap, SD = Standard deviation.

		Cohort 1 (2019) (<i>n</i> = 45)		Cohort 2 (2020) (<i>n</i> = 29)		p-value
		n	%	n	%	
Timing	Delayed	12	26.7	6	20.7	0.467
	Immediate	33	73.3	23	79.3	
Unilateral DIEP	Right	15	71.7	9	79.3	0.093
	Left	18		14		
Bilateral DIEP		13	28.3	6	20.7	
Mastectomy	SSM	28	96.6	22	95.7	0.813
	NSM	1	3.4	1	4.3	
Nodal surgery	SLNB	6	50.0	13	81.2	0.012
	ANC	6	50.0	3	18.8	
Number of pedicles	Unipedicled	41	89.1	26	89.7	0.928
	Bipedicled	5	10.9	3	10.3	
Contralateral symmetrisation	Yes	9	27.3	8	34.8	0.419
	No	24	72.7	15	65.2	
Mean drain per breast		1.0		1.0		1.000
Mean drain per abdomen		1.0		0.0		<0.0001
		Mean	SD	Mean	SD	p-value
Mastectomy weight (g)		504.4	184.9	517.2	192.9	0.857
Flap weight (g)		554.5	150.1	704.2	249.8	0.017
Ischaemic time (mins)		47.3	20.7	38.4	13.8	0.071
Operation time (mins)	Unilateral DIEP	395.6	96.7	308.3	68.4	0.0002
	Bilateral DIEP	481.8	92.5	505.3	104.0	0.647

Table 3 Summary of postoperative course. Statistically significant *p*-values are in red and bold. VTE = Venous thromboembolism; N/A = Not applicable.

	Cohort 1 (2019) (<i>n</i> = 45)		Cohort 2 (2020) (<i>n</i> = 29)		p-value
	Mean	SD	Mean	SD	
Length of stay (days)	5.1	1.4	3.0	1.2	<0.0001
	n	%	n	%	
Recatheterisation	N/A	N/A	3	10.3	0.55
Return to theatre	4	8.7	3	10.3	0.75
Unplanned readmission	5	10.9	0	0.0	0.06
VTE	0	0.0	0	0.0	N/A
Infection	4	8.7	1	3.4	0.32
Flap failure	0	0.0	0	0.0	N/A
Haematoma	1	2.2	2	6.9	0.09
Seroma	2	4.4	1	3.4	0.79
Wound dehiscence	5	11.1	0	0.0	0.06
Fat necrosis	1	2.2	0	0.0	0.42

Table 4 Summary of Trainer and Trainee presence in microsurgical autologous breast reconstruction cases. SD = Standard deviation.

	Cohort 1 (2019) (<i>n</i> = 45)		Cohort 2 (2020) (<i>n</i> = 29)		p-value
	Mean	SD	Mean	SD	
Number of Trainers	1.5	0.6	1.8	0.7	0.08
Number of Trainees	2.0	0.7	1.7	0.9	0.13
Trainee: Trainer ratio	1.6	0.9	1.3	1.0	0.55

different range of axillary procedures performed between cohorts.

The impact of COVID-19

Preceding the COVID-19 pandemic, Mennie et al. found that there was an increasing trend in the use of free flaps in both immediate and delayed breast reconstruction across England,¹³ with the DIEP flap being the most common flap used.

The psychological and psychosocial benefits of breast reconstruction have been systematically investigated. Al-Ghazal et al. found that patients who had immediate reconstruction recalled less distress and had better psychosocial well-being than those who had delayed reconstruction.¹⁴

In addition, autologous breast reconstruction has also been shown to be more cost-effective than implant-based reconstruction or no reconstruction. Data from the United States of America (USA) found no significant differences in patient satisfaction or in psychosocial, sexual or physical well-being at two years.¹⁵ Cheng et al. had shown that in autologous breast reconstruction using either a DIEP or SIEA flap, delayed breast reconstruction is as cost-effective as immediate reconstruction in the Taiwanese healthcare system.¹⁶

Despite recommencing microsurgical autologous breast reconstruction in the earliest soonest opportunity, our unit had a 37.0% reduction in the number of procedures performed.

This study was unable to account for the reduction in numbers of patients who underwent autologous breast reconstruction, but this is likely attributable to a combination of stricter patient selection to meet the new trust admission criteria for elective patients, patient choice and lack of theatre availability and staffing. This is consistent with the findings of a survey of 970 surgeons working within the UK published by RCSEng on 1 October 2020. At this point in time, nearly half (48%) said access to more theatres and facilities to limit theatre ‘downtime’ was necessary for deep cleaning.¹⁷

The impact of COVID-19 may indirectly create a “lost tribe” of patients who could have benefited from immediate breast reconstruction, but instead have indirectly been placed in the back of the queue of an increasingly long waiting list for delayed breast reconstruction, which is likely to compound the longer the pandemic draws on.

Risk management

A substantial part of restarting microsurgical autologous breast reconstruction was consideration of risk to patients, as described by Jallali et al.¹⁰ In our unit, one key effort involves minimising the length of stay and the potential risk for complications for selected patients. To facilitate this, patient selection was key to identify motivated patients, with minimal co-morbidities, who would have the best chance of going through the accelerated pathway with a minimal risk of problems.

As cohorts 1 and 2 have no significant statistical difference in patient demographics, from a physical perspective,

it is apparent that the “pre-COVID” method of selecting patient was sufficient, and that in the “post-COVID” period, we were able to deliver safe care throughout the microsurgical autologous breast reconstruction pathway for patients with similar medical backgrounds as the “pre-COVID” period.

Training

As a large proportion of workload in Plastic Surgery constitutes elective work, concerns regard how COVID-19 would directly impact training have been raised. Although data on the parts of the procedure that are actually performed by the trainee are not available for analysis, the number of trainers (Plastic Surgery Consultants) and trainees (Plastic Surgery Fellows and Registrars) available were used as a surrogate marker to assess the exposure that trainees are obtaining during the “post-COVID” period. Through this, several pertinent findings were observed:¹ The mean number of trainers, mean number of trainees and trainee-to-trainer ratio has not significantly changed between cohorts throughout the study period;² Although the trainee-to-trainer ratio was initially low after recommencement of microsurgical autologous breast reconstruction during the “post-COVID” period, there was an increasing trend towards the average ratio as more procedures were performed. This is an objective marker showing our unit’s continued commitment and achievement in breast microsurgical training during the COVID-19 pandemic.

Nationally, a survey by RCSEng found that 46% of surgeons said that surgical training has resumed having previously been suspended due to the pandemic, and a further 41% said training had never stopped. Just 8% of surgeons report that surgical training has yet to resume. Two-thirds (67%) of surgeons indicated that a lack of elective activity meant that there were fewer opportunities for training.¹⁷

Analysis on training was not able to assess the individual parts of procedures that trainees were able to perform as part of their training. This study merely looked at the proportion of trainees present to estimate the training. We therefore cannot make strong conclusions on the quality of training received.

Conclusion

This study concludes that autologous breast reconstruction was as safely delivered throughout the COVID-19 pandemic in the first wave as the “pre-COVID” period.

In spite of being one of the first units in the UK to recommence autologous breast reconstruction, our throughput is still reduced compared to a similar time period last year was still.

Opportunities for training were initially reduced in view of ensuring efficiency in theatres and minimal contact with patients, however, the trend showed recovery towards that of the “pre-COVID” period.

Declaration of Competing Interest

None declared.

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Ethical approval

Not required.

References

- Zhang L, Zhu F, Xie L, Wang C, Wang J, Chen R, Jia P, Guan HQ, Peng L, Chen Y, Peng P, Zhang P, Chu Q, Shen Q, Wang Y, Xu SY, Zhao JP, Zhou M. Clinical characteristics of COVID-19-infected cancer patients: a retrospective case study in three hospitals within Wuhan, China. *Ann Oncol* 2020;31(7):894-901 Jul 1.
- Ma J, Yin J, Qian Y, Wu Y. Clinical Characteristics and Prognosis in Cancer Patients with COVID-19: a Single Center's Retrospective Study, 81. W.B. Saunders Ltd; 2020. p. 318-56. *Journal of Infection*.
- Liang W, Guan W, Chen R, Wang W, Li J, Xu K, Li C, Ai Q, Lu W, Liang H, Li S, He J. Cancer Patients in SARS-CoV-2 infection: a Nationwide Analysis in China, 21. Lancet Publishing Group; 2020. p. 335-7. *The Lancet Oncology*.
- Dai M, Liu D, Liu M, Zhou F, Li G, Chen Z, Zhang Z, You H, Wu M, Zheng Q, Xiong Y, Xiong H, Wang C, Chen C, Xiong F, Zhang Y, Peng Y, Ge S, Zhen B, Yu T, Wang L, Wang H, Liu Y, Chen Y, Mei J, Gao X, Li Z, Gan L, He C, Li Z, Shi Y, Qi Y, Yang J, Tenen DG, Chai L, Mucci LA, Santillana M, Cai H. Patients with cancer appear more vulnerable to SARS-CoV-2: a multicenter study during the COVID-19 outbreak. *Cancer Discov* 2020 Jun 1;10(6):783.
- Yu J, Ouyang W, Chua MLK, Xie C. SARS-CoV-2 Transmission in Patients with Cancer at a Tertiary Care Hospital in Wuhan, China, 6. American Medical Association; 2020. p. 1108-10. *JAMA Oncology*.
- Mehta V, Goel S, Kabarriti R, Cole D, Goldfinger M, Acuna-Villaorduna A, Pradhan K, Thota R, Reissman S, Sparano JA, Gartrell BA, Smith RV, Ohri N, Garg M, Racine AD, Kalnicki S, Perez-Soler R, Halmos B, Verma A. Case Fatality Rate of Cancer Patients with COVID-19 in a New York Hospital System. *Cancer Discov* 2020 Jul 1;10(7):935-41.
- Miyashita H, Mikami T, Chopra N, Yamada T, Chernyavsky S, Rizk D, Cruz C. Do patients with cancer have a poorer prognosis of COVID-19? An experience in New York City. *Ann Oncol* 2020.
- COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet* 2020;396(10243):27-38.
- Federation of Surgical Specialty Associations. Clinical guide to surgical prioritisation during the coronavirus pandemic. 2020 Apr. https://fssa.org.uk/_userfiles/pages/files/covid19/guidelines_for_preoperative_covid19_testing_for_elective_cancer_surgery_190520.pdf. Accessed: 10 January 2021.
- Jallali N, Hunter JE, Henry FP, Wood SH, Hogben K, Almufti R, Hadjiminis D, Dunne J, Thiruchelvam PTR, Leff DR. The feasibility and safety of immediate breast reconstruction in the COVID-19 era. *J Plast Reconstr Aesthet Surg* 2020.
- Masud D, Sharp OL, Rosich-Medina A, Köhler G, Haywood RM. Resuming autologous free tissue transfer for breast reconstruction in the COVID-19 era. *J Plast Reconstr Aesthet Surg* 2020.
- Sharp O, Masud D. Breast reconstruction with immediate autologous free tissue transfer in a peri-operative COVID-19 positive patient: a case report illustrating feasibility of aftercare. *J Plast Reconstr Aesthet Surg* 2020;74(2):407-47 Churchill Livingstone.
- Mennie JC, Mohanna PN, O'Donoghue JM, Rainsbury R, Cromwell DA. National trends in immediate and delayed post-mastectomy reconstruction procedures in England: a seven-year population-based cohort study. *Eur J Surg Oncol* 2017.
- Al-Ghazal SK, Sully L, Fallowfield L, Blamey RW. The psychological impact of immediate rather than delayed breast reconstruction. *Eur J Surg Oncol* 2000 Feb 1;26(1):17-19.
- Yoon AP, Qi J, Brown DL, Kim HM, Hamill JB, Erdmann-Sager J, Pusic AL, Wilkins EG. Outcomes of immediate versus delayed breast reconstruction: results of a multicenter prospective study. *Breast* 2018.
- Cheng MH, Lin JY, Ulusal BG, Wei FC. Comparisons of resource costs and success rates between immediate and delayed breast reconstruction using DIEP or SIEA flaps under a well-controlled clinical trial. *Plast Reconstr Surg* 2006;117(7):2139-42 Jun.
- Royal College of Surgeons of England. Report: Protecting surgery through a second wave. <https://www.rcseng.ac.uk/-/media/files/rcs/coronavirus/report-protecting-surgery-through-a-second-wave-6-oct.pdf>. Accessed: 10 January 2021.