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Robotic breast and reconstructive surgery: 100 procedures in 2-years for 80 patients

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ABSTRACT

Objective: To analyze results of the first 100 robotic breast surgeries: feasibility, morbidity, indications and standardization of patient positioning and operative technique.
Background: Robotic breast surgery is an emergent procedure.
Methods: A prospective cohort of patients undergoing robotic latissimus dorsi-flap reconstruction (RLDFR) and or robotic mastectomy, over a period of 24 months was analyzed. We analyzed patient's characteristics, previous treatment for breast cancer, primitive breast cancer or local recurrence, immediate or delayed breast reconstruction and type of reconstruction. Surgical techniques and duration of surgery were reported according to three successive periods.
Results: 46.2% of patients (37/80) had previous breast radiotherapy and 26.2% (21/80) had received neo-adjuvant chemotherapy. Surgical procedure and patient position are described. Surgical incision used for RLDFR was: 37 axillar (50.7%), 20 (27.4%) areolar, 7 (9.6%) central breast, 10 (13.7%) previous incision. Number of surgical procedures was > 2 for 35 patients.

In logistic regression, factors significantly associated with duration of surgery ≥305mn were: P2 with decreased operative duration (OR: 0.077, p = 0.002) and P3 (OR: 0.015, p < 0.0001) versus P1; and number of surgical procedures: 4 surgical procedures (OR: 15.60, p = 0.048) versus 1. Median hospital stay was 4 days. Total complication rate was 57.5% (46 patients) with 6 grade 2, 9 grade 3 and 1 grade 4 complication. For RLDFR we reported 1 grade 3 (1.3%) and 29 grade 1 (39.7%) complications consisting in dorsal seromas.
Conclusion: RLDFR is a safe and reproducible procedure that allows breast reconstruction through a single incision, without dorsal scar. A decrease in surgery duration was observed with technique standardization and throughout the learning curve.

1. Introduction

There has been over the past few years substantial development in robotic surgery, particularly in prostatic cancer, gynecologic cancer, colo-rectal cancer, thoracic and thyroid surgery [1–3]. Endoscopic non-robotic latissimus dorsi-flap breast reconstruction (LDFR) has been reported in several studies [4–8]. Very few experiences are reported in the field of breast surgery: with a small number of series including very few patients on robotic mastectomy or LDFR [10–13]. Endoscopic single-axillary nipple sparing mastectomy (NSM) or LDF dissection, using a single port and endoscopic instruments with a two-dimensional endoscopic camera produces an inconsistent optical window around the curve of the breast skin flap and the thoracic wall. Furthermore, internal mobility of traditional endoscopic rigid tip instruments through a single access is limited. Robotic surgery with a three-dimensional camera and flexibility of instruments has been reported to have the potential to overcome these difficulties and has been applied for breast reconstruction, LDF harvesting or pectoral muscular dissection for insertion of implants [9–12]. The aim of this study was to report results of the first 100 robotic breast surgies performed over a period of 24 months, through the analysis of feasibility, morbidity, indications and standardization of patient positioning and operative technique.

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Table 1
Patient characteristics.

	Population	Total		P1		P2		P3		Chi2
		Nb	%	Nb	%	Nb	%	Nb	%	p
	Number of patients	80		24	30.0	26	32.5	30	37.5	
IBR for Breast Cancer	NSM	39	48.8	10	41.7	16	61.5	13	43.3	0.158
	SSM	32	40.0	11	45.8	10	38.5	11	36.7	
DBR for Breast Cancer		9	11.2	3	12.5	0	0	6	20.0	
Primitive Breast Cancer		58	72.5	14	58.3	19	73.1	25	83.3	0.141
Local Recurrence		21	26.2	10	41.7	7	26.9	4	13.3	
Prophylactic		1	1.2	0	0	0	0	1	3.3	
Tobacco		18	22.5	8	44.4	4	22.2	6	33.3	0.290
Diabetes		4	5.0	3	12.5	0	0	1	3.3	0.112
ASA score	1	32	40.0	11	45.8	10	38.5	11	36.7	0.543
	2	47	58.7	12	50.0	16	61.5	19	63.3	
	3	1	1.3	1	4.2	0	0	0	0	
Breast size	A-B	38	47.5	11	45.8	11	42.3	16	53.3	0.80
	C	27	33.8	7	29.2	11	42.3	9	30.0	
	D-E-F	15	18.7	6	25.0	4	15.4	5	16.7	
Prosthesis size	< 300	11	31.4	7	46.7	1	9.1	3	33.3	0.15
	> = 300	24	68.6	8	53.3	10	90.9	6	66.7	
Previous radiotherapy		37	46.2	14	58.3	11	42.3	12	40.0	0.360
Neo-adjuvant chemotherapy		21	26.2	7	29.2	5	19.2	9	30.0	0.611
Reconstruction	Autologous LDF	40	50.0	8	33.3	12	46.2	20	66.7	
	Non autologous LDF	5	6.2	1	4.2	3	11.5	1	3.3	
	LDF + prosthesis	28	35.0	14	58.4	9	34.6	5	16.7	
	Implant	7	8.8	1	4.2	2	7.7	4	13.3	
Incision for RLDFR	Axillar	37	50.7	12	52.2	15	62.5	10	38.5	0.027
	Areolar	20	27.4	4	17.4	7	29.2	9	34.6	
	Central elliptic	6	8.2	5	21.7	0	0	1	3.8	
	Previous mastectomy	7	9.6	2	8.7	0	0	5	19.2	
	Previous breast incision	3	4.1	0	0	2	8.3	1	3.8	
Breast Cancer	Invasive	63	79.7	20	83.3	21	80.8	22	75.9	
	DCIS	16	20.3	4	16.7	5	19.2	7	24.1	

	Population	Total		P1		P2		P3		Chi2
		Nb	%	Nb	%	Nb	%	Nb	%	p
Number of surgical procedures	1	12	15.0	2	8.3	1	3.8	9	30.0	0.019
	2	33	41.2	8	33.3	10	38.5	15	41.2	
	3	28	35.0	12	50.0	12	46.2	4	13.3	
	4	7	8.8	2	8.3	3	11.5	2	6.7	
Da Vinci system	SI	47	58.8	24	100	17	65.4	6	20.0	< 0.0001
	XI	33	41.2	0	0	9	34.6	24	80.0	
Number of robotic arms	2	58	72.5	10	41.7	22	84.6	26	86.7	< 0.0001
	3	22	27.5	14	58.3	4	15.4	4	13.3	
Hospital stay (days)	< 4 days	30	37.5	3	12.5	9	34.6	18	60.0	0.002
	> = 4 days	50	62.5	21	87.5	17	65.4	12	40.0	
Duration of surgery	< 305 mn	42	52.5	3	12.5	14	53.8	25	83.3	< 0.0001
	> = 305 mn	38	47.5	21	87.5	12	46.2	5	16.7	
Duration of anesthesia	< 382 mn	41	51.2	5	20.8	12	46.2	24	80.0	< 0.0001
	> = 382 mn	39	48.8	19	79.2	14	53.8	6	20.0	
BMI	< 23.5	45	56.2	16	66.7	14	53.8	15	50.0	0.450
	> = 23.5	35	43.8	8	33.3	12	46.2	15	50.0	

(*continued on next page*)

2. Methods

2.1. Patients

A prospective cohort of patients undergoing robotic latissimus dorsi-flap reconstruction (RLDFR) and/or robotic mastectomy (RM) over a period 24 months (February 2016 to January 2018) was analyzed. All patients agreed to surgery with robotic assistance and received information on the procedure. The study protocol was approved by our institutional ethical committee. During the study period we performed 321 immediate breast reconstructions (IBR) and 244 delayed breast reconstructions (DBR) including the 80 patients undergoing robotic procedures (14.1%: respectively, 22.1% IBR and 3.7% DBR). The decision to perform robotic surgery was made by the four surgeons who participated in this program in accordance with the patient's wishes after information on different reconstruction techniques available.

We analyzed patient characteristics (age, body mass index (BMI), tobacco use, diabetes, ASA score, breast volume), previous treatment for breast cancer (sentinel lymph node biopsy (SLNB), axillary lymph node dissection (ALND), neo-adjuvant chemotherapy (NAC), previous breast radiotherapy), indications for robotic surgery (type of mastectomy, nipple sparing mastectomy (NSM) or skin sparing mastectomy (SSM), primitive breast cancer or local recurrence, IBR or DBR and type of reconstruction (LDFR and or breast implant).

Surgical technique using *Da Vinci Si* ® Surgical system (Intuitive Surgical, Sunnyvale, CA), number of trocars, skin incision, duration of anesthesia and surgery were reported according to period of treatment and associated surgical procedures (mastectomy, breast implant, LDFR, ALND and contra-lateral breast surgery). Three periods were established: P1 (year 2016), P2 (January to June 2017) and P3 (July to January 2018). Duration of anesthesia was defined as time from anesthesia induction to tracheal extubation. Duration of surgery was defined as time from skin incision to the end of skin suture including, all associated procedures and changes in patient positioning.

2.2. Surgery

When mastectomy was performed with a concomitant LDF, patients were either first positioned in dorsal decubitus followed by a side decubitus or in side decubitus during the full procedure. With the side decubitus position alone, dissection of the internal fold of the breast was more difficult due to the drop of the gland towards the inner area. We performed a subcutaneous breast infiltration with a combination saline serum and adrenaline. The anterior border of the LD muscle and the axillar line were marked before anesthesia. The sub mammary fold was also marked in case of IBR.

A vertical incision, on the anterior axillary line allowed the beginning of the dissection of the sub-cutaneous plan and a limited dissection under the incision along the anterior axillary line about 6 cm under axillar incision in order to insert one robotic trocar. For patients with SSM or previous surgery (conservative surgery or mastectomy for DBR) we used this previous incision. Then, a *Gelpoint*® Path single site device (Applied Medical) was inserted through the incision with 2 robotic trocars and 1 trocar for an *Airseal*® device insufflation (AirSeal, CONMED) also used by the assistant surgeon when necessary. We operated under low pressure (7 mmHg). Depending of the breast side, we inserted monopolar scissors and bipolar forceps into up and down robotic trocars with 0° camera in the middle robotic trocar. After monotrocar removal, we systematically performed a retro nipple biopsy for NSM without extemporaneous analysis and pathological analysis of total gland removal. An incision of 4–7 cm was performed depending on breast volume for patients with concomitant mastectomy for specimen retrieval.

Robotic surgery started with a superficial dissection of LD muscle from the middle of the muscle to the inferior part (5–6 cm under the inferior mammary fold) and to superior part with a total section of the tendinous insertion. Then, we performed dissection underneath LD muscle from the middle to inferior part and to the level of the vascular pedicle. Section of LD muscle was performed with monopolar scissors for posterior dorsal insertions, then at the inferior part of dissection, with progressive mobilization of muscle.

Complication rate was determined using Clavien-Dindo grading [14], re-operation rate and type of complication. Number of post-operative hospitalization days was reported.

2.3. Statistics

Main characteristics were reported using median, mean, 95% confident interval (CI95) for quantitative criteria. Comparisons were performed using Chi2, *t*-test and logistic binary regression with SPSS® software version 16.0.

3. Results

We analyzed 100 robotic procedures performed on 80 patients: 73 RLDFR with 26 concomitant RM (73 patients) and 8 RM (7 patients including one bilateral prophylactic mastectomy). Breast reconstruction was performed in all patients, with 71 IBR (39 NSM, 32 SSM) and 9 DBR. IBR was performed with 40 autologous RLDF, 28 RLDF + breast implant, 5 non-autologous RLDF and 7 breast implants. Patients characteristics are reported in Tables 1 and 2.

3.1. Indications and type of reconstruction

46.2% patients had previous breast radiotherapy (37/80), respectively 41% (29/71) for IBR and 88.9% (8/9) for DBR. Mastectomy was performed for 21 local breast cancer recurrences with previous radiotherapy, 58 primary breast cancers including 9 DBR with 8 previous radiotherapy and 4 patients with NAC and radiotherapy before mastectomy.

Breast reconstruction using implant reconstruction alone was performed in all 7 cases of NSM without previous radiotherapy, in 6 cases for primary breast cancer and in 1 case of prophylactic mastectomy. RLDFR without breast implant was performed in 48.9% patients after NSM, in 37.8% patients after SSM and in 13.3% patients after standard mastectomy, in 44.4% after previous radiotherapy (Table 3). RLDFR with breast implant was performed in 35.7% after NSM, in 53.6% after SSM and in 10.7% after standard mastectomy, in 60.7% after previous radiotherapy. Mastectomy weight, breast cup size and BMI according to type of reconstruction are reported in Table 2.

Robotic breast surgery was indicated in carefully selected cases during the study period: 71 RLDF for IBR among 332 IBR (21.4%), 9 RLDF for DBR among 259 DBR (3.5%) and 33 robotic NSM among 932 patients who required a total mastectomy (3.5%).

3.2. Surgery

Surgical incisions for RLDFR were the following: 37 axillar, 20 areolar, 7 central breast incisions, 7 previous mastectomy incisions and 3 previous incisions of conservative resections. A different incision for RLDFR than the mastectomy incision was used for 6 patients with a second incision in the axillar area (9.4%: 6/64).

39 right, 40 left and 1 bilateral mastectomy were performed. Robotic procedures were performed using 3 arms for 22 patients: 3 arms 14/24 (58.3%) during 2016 and 8/56 (14.3%) during 2017-18. Patients were positioned in dorsal decubitus followed by side decubitus; 11 NSM among 19 patients with NSM and RLDFR (57.9%) were positioned in a side decubitus alone.

Concomitant other surgical procedure: In 36 cases a partial homolateral breast resection had been performed. Axillary surgery was performed concomitantly in 34 cases (24 sentinel lymph node biopsies, 7 axillary lymph node dissections and 3 sentinel lymph node dissections

Table 1 (*continued*)

	Population	Total		P1		P2		P3		Chi2
		Nb	%	Nb	%	Nb	%	Nb	%	p
Incision for mastectomy	axillar	38	53.5	10	47.6	16	61.5	12	50.0	0.022
	areolar	24	33.8	6	28.6	8	30.8	10	41.7	
	central elliptic	5	7.0	5	23.8	0	0	0	0	
	previous breast incision	4	5.6	0	0	2	7.7	2	8.3	
Number of robotic procedures	1	60	75	21	87.5	13	50	26	86.7	< 0.01
	2	20	25	3	12.5	13	50	4	13.3	

Abbreviations: IBR: Immediate breast reconstruction, DBR: Delayed breast reconstruction, RLDFR: Robotic latissimus dorsi flap reconstruction, BMI: Body mass index, NSM: nipple sparing mastectomy, SSM: skin sparing mastectomy.

followed by axillary lymph node dissections). A contra lateral breast surgery was performed during the same time in 10 (12.5%) patients.

3.2.1. Duration of procedure

Number of surgical procedures (mastectomy, LDFR, breast implant, axillary lymph node dissection, contra-lateral breast surgery) were ≥3 for 35 patients. Median anesthesia duration was 380 min and median surgery duration was 301 min (Table 2).

In univariate analysis, duration of surgery were significantly different depending on the study period ($p < 0.0001$) (Fig. 1), number of surgical procedures perfomed (28/45 with duration < 305mn for ≤ 2 procedures vs 14/35 for > 2 procedures: $p = 0.040$) (Fig. 2), robot system used (SI 18/47 < 305mn: 38.3% versus XI 24/33 < 305mn: 72.7% - $p = 0.002$) and not significant for BMI (duration < 305mn for 22/45 BMI < 23.5 and 20/35 ≥ 23.5), IBR versus DBR ($p = 0.294$), mastectomy procedure ($p = 0.276$). In binary logistic regression including the 3 study periods, number of procedures and robot system used, significant factors of duration of surgery ≥305mn were: P2 with a reduction in duration of surgery (OR: 0.077, CI95%: 0.015–0.386, $p = 0.002$) and P3 (OR: 0.015, CI95%: 0.002–0.134, $p < 0.0001$) versus P1 and number of surgical procedures performed: 4 surgical procedures (OR: 15.60, CI95%: 1.03–236, $p = 0.048$) versus 1 procedure.

In univariate analysis, duration of anesthesia was significantly different depending on the study period ($p < 0.0001$) and robot system used, (18/47 < 382mn with SI (38.3%) versus 23/33 < 382mn with XI (69.7%) $p = 0.005$), without any significant difference according to the number of surgical procedures ($p = 0.136$), BMI (24/45 BMI < 23.5 and 17/35 ≥ 23.5: $p = 0.422$), IBR versus DBR (35/71 < 382mn and 6/9: $p = 0.267$), mastectomy procedure ($p = 0.351$). In binary logistic regression, duration of anesthesia < or ≥382 mn differed significantly with P3 (OR: 0.045, CI95%: 0.007–0.296, $p = 0.001$) and P2 (OR: 0.246, CI95%: 0.062–0.980, $p = 0.047$) versus P1.

Comparison of side decubitus alone versus dorsal followed by side decubitus position for NSM and RLDFR showed no difference for all criteria (breast cup size, mastectomy weight, BMI, robotic system, number of surgical procedures, complication rate) except for periods with a near significant result ($p = 0.059$). Difference of surgical duration was about 45 min with shorter time for single positioning.

3.3. Pathologic results

Median mastectomy weight was 330gr: respectively, 250 gr (CI95%: 243–338, mean: 290, Range: 80–637) for NSM, 364 gr (CI95%: 342–521, mean: 431, Range: 100–1500) for SSM and 574 (mean 661, CI95%: 444–788, Range: 250–930) for standard mastectomy.

Median size of invasive breast cancer was 15.5 mm (mean 23.5, Range: 0.3–120) with 28 multifocal breast cancers (28/69: 35%) (38 ductal, 15 lobular, 3 others types and 13 DCIS). Mean size of DCIS was 38.7 mm (median 12.5, Range: 1–120).

3.4. Post-operative treatment

9 patients underwent post-mastectomy radiotherapy (20.9%) among 43 patients without previous radiotherapy, 17 patients received adjuvant chemotherapy, 53 patients endocrine therapy and 7 patients received trastuzumab.

3.5. Post-operative outcome

Median hospital stay was 4 days (Table 2): 30 patients < 4 days (37.5%) and 50 patients ≥ 4 days. Hospital stay < 4 days was significantly associated with study periods (Table 2, Supplementary Figure 3: $p = 0.002$), type of reconstruction (Implant or RLDF or LDF + implant: $p = 0.003$) (Supplementary Figure 4) and number of surgical procedures (> 2 or ≤ 2) ($p = 0.045$). Other criteria analyzed were not significant: IBR or DBR (26/71 < 4 days for IBR and 4/9 for DBR: $p = 0.454$), < 4 days for 19/45 patients (42.2%) with BMI < 23.5 versus 11/35 (31.4%) with BMI ≥23.5 ($p = 0.225$). In binary logistic regression, post-operative hospitalization ≥4 days was lower during P3 (OR: 0.124, CI95%: 0.027–0.570, $p = 0.007$) and higher for RLDF + implant (OR: 17.4, CI95%: 1.55–195, $p = 0.021$).

Total complication rate was 57.5% (46 patients): 26 breast complications and 9 re-operations (11.2%). No patients were lost for follow-up. 30 patients had grade 1 complications and 16 patients had grade 2-3-4 complications (20.0%): respectively 6 grade 2, 9 grade 3 and 1 grade 4. Complication rate was significantly different depending on study periods ($p < 0.001$) but not significant for grade 2-3-4 complications ($p = 0.50$).

For RLDFR we reported 30 complications (41.1%): 29 grade 1 complications (39.7) consisting in dorsal seromas that required 1 or several punctures and 1 grade 3 complication (1.3%) with a hemorrhage in the dorsal area that required re-operation. Dorsal seroma (grade 1) was significantly correlated in univariate analysis with BMI (37.9%, 11/38 for BMI < 23.5 versus 62.1%, 18/35 for BMI ≥23.5: 0.042) and periods (30.4%, 7/23 for P1, 60.0%, 15/25 for P2 and 28.0%, 7/25 for P3: 0.038). Other criteria, previous radiotherapy, previous NAC, primary breast cancer or recurrence, IBR or DBR and type of reconstruction were not significant. In logistic binary regression, dorsal seroma rate was higher for BMI ≥23.5 (OR: 3.10, CI95%: 1.07–8.93, $p = 0.036$) without difference according to periods.

Higher rate of complications were observed for mastectomies: 11 grade 1 (4 hematomas, 1 infection, 4 local cutaneous blistering), 6 grade 2 (4 local cutaneous blistering, 1 infection and 1 bleeding), 7 grade 3 with re-operation (5 infections with 4 implant explantations, 3 hematomas, 2 local cutaneous blistering) and 1 grade 4 (bilateral explantation for septic choc).

4. Discussion

This is to our knowledge the largest series of RLDFR with acceptable results; over the study period we observed a reduction in surgery and anesthesia duration and a decrease in post-operative hospital stay over

Table 2
Patient and surgery characteristics.

Population	All patients	median	mean	CI 95%	Range
Age		53.5	54.68	51.7–57.6	21–83
Mastectomy weight		330	383	333–433	80–1500
BMI		23.2	24.1	23.2–25.0	18.1–38.0
Duration of surgery		301	310	292–329	127–495
Duration of anesthesia		380	387	368–406	234–575
hospital stay duration		4	4.06	3.73–4.39	1.0–8.0
Duration of surgery	P1	361	358.5	330–386	210–495
	P2	300	328.8	292–365	127–495
	P3	248	255.8	235–277	153–390
Duration of surgery	SI	330	333	308–358	153–495
	XI	280	278	253–302	127–420
Duration of anesthesia	SI	405	413	388–437	234–575
	XI	349	351	324–377	240–563
Duration of surgery	1 Surgical procedure	242	238	194–281	127–351
	2 Surgical procedure	300	310	284–335	195–474
	3 Surgical procedure	327	326	295–357	209–495
	4 Surgical procedure	420	372	278–466	190–495
Duration of surgery	autologous LDF	282	295	271–318	166–474
	non autologous LDF	335	333.4	268–398	253–398
	LDF + implant	347	345.7	301–390	190–495
	autologous LDF + implant	334	345.1	293–397	270–495
	Implant	229	241.1	151–331	127–390
Duration of anesthesia	autologous LDF	357	371	345–397	240–563
	non autologous LDF	424	409.0	357–461	340–442
	LDF + implant	418	426.9	382–471	289–575
	autologous LDF + implant	403	401.6	366–437	347–470
	Implant	297	337.9	233–443	234–563
Hospital stay (days)	autologous LDF	4	3.8	3.3–4.2	2.0–7.0
	non autologous LDF	4	3.8	1.9–5.6	2.0–6.0
	LDF + implant	5	4.6	3.9–5.4	2.0–8.0
	autologous LDF + implant	5	5.3	4.5–6.1	4.0–7.0
	Implant	3	2.86	1.6–4.1	1.0–5.0
BMI	autologous LDF	23.04	24.22	22.7–25.8	18.1–38.0
	non autologous LDF	22.53	22.90	19.7–26.1	20.5–26.7
	LDF + implant	24.70	25.77	24.1–27.4	20.3–32.1
	autologous LDF + implant	23.1	23.4	21.3–25.6	19.5–28.0
	Implant	20.17	20.79	19.4–22.1	19.1–23.0
Mastectomy weight	autologous LDF	318	370.5	281–459	80–1500
	non autologous LDF	217	250.2	141–359	159–385
	LDF + implant	465	453.2	371–535	201–780
	autologous LDF + implant	488	464	387–541	263–574
	Implant	230	257	183–332	160–391
Hospital stay (days)	P1	5	5.08	4.47–5.69	2–8
	P2	4	3.96	3.41–4.52	2–7
	P3	3	3.33	2.91–3.75	1–6
Mastectomy weight	NSM	250	290	243–338	80–637
	SSM	364	431	342–521	100–1500
	standard	574	616	444–788	250–930

Abbreviation: BMI: Body mass index, SI: Da Vinci SI system, XI: Da Vinci XI system, P1-2-3: Periods 1-2-3, LDF: Latissimus dorsi flap, NSM: Nipple sparing mastectomy, SSM: Skin sparing mastectomy.

the successive periods and throughout the learning curve. This first experience with RLDFR allows standardization of patient positioning and surgical technique.

After this initial experience of 100 procedures, we believe that robotic endoscopic harvesting of the LDF is a feasible and reproducible technique that can be performed within a competitive surgical duration for a team trained in robotic surgery. This technique may be improved through the contribution of robotic dorsal padding in order to reduce dorsal seromas. Robotic NSM appears also feasible, with however morbidity related to infectious complications when breast implant was used and cutaneous blistering due to the use of robotic scissors with mono-polar coagulation at the beginning of the learning curve. Endoscopic non-robotic LDFR was reported in several studies [4–8], in 2007 Missana et al. reported a study including 52 patients [4] and more recently by others with smaller series [6–8]. Nakajima et al. [8] reported a study with 168 LDF video-assisted reconstructions but only for reconstruction after partial mastectomy.

Current literature includes some preliminary reports of RLDFR with however no more than 17 procedures [9–13]. The main differences in robotic surgical technique that should be underlined include the area of incision and use of a single site trocar.

Duration of surgery, including changes in patient position and docking, decreased throughout the learning curve and over the three successive periods: indeed we observed a reduction in the duration of the actual operative procedure but also in the duration of all the other steps related to the procedure such as patient positioning and docking. This observation can be explained by the fact that the learning curve concerned the surgeons but also all the other members of staff involved in these procedures. The following standardization of the procedure can be proposed: side decubitus position for a double robotic procedure for patients with a low breast volume (cup size A-B) and without contralateral breast surgery, and then, successive times of RLDF dissection.

NSM can be offered for breast cancers with a tumor-nipple distance of more than 2 cm [15,16]. For NSM, reconstruction with implant or fat grafting only for low breast volume or RLDF was proposed. Patient's choice was made mainly depending the wish to use implant or not. Robotic NSM has been reported for therapeutic and prophylactic mastectomies [17,18].

For SSM, various methods of IBR can be used: myo-cutaneous LDF, DIEP, implant with or without acellular dermal matrix, exclusive fat grafting for low breast volume and LDF without skin flap. Myo-cutaneous flap allowed nipple areolar complex reconstruction in the same time with a larger volume than muscle flap alone. However a dorsal scar is necessary in comparison with RLDF which is performed with circumferential areolar incision performed for SSM. More and more

Table 3
Results according to reconstruction type.

		Implant	RLDF without implant	RLDF + implant	Chi2			
		Nb	%	Nb	%	Nb	%	p
Age	< = 50 years	5	71.4	19	42.2	8	28.6	0.106
	> 50 years	2	28.6	26	57.8	20	71.4	
Periods	P1	1	14.3	9	20.0	14	50.0	0.033
	P2	2	28.6	15	33.3	9	32.1	
	P3	4	57.1	21	46.7	5	17.9	
Breast cup size	A-B	5	71.4	26	57.8	7	25.0	
	C	2	28.6	14	31.1	11	39.3	
	> = D	0	0	5	11.1	10	35.7	
BMI	< 23.5	7	100	26	57.8	12	42.9	0.023
	> = 23.5	0	0	19	42.2	16	57.1	
Type mastectomy	NSM	7	100	22	48.9	10	35.7	0.043
	SSM	0	0	17	37.8	15	53.6	
	DBR	0	0	6	13.3	3	10.7	
Primitive breast cancer		6	85.7	33	73.3	19	67.9	0.012
Local recurrence		0	0	12	26.7	9	32.1	
Prophylactic		1	14.3	0	0	0	0	
Previous radiotherapy	No	7	100	25	55.6	11	39.3	0.015
	Yes	0	0	20	44.4	17	60.7	
Hospital stay (days)	< 4 days	5	71.4	21	46.7	4	14.3	0.003
	> = 4 days	2	28.6	24	53.3	24	85.7	
Duration of surgery	< 305 mn	5	71.4	28	62.2	9	32.1	0.025
	> = 305 mn	2	28.6	17	37.8	19	67.9	
Duration of anesthesia	< 382 mn	5	71.4	25	55.6	11	39.3	0.214
	> = 382 mn	2	28.6	20	44.4	17	60.7	
Mastectomy weight	< = 330 gr	6	85.7	27	60.0	7	25.0	0.002
	> 330 gr	1	14.3	18	40.0	21	75.0	
		Median	CI 95%	Median	CI 95%	Median	**CI 95%**	
Age		45	36–55	52	50–58	61	53–62	
Mastectomy weight		230	183–333	285	277–437	483	399–515	
BMI		20.2	19.4–22.2	22.8	22.7–25.5	24.2	23.7–26.3	
Hospital stay (days)		3	1.6–4.1	4	3.4–4.1	5	4.3–5.4	

Abbreviations: RLDFR: Robotic latissimus dorsi flap reconstruction, BMI: Body mass index, P1-2-3: Periods 1-2-3, LDF: Latissimus dorsi flap, NSM: Nipple sparing mastectomy, SSM: Skin sparing mastectomy, DBR: Delayed breast reconstruction.

centers offer breast implant reconstruction with acellular dermal matrix (ADM). However, covering the entire implant with a thin, expensive ADM is not generally feasible, and the use of ADMs also increases the risk of complications such as infection and seroma [19–24]. Dikmans et al. [25] reported results of a randomized trial: One-stage IBR with ADM was associated with significantly higher risk of surgical complications (crude odds ratio 3·81, $p < 0·001$), reoperation (3·38, $p < 0·001$), and removal of implant, of ADM, or both (8·80, $p < 0·001$) than two-stage IBR.

For DBR, implant reconstruction can be sometimes proposed even for patients undergoing post-mastectomy radiotherapy usually after one or several lipoffilings in order to obtain better trophic tissue and thickness before reconstruction. Myo-cutaneous flap (mainly LDF or DIEP) can be also proposed when cutaneous flap is required. Finally, RLDF is an option for DBR combined with abdominal advancement flap and then lipofilling. For patients with previous radiotherapy, including local recurrence, NAC and radiotherapy [26–28], with DBR after post-mastectomy radiotherapy, the latissimus dorsi-muscle nourishes and protects the thin skin. In these cases, RLDFR can be associated with implant reconstruction depending on breast size and according to patient's choice. One or several lipoffiling were next proposed in order to obtain good cosmetic result and sufficient breast volume.

Moreover, quality of life was improved by IBR [29] and NSM [30].

5. Conclusion

RLDFR is a safe and reproducible procedure that provides breast reconstruction by a single incision, without dorsal scar. A decrease in surgery duration was observed with the standardization of the technique and throughout the learning curve. The cosmetic result and patient satisfaction appeared to be very good but a next study is planned in order to more precisely evaluate satisfaction, cosmetic results and quality of life.

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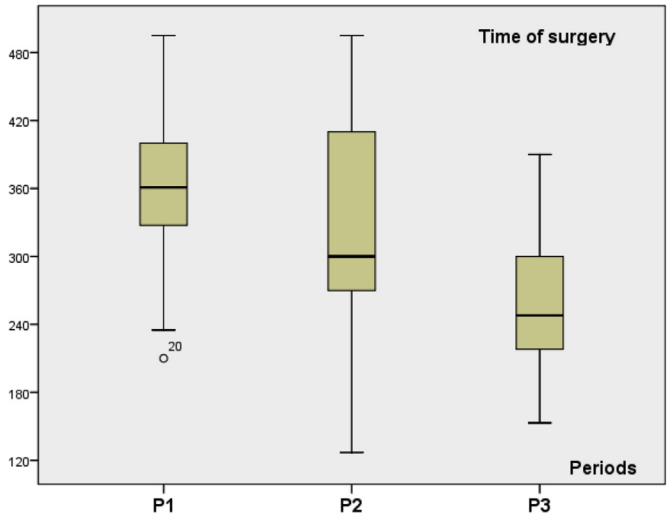

Fig. 1. Duration of surgery according to three successive periods ($p < 0.0001$). Legend: Mean duration (CI95%): P1: 361mn (330–386), P2: 300mn (292–365), P3: 248mn (235–277).

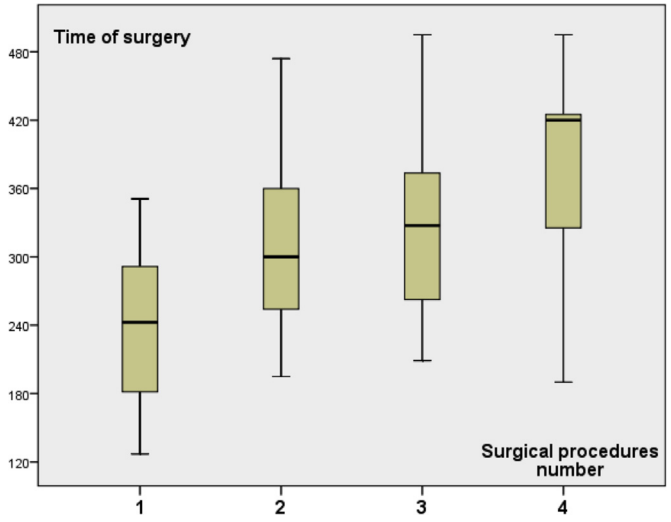

Fig. 2. Duration of surgery according to number of surgical procedures (mastectomy, RLDFR, implant, ALND, contra-lateral breast surgery) ($p = 0.040$). Legend: Mean duration (CI95%): 1 procedure: 242mn (194–281), 2 procedures: 300mn (284–335), 3 procedures: 327mn (295–357), 4 procedures: 420mn (278–466).

Statements

No funding or benefits were received, by any of the authors.

There is no conflict of interest by any of the authors regarding this manuscript.

Research is performed in accordance with the ethical standards in the 1964 Declaration of Helsinki. As this study does not involve subject-related research, it is not covered by Dutch law on human subjects' research. This study is approved by the institutional review board from our institution.

Data collection capturing and analyses were performed at the Paoli Calmettes Institute.

Conflicts of interest

None declared.

Contributors

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.suronc.2019.09.005.

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