INTRODUCTION

Despite the advances and increasing prevalence of autologous, abdominally-based breast reconstruction, the latissimus dorsi (LD) flap remains an important option for certain cases in primary and salvage reconstructions as well as for high-risk patients (morbid obesity, preoperative radiation, and clotting disorders).1,5 The LD muscle or myocutaneous flap remains a pillar in breast reconstructive algorithms due to its high reliability, shorter operating times, and hospital stays compared with free tissue transfer, minimal donor site morbidity, and high patient satisfaction.1,2,4-6 Recent innovations to the LD flap include direct to implant (DTI) reconstructions with acellular dermal matrix.3,7

From both resource-conscious healthcare systems and patient experience perspectives, LD reconstructions can offer advantages over other techniques, with the exception of requiring a second surgery to exchange expansion devices for permanent implants.2,5,7-9 Devices that act as both tissue expander and permanent implant are available, such as Mentor’s Spectrum devices (Irving, Tex.). Despite the rise in DTI, LD flap with acellular dermal matrix reconstructions achieving symmetry and avoiding mastectomy flap ischemia can be a challenge. The use of the saline Spectrum adjustable expander/implant (Mentor, Irving, Tex.) offers the opportunity to perform a single-stage LD reconstruction with implants, while still offering the opportunity for the implant to be adjusted for size and symmetry postoperatively. Removing the expansion port under local anesthetic avoids the need for a second return to the main operating room.10 Additionally, compared with expanders with an integrated port, Spectrum...
implants allow expansion to be performed remotely from the breast pocket, potentially reducing the risk of infection or rupture. Remote ports are also technically easier to use, particularly in patients with thick LD flaps. In these patients, it can be difficult to find the integrated port using a magnet, which can, at times, require a spinal needle to penetrate the integrated port.11

The aim of this study was to report the technique and experience with single-stage LD breast reconstruction using Spectrum implants (Mentor, Irving, Tex.).

METHODS

Institutional approval was obtained from the Nova Scotia Health Authority Research Ethics Board (File no. 1024677). Patients undergoing an LD myocutaneous flap with Spectrum implant device (Mentor, Irving, Tex.) by a single surgeon at an academic, tertiary hospital were retrospectively identified by billing codes. All oncologic resections were performed by general surgeons. All patients, unilateral or bilateral, immediate or delayed reconstructions were included from June 2009 to September 2019.

Electronic medical records for each identified patient were reviewed to determine the type of reconstruction (unilateral/bilateral, immediate/delayed), initial procedure date, implant fill volume during initial surgery, and any intraoperative incidents. Surgical implant records were utilized to obtain the size and model of Spectrum implant. All postoperative clinic and procedure notes were reviewed chronologically until port removal. The following information was collected for each patient undergoing breast reconstruction: volume of expansion, date of drain removal, and complications (wound dehiscence or delayed healing, mastectomy flap necrosis, minor/major infection, seroma, return to the main operating room for any reason, including implant exchange).

All data extracted were stored in a secure Microsoft Excel file (version 16.16.3, Redmond). All statistical analyses were also performed using Microsoft Excel.

LD Reconstruction Technique

The first stage of the reconstruction is to establish the breast pocket. Unilateral reconstructions are typically performed in lateral decubitus, whereas bilateral cases require flap harvest in prone followed by inset in supine positions. In an immediate reconstruction, any modifications to the pocket size or shape following mastectomy are performed using cautery. In delayed reconstructions, the pocket is dissected subcutaneously to define the breast footprint (using contralateral side as a guide, or, in bilateral cases, to achieve symmetry). In cases where preoperative radiation has been performed, the pocket dissection is slightly larger to allow for softer transition between the breast footprint and surrounding tissues. The LD flap is then raised using a skin paddle oriented horizontally such that the scar falls under the bra line (Fig. 1A). Once the skin paddle is defined, the skin overlying the LD is raised subcutaneously. If there is sufficient subcutaneous fat immediately caudal to the skin paddle, this can be kept on the underlying muscle and tapered down to the muscle. Once transposed, this fat will contribute to a soft and full upper pole. The free edge of the LD is identified at the tip of the scapula and traced toward midline. Cautery is used to dissect through the LD along the midline followed by inferior border (along the posterior superior iliac spine). While lifting the flap laterally, dissection is slowed to ensure that the serratus remains attached to the chest wall. This landmark is identified based on the direction of the muscle fibers. The serratus branch of the thoracodorsal pedicle is identified and traced proximally to dissect the pedicle. The senior author does not cut the thoracodorsal nerve. There have been no concerns regarding animation deformity to date. The muscle does show some mild atrophy, however, which has been found to contribute to a smooth transition from breast to chest wall tissue. Once the pedicle is dissected, a subcutaneous pocket to the anterior chest is developed (Table 1). Special attention is given to ensure the tunnel is wide enough to avoid any pressure on the pedicle.

On the anterior chest, the periphery of the LD muscle is sutured to the chest wall along the medial, superior, and
lateral borders using 3-0 Vicryl to define the breast pocket (Table 1). The breast/chest wall skin is sutured to the flap in a multi-layer closure. A small subcutaneous pocket on the inferolateral chest wall is made for the port (Table 1). Spectrum implants are prepared and inserted as recommended by Mentor (Mentor, Irving, Tex.). The LD muscle is then sutured to the chest wall along the inferior border. The implant is inflated with normal saline to maximally fill out the breast skin and flap. Operative time, excluding mastectomy (if performed), is <2 hours for a unilateral reconstruction (patient in lateral decubitus) and 4 hours for bilateral cases (including position change from prone to supine).

Expansion is usually started 2 weeks postoperatively and continued weekly on an outpatient basis until final size and shape are achieved (See Table 1 for more technical pearls).

**Port Removal Technique**

Consent to perform the expansion port removal under local anesthetic is obtained. The patient is brought to a minor procedures room and placed in a supine position with her ipsilateral arm to the port extended laterally, superiorly and medially leaving an opening inferiorly large enough to insert the Spectrum device.

Do not over dissect superior pole or suture the LD too proximally to avoid high riding Spectrum device

Dissect a small subcutaneous pocket inferolaterally outside of the breast pocket for the expansion port

To avoid deflation during port removal, ensure the connecting coupler (on the tubing to the expansion port) is free of scar. Grasp this and pull to disconnect the tubing from the device and seal the internal valve. If the connector itself pulls apart there will be leakage of the saline

**RESULTS**

Forty-one patients with 56 LD-reconstructed breasts were included. Patient demographics and surgical details are outlined in Table 2. Follow up ranged from 1 to 10 years (mean of 1 year). Table 3 details the Spectrum device selection, expansion procedure, and final implant volume. The most commonly used Spectrum device was the 325–390 cm3 implant (37.5%), and the average number of expansions per implant was 3.73 ± 0.43 (range 2–11 expansions). The final implant volume was 366.1 ± 32.7 cm3, with a range of 120–530 cm3.

The fate of expansion port removal is outlined in Table 4. The majority of patients (58.5%) kept the

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**Table 1. Tips and Pearls for Successful Single-stage LD Breast Reconstruction Using Spectrum Implants**

| Step | Tip |
|------|-----|
| 1    | Make the subcutaneous tunnel to pass the LD anteriorly as narrow as possible and close off once inset without any pressure around the pedicle |
| 2    | Define the breast pocket—suture the LD muscle to the chest wall laterally, superiorly and medially leaving an opening inferiorly |
| 3    | Do not over dissect superior pole or suture the LD too proximally to avoid high riding Spectrum device |
| 4    | Dissect a small subcutaneous pocket inferolaterally outside of the breast pocket for the expansion port |
| 5    | To avoid deflation during port removal, ensure the connecting coupler (on the tubing to the expansion port) is free of scar. Grasp this and pull to disconnect the tubing from the device and seal the internal valve. If the connector itself pulls apart there will be leakage of the saline |

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**Table 2. Characteristics of Patients Undergoing LD Myocutaneous Flap with Spectrum Implant Device (N = 41)**

| Characteristic | Frequency (%) |
|---------------|---------------|
| Age at time of initial surgery | |
| 36–40 | 5 (12.2) |
| 41–45 | 7 (17.0) |
| 45–50 | 6 (14.6) |
| 51–55 | 11 (26.8) |
| 56–65 | 8 (19.5) |
| 61–65 | 3 (7.3) |
| 66–70 | 1 (2.4) |
| (Average age = 54.3 +/- 5.6) |
| Overall timing of reconstruction | |
| Immediate | 12 (29.3) |
| Delayed | 23 (56.1) |
| Combination (one immediate, one delayed) | 6 (14.6) |
| Overall laterality of reconstruction | |
| Unilateral | 32 (78.0) |
| Bilateral | 9 (22.0) |
| Combined timing and laterality | |
| Immediate unilateral | 8 (19.5) |
| Immediate bilateral | 4 (9.8) |
| Delayed unilateral | 18 (43.9) |
| Delayed bilateral | 5 (12.2) |
| Combined one immediate, one delayed | 6 (14.6) |

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**Table 3. Details of Spectrum Implant Device Expansion Process for Patients Undergoing LD Myocutaneous Flap Reconstruction. Total implants (N = 56)**

| Characteristic | Frequency (%) |
|---------------|---------------|
| Implant size (Cm^3) | |
| 225–270 | 5 (8.9) |
| 275–330 | 9 (16.1) |
| 325–390 | 21 (37.5) |
| 375–450 | 16 (28.6) |
| 425–510 | 5 (8.9) |
| No. expansions per device | |
| 2 | 8 (14.3) |
| 3 | 15 (26.8) |
| 4 | 17 (30.4) |
| 5 | 7 (12.5) |
| 6 | 6 (10.7) |
| 7+ | 5 (9.1) |
| (Average = 3.73 ± 0.43 expansions) |
| Final implant volume (Cm^3) | |
| 100–150 | 3 (5.4) |
| 151–200 | 2 (3.6) |
| 201–250 | 4 (7.1) |
| 251–300 | 8 (14.3) |
| 301–350 | 10 (17.9) |
| 351–400 | 14 (25.0) |
| 401–450 | 6 (10.7) |
| 451–500 | 6 (10.7) |
| 501+ | 3 (5.4) |
| (Average = 366.1 ± 32.7 Cm^3) |
Spectrum device in place and had the expansion port removed under local anesthetic. The remaining expansion ports were either removed en bloc with the Spectrum device for any reason (24.4%) or were not removed at the time of this study (17.1%), as they were still in the post-expansion phase. The average duration the expansion port remained in situ for those who had them removed under local anesthetic was 9.29 ± 1.66 months.

Surgical outcomes for patients are outlined in Table 5. Overall, 6 patients (14.6%) had a major complication requiring a return to the main operating room. The most common reason for return to the main operating room was capsular contracture occurring in 4 patients and representing 66.7% of all major complications. Three patients required a partial capsulectomy (5.3%) and 1 required a capsulotomy with implant repositioning (1.8%). The remaining reasons for return to the main operating room were infection (1.8) and venous congestion of the LD flap (1.8%). Interestingly, on exploration this was found to be due to a kink in the thoracodorsal pedicle caused by tethering of the serratus branch. Five patients (12.2%) elected to have the Spectrum device exchanged for a gel implant due to a kink in the thoracodorsal pedicle caused by tethering of the serratus branch.

Eleven minor complications occurred, the most common of which was seroma formation at the breast site (3 patients). All of the breast seromas were in immediate reconstructions. Seromas were managed with the in situ suction drains placed at the time of the operation (one deep to and another superficial to the latissimus muscle) or, if the drains had already been removed, were aspirated in clinic. Seroma formation and delayed wound healing at the donor site were equally common, occurring in 2 patients each. Additional minor complications included delayed wound healing at breast site (1 patient), mastectomy flap necrosis (1 patient; managed with bedside debridement and secondary intention healing), minor infection at breast site (1 patient, managed with oral antibiotics), and minor infection at back donor site (1 patient, managed with oral antibiotics). No incidences of fat necrosis occurred. Fortunately, none of the complications affected adjuvant therapy and only 1 Spectrum device was compromised (due to infection).

**DISCUSSION**

The increasing popularity of single-stage breast reconstructions has demonstrated economic benefit as well as improved patient experience, as only 1 procedure in the main operating room is required.\textsuperscript{2,5} However, not all patients are suitable candidates for a purely implant-based or autologous tissue reconstruction using abdominal flaps and as such, the LD flap remains an option in the breast reconstruction algorithm.\textsuperscript{3} Like many breast reconstruction surgeons, the senior author has adopted DTI reconstruction, given its many benefits (single-stage prepectoral, no donor site morbidity, etc.). However, in the senior author’s practice, there is still an important role for the LD flap, which offers enhanced reliability in certain patients. The typical patients for LD over a pure alloplastic reconstruction are often in the setting of previous radiation or those in need of soft tissue coverage but are not candidates or do not desire an abdominally-based surgery. LD with Spectrum devices represent approximately 15% of the senior author’s reconstructions. With respect to preoperative radiation, in the senior author’s practice, it is not an absolute contraindication to pure alloplastic reconstruction. However, the higher complication rate in these reconstructions is reviewed with the patient. The benefits of LD and abdominally-based reconstructions are also presented. Ultimately, the patient’s goals and preferences dictate the eventual selection of reconstruction technique.
That being said, it is the senior author’s preference to do an abdominally-based or LD and Spectrum reconstruction in patients who have received preoperative radiation.

The technique reported in this study eliminates the most criticized disadvantages of using this flap—a return to the main operating room for tissue expander exchange for permanent implants. Other authors have described their use and outcomes using expander/implant devices for various types of breast reconstruction; however, this is the first in-depth look at a similar technique in LD reconstructions.10

Spectrum implants were designed to act as both tissue expanders and permanent implants. The expansion port is remote and often positioned inferiorly and outside the implant pocket on the lateral chest wall. The incidence of capsular contracture in our study was 7.1%, which is low compared with the 40% reported by Cordeiro et al11 in 2-stage alloplastic reconstructions without radiation. No difference in capsular contracture rate between patients who received radiation therapy was found. Our infection rate was comparable to the literature at 1.8%.10,12 As these devices are available with a smooth surface, the risk for development of breast-implant–associated anaplastic large-cell lymphoma (BIA ALCL) is low.13 Furthermore, anecdotally, patients rarely complain about the texture of their LD reconstructed breasts (with saline-filled Spectrum devices) compared with their pure saline implant reconstruction counterparts. This is likely because the thickness of the overlying LD flap maintains a natural feel to the reconstructed breast. This was demonstrated by 2 patients in this cohort who opted for gel implants on contralateral breast that was augmented for symmetry. Neither patient reported significant differences between the sides, which the authors feel is likely due to the thickness of the overlying LD flap. In rare cases where rippling is present, it is typically mild, and some patients request exchange for a silicone implant (Fig. 2). Despite the difference in fill between the (saline) Spectrum and gel implant in the symmetrized breast, patients did not report feeling significant differences. With respect to symmetrization (Table 6), patient preference dictates if the contralateral breast is operated on. In preoperative consultation, evaluation of the contralateral breast is performed and if there is an existing size or contour discrepancy or there will likely be one postoperative (eg, lack of upper pole fullness in ptotic breasts compared with reconstruction with a Spectrum), then this is reviewed with the patient. The augmented or reduced contralateral breast is targeted to match the patient’s desired final size and shape. The flexibility of the Spectrum device in the reconstructed device allows postoperative adjustments to match the symmetrized breast.

Additional advantages of using the Spectrum implants (Mentor, Irving, Tex.) include the ability to tailor expansions to improve symmetry as tissues settle postoperatively, which, in our study, was achieved in an average of 4 expansions. Using Spectrum implants with LD flap reconstruction enables the surgeon to better match the mild ptosis (Fig. 3) or accommodate patients’ breast size preferences (Fig. 1B). It is also advantageous for patients with a very tight breast pocket who could not fit even a small implant (such as the patient who had an ultimate fill volume of 120 cm³ in this cohort). The Spectrum device size is chosen preoperatively and confirmed intraoperatively, and is based primarily on base width of the breast more than the volume of the device. Volume adjustment postradiation therapy occurs rarely in a small minority of patients. From an economic perspective, LD reconstructions boast financial benefits. The cost of a Mentor tissue expander and permanent silicone implant in a 2-stage reconstruction is more than double that of a single-stage reconstruction with a Spectrum implant (Mentor, Irving, Tex.) for the devices alone, excluding additional expenses associated with a second operation. Previous studies have also shown that LD reconstruction has significantly less cost than abdominally-based free flap reconstruction.14,15 The study by Marchac et al (2011) showed a 22% cost reduction for LD compared with DIEP in unilateral reconstructions. However, their average length of stay for LD with implant reconstructions was 5 ± 2 days compared with 1–2 days in our centre.14 This difference would make the economic benefit of the LD even more apparent. This being

### Table 6. Details of Preoperative Radiation Therapy and Concurrent Surgical Procedures during Reconstruction Using LD Myocutaneous Flap with Spectrum Implant Device

| Characteristic                                      | Frequency (%) |
|-----------------------------------------------------|---------------|
| Preoperative radiation therapy                      | 24 (58.5)     |
| No radiation therapy                                | 13 (31.7)     |
| Unilateral therapy                                  | 4 (9.8)       |
| Bilateral therapy                                   |               |
| Concurrent surgical procedures during initial       |               |
| reconstruction                                      |               |
| Contralateral reduction mammoplasty                 | 6 (14.6)      |
| Contralateral augmentation mammoplasty (not with Spectrum device) | 2 (4.9)   |

*Fig. 2. Example of rippling defect with the Spectrum device. Left delayed breast reconstruction with LD flap and Spectrum device with contralateral reduction mammoplasty, which demonstrated mild rippling, leading to patient requesting exchange for silicone implant. Arrows indicate areas of rippling.*
said, the use of any implant likely necessitates another surgery in the long term. With an average age of 54 years in our patients, the number of additional ORs for an implant exchange will likely be modest.

In an effort to avoid any complications surrounding the use of implants in LD breast reconstruction, some authors describe a purely autologous LD reconstruction using fat grafting. High aesthetic and patient satisfaction outcomes have been described with lipofilling. This technique, however, is resource intensive, as it often requires a second and occasionally third stage in the main operating room to achieve adequate volume to the reconstructed breast. Additionally, fat grafting alone may be insufficient to achieve an adequate volume in large-breasted patients.

Our study is not without limitations. It is retrospective and a single-surgeon’s experience from a single center. However, our outcomes were comparable to those published by others. We did not specifically investigate patients’ experience of the port removal under local anesthetic. Anecdotally, however, this was very well tolerated, and the additional small scar on the chest wall was not considered to be a problem by patients.

**CONCLUSIONS**

The LD flap remains an attractive option for breast reconstruction in patients who may not be candidates for, or do not desire, a purely implant- or abdominally-based reconstruction. In our experience, in cases where an LD reconstruction is selected as the best option for a given case, the use of Spectrum devices leads to the majority of patients (59%) requiring only 1 stage, compared with traditional TE and permanent implant reconstructions where 100% of patients necessitate a second stage. The minority of cases that required second stages were typically due to capsular contracture with implant malposition. This study shows a safe and effective way to perform a single-stage LD breast reconstruction using Spectrum implants (Mentor, Irvine, Calif.).

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Fig. 3. A, Preoperative appearance of breasts. B, Postoperative result showing similar ptosis between breasts following right immediate breast reconstruction with LD flap and Spectrum device with left symmetrization procedure with placement of Spectrum implant.
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