Lower extremity anterior compartment syndrome complicating bilateral mastectomy and immediate breast reconstruction: A case report and literature review

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AY Tashakkor, SA Macadam. Lower extremity anterior compartment syndrome complicating bilateral mastectomy and immediate breast reconstruction: A case report and literature review. *Can J Plast Surg* 2012;20(2):103-106.

'Well leg compartment syndrome' refers to compartment syndrome occurring in a nontraumatic setting. This occurs most commonly in the lower limb during surgery performed with the patient in an anatomically vulnerable position. While this complication is well documented in the setting of orthopedic, urological and gynecological surgeries, it is an exceptionally rare complication in plastic surgery; only seven cases have been published on compartment syndrome complicating an operation performed on a supine patient. A case involving a 56-year-old woman who developed an anterior compartment syndrome of her right lower leg following a bilateral mastectomy with immediate breast reconstruction is presented. A detailed literature review is also included.

Key Words: *Breast reconstruction; Compartment syndrome; Postoperative complication; Supine*

Acute compartment syndrome (CS) is a serious condition associated with increased intracompartmental pressure. Most cases of CS occur in the setting of trauma, usually secondary to local hemorrhage after a fracture (1). 'Well leg compartment syndrome' (WLCS) is a term reserved for CS in a nontraumatic setting, particularly associated with inappropriate positioning of the patient's lower limb during surgery performed with the patient in an anatomically vulnerable position (2). The etiology of WLCS is not well understood. Prompt surgical intervention consisting of compartment-releasing fasciotomy is recommended to reduce or possibly prevent acute and long-term complications (3). We present a case of bilateral mastectomy and immediate breast reconstruction complicated by lower leg CS in a 56-year-old woman, followed by a detailed literature review.

CASE PRESENTATION

A 56-year-old woman diagnosed with in situ ductal carcinoma of the right breast in October 2009 is presented. The patient elected to undergo a right skin-sparing mastectomy as well as simultaneous prophylactic left skin-sparing mastectomy with immediate bilateral reconstruction using deep inferior epigastric artery perforator (DIEP) flaps. The patient had no concurrent medical problems. She was not treated with chemotherapy or radiation. She was 165.1 cm in height with a body mass index of 22.6 kg/m². She had been physically active and regularly exercising for most of her life but had stopped exercising three years previously.

Operative procedure

Bilateral skin-sparing mastectomies were performed in April 2010. Standard single-perforator DIEP flaps were raised bilaterally. Prolene

Un syndrome des loges des membres inférieurs antérieurs compliquant une mastectomie bilatérale suivie d'une reconstruction mammaire immédiate : un rapport de cas et une analyse bibliographique

On observe surtout le syndrome des loges de la jambe « en santé » en situation non traumatique dans le cadre d'une opération exécutée sur un patient en position anatomique vulnérable. Cette complication est bien étayée en cas d'opération orthopédique, urologique ou gynécologique, mais il s'agit d'une complication d'une extrême rareté en chirurgie plastique, puis qu'il existe seulement sept cas publiés de syndrome des loges compliquant une opération effectuée sur un patient en position couchée. Les auteurs présentent le cas d'une femme de 56 ans qui a présenté un syndrome des loges de la jambe inférieure droite après une mastectomie bilatérale suivie d'une reconstruction mammaire immédiate. Ils incluent une analyse bibliographique détaillée.

mesh was used to reinforce the abdominal closure. She was supine for the majority of the operation. Before separation of the flap, she was repositioned in the semisitting position to verify that the abdomen would close. She was then returned to the supine position. From the onset of abdominal closure until completion of the case, the patient was in a hip-flexed position for approximately 2 h. Retrospectively, no intraoperative malposition of the legs was noted. Pneumatic intermittent calf-compression devices and thromboembolic deterrent stockings were applied bilaterally throughout the procedure to prevent deep vein thrombosis. Blood loss was recorded to be 500 mL and the patient received 6 L of crystalloid and 200 mL of colloid fluid. In total, the duration of the procedure was 12.5 h. Her average urine output was 48 mL/h and mean arterial pressure measured through an arterial line ranged from 51 mmHg to 84 mmHg throughout the case. Standard prophylaxis with subcutaneous heparin was administered postoperatively.

Postoperative course

One hour after completion of surgery, slight bilateral swelling of the patient's lower legs and ankles, and subjective numbness of the right hallux was charted. On postoperative day 1, the patient began to experience pain in her right lower extremity distal to her right knee. Her pain gradually worsened. On postoperative day 2, the right calf circumference was documented to be 1.27 cm wider compared with her left calf. Neurovascular examination was normal bilaterally. Mild redness and swelling in her right leg was noted and her right anterior compartment was tense on palpation. There was no pain on passive stretch of the anterior compartment of the right leg, but she complained of pain to palpation of the compartment. She was able to

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Figure 1) Right lower extremity of a 56-year-old woman diagnosed with compartment syndrome following breast reconstruction. Note the abnormally dark and dusky appearance of the musculature

plantar flex her right foot, but was unable to dorsiflex her ankle or elevate her toes. Findings on her left leg were unremarkable. The surgeon had a high index of suspicion for anterior CS, which was confirmed by compartmental pressure measurement using a Stryker needle, which demonstrated an anterior compartment pressure of 90 mmHg on the right leg compared with a right posterior compartment pressure of 10 mmHg. On further inquiry, the patient recalled multiple incidences of 'shin splints' in her right leg, precipitated by rapid or long-distance walking during the month before her surgery. The pain was severe enough to force the patient to stop walking, but was alleviated when she rested for several minutes.

Anterior compartment decompression

An orthopedic consult was obtained and the patient was emergently returned to the operating room for a single lateral-incision, four-compartment fasciotomy of her right leg. The posterior and lateral compartment muscles were noted to be viable as indicated by active pinpoint bleeding. There were no local signs of an infection, hematoma or seroma to immediately account for the increased intracompartmental pressure. There was evidence of significant hypoxic injury to the anterior compartment muscles indicated by their dusky and abnormally dark appearance (Figure 1); all muscles of the anterior compartment were noncontractile. The lateral compartment and the two posterior compartments were entirely normal. The incision was left open with sterile dressings (Figure 2) and arrangements were made for her to return for closure of incisions, which was performed two days later.

Postoperatively, she was placed in an ankle-foot orthotic (AFO) splint, which she used exclusively for ambulation. Two weeks after the bilateral DIEP reconstruction, her breasts and abdomen had healed completely. Her right leg was still swollen and she was unable to dorsiflex her right ankle. Physiotherapy commenced one month postoperatively. At two months postoperatively, she had a flicker of right toe extension and very limited right ankle extension. Her passive right ankle flexion/extension was good and she ambulated well in the AFO.

Four months postoperatively, the patient was assessed by a vascular surgeon for a potential etiology as well as possible risks to the contralateral lower extremity. A treadmill exercise challenge demonstrated markedly raised intracompartmental pressure in the left lower extremity anterior compartment consistent with asymptomatic chronic exertional CS.

One year postsurgery, the patient remained unable to dorsiflex her right foot and she demonstrates a clear dropfoot-type gait. Her

Figure 2) Right lower extremity of a 56-year-old woman diagnosed with compartment syndrome following breast reconstruction. Postfasciotomy, the incision was left open with sterile dressings for two days

neurological examination reveals entirely normal sensation of the lower extremities bilaterally; however, her right leg motor function demonstrates 2+ function in the tibialis anterior muscle, 2+ functions in the extensor digitorum longus tendon as well as the extensor hallucis longus, with all other muscles being normal. She requires her AFO splint during ambulation. She continues physical therapy and will be reassessed for a potential tendon transfer.

DISCUSSION

After a comprehensive literature search for all cases published to date, we encountered only seven relevant reports (4-10), which are descriptively summarized in Table 1. WLCS associated with a surgery performed supine is exceptionally rare and, hence, poorly characterized. Reports similar to ours have repeatedly been published in the setting of prolonged orthopedic (11-12), urological (13-14) and gynecological (15-16) surgeries in which patients are frequently placed in the lithotomy, the hemilithotomy or the decubitus position intraoperatively. The elevated position of the patient's lower extremities places them at particular risk for WLCS.

CS is associated with significant morbidity and, in some cases, mortality (17). Prompt diagnosis and surgical treatment is performed to prevent irreversible damage. Early signs of CS include severe pain, particularly on passive stretching of the involved muscles and diminished sensory discrimination (18). Pulselessness and eventual local paralysis are late signs associated with a relatively poor prognosis (18). However, the clinical signs and symptoms of acute CS are widely recognized to be unreliable (1,19-22). A high index of suspicion is thus necessary for prompt diagnosis. Compartmental pressures are routinely measured, often by a Stryker needle, for confirmation, with normal anterior compartment pressure being <10 mmHg.

Pathophysiology and etiology of WLCS

The underlying mechanism of WLCS is hypothesized to be due to vascular insufficiency and hypoperfusion of compartmental muscles, or external forces compressing and raising the intracompartmental pressure. The rapidly progressive clinical signs of CS likely result from its self-amplifying pathophysiology. The initiating factor may be acute ischemia of the muscles within the compartment, which results from perfusion failure due to vascular obstruction, systemic hypotension or trauma. This ischemia results in tissue membrane damage, which in turn results in fluid leakage through capillaries and muscle membranes. Reperfusion injury causes additional leakage through the vasculature and further expansion of local edema (14). Leaked fluid collects within the limited, nonexpandable compartmental space. This leads to an intracompartmental pressure near or above the effective capillary pressure, which hinders further arterial perfusion causing further

TABLE 1

Summary of all published reports pertaining to compartment syndrome complicating surgeries performed on a supine patient

Author (ref), year	Patient age, years/sex	Type of surgery	Length of operation, h	Location of compartment syndrome	Initial symptoms leading to diagnosis	Potential contributing etiology
Beadnell et al (4), 1988	23/male	Maxillofacial reconstruction	Not reported	Right anterior and lateral leg compartments	Right calf pain, tenderness and a positive Homans' sign; erythematous overlying skin; decreased sensation over the lower right leg, right foot drop and paralysis of the right peroneus muscles; increased intracompartmental pressure	<ul style="list-style-type: none"> • Improper intraoperative patient positioning • Incorrect leg-strap placement during surgery • Trauma during the postoperative transport and recovery phase
Leroux et al (5), 1999	26/male (ASA 1)	Maxillofacial reconstruction	12	Bilateral tibialis anterior leg compartments	Progressively worsening pain; tenderness and edema on palpation; tibial nerve deficits; symptoms bilaterally	<ul style="list-style-type: none"> • Long-lasting procedure • Controlled hypotension • Inappropriate position of the lower limbs • Hardness of operating tables • Rigid rubber heel support
Kavouni et al (6), 2000	30/female	Mastectomy with immediate free TRAM flap	5.75	Bilateral antero-lateral leg compartments	Severe leg pain; edema; tenderness and indurations localized to 12 cm above lateral malleolus; increased intracompartmental pressure; symptoms similar bilaterally	<ul style="list-style-type: none"> • Latex-covered heel pads
O'Shea et al (7), 2000	43/female	Whipple's pancreaticoduodenectomy	9	Right posterior leg compartment	Left lower limb discomfort; visible, tender erythematous band-like area, 8 cm × 5 cm on the posterior aspect of calf; increased intracompartmental pressure	<ul style="list-style-type: none"> • Prolonged surgical duration
Pollard et al (8), 2009	44/female	Delayed left DIEP flap breast reconstruction	9	Left posterior and anterior leg compartments	Bilateral leg cramps; swollen left leg on postoperative day 4; leg cramps and radiological changes on postoperative day 9	<ul style="list-style-type: none"> • Deliberate hypotension • Presurgical injury with elevated intracompartment pressures • External intraoperative forces or drug effects
Teeples et al (9), 2010	53/male	Maxillomandibular	5.5	Left anterior leg compartment	Bilateral pain in lower extremities, severe pain and later swelling of left leg; tenderness on palpation and muscle weakness in left leg	<ul style="list-style-type: none"> • Thrombo-embolic deterrent stocking
O'Connor et al (10), 2010	27/male (ASA 1)	Upper limb vascular reconstruction	15	Left medial and dorsal leg compartments	Severe pain in left foot; tense and swollen left calf and dorsum of the foot; increased pain on passive stretching of left foot; increased intracompartmental pressure	<ul style="list-style-type: none"> • Preoperative chronic compartment syndrome • Intraoperatively high exertional forces malpositioning, prolonged pressure, trauma or poorly tolerated fluid shifts
Tashakkor and Macadam (present study), 2012	56/female (ASA 2)	Bilateral mastectomy with immediate bilateral DIEP flap breast reconstruction	12.5	Right anterior leg compartment	Progressively worsening 'pressure' pain in right lower leg; wider calf circumference of affected limb; pale skin and slight swelling of lower legs and ankles, bilaterally; pain to palpation of the right anterior compartment; inability to dorsiflex right ankle or elevate right toes; increased intracompartmental pressure	

ASA American Society of Anaesthesiologists (status); DIEP Deep inferior epigastric artery perforator; ref Reference; TRAM Transverse rectus abdominis myocutaneous

ischemia (14). This worsening cycle rapidly increases the intra-compartmental pressure, abolishing effective perfusion to the area within a few hours and, in turn, causing local ischemia and eventual necrosis. Recognized attributable risk factors for WLCS include obesity, hypotension, malposition of the extremity and prolonged surgical duration.

Case review

Contributing factors in our case likely included the long duration of the procedure and, possibly, improper or excessively tight application of the compression devices. External forces placed on the lower extremities can dramatically restrict the compartmental volume and raise intracompartmental pressures intraoperatively (23). The patient's pre-existing chronic exertional CS may have predisposed her to an acute event. While the exact cause of WLCS in this patient will likely

never be determined, potential factors such as inflammation from a previous injury or an abnormally tight osteofascia, aggravated by secondary intraoperative events, such as abnormally high exertional forces, prolonged pressure or poorly tolerated fluid shifts, may have contributed.

In the present case, more than 40 h had elapsed before definitive diagnosis of WLCS was made. This delay was partially due to the exceptional rarity of this condition. Serious and potentially tragic outcomes of WLCS warrant clinician awareness. We recommend that patients complaining of recent shin splints or other potential risk factors for WLCS be thoroughly evaluated and potentially referred for stress testing before any surgery. For high-risk patients, we recommend pneumatic compression devices to be placed before induction of anesthesia, enabling the patient to communicate any symptoms indicating improperly placed garments. At the Vancouver General Hospital

(Vancouver, British Columbia), the senior author (SAM) also enforces regular limb checks for surgeries lasting longer than 3 h or for surgeries that include a position change intraoperatively.

CONCLUSION

Reconstructive and plastic surgery covers a broad spectrum of procedures, most of which are performed on a supine patient. Complications in our case are not unique to DIEP surgery but may occur in any surgical setting. We hope that our experience with this case increases clinician awareness in the setting of reconstructive and plastic surgery, as well as motivates institutions to implement team education programs aimed at earlier diagnosis and treatment of CS.

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