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CASE REPORT
Reconstructive

A Novel Technique to Lengthen the Reverse Latissimus Dorsi Muscle Flap Arc

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Summary: Reconstruction of the lower lumbar region is challenging for surgeons due to limited locoregional flap choices. The latissimus dorsi muscle flap is a mainstay for this area; however, there are several limitations, including that the dominant thoracodorsal artery and vein pedicle-based flaps are not reachable for reconstruction of the lumbar region, while perforator of intercostal artery and veins pedicle-based reverse latissimus dorsi (RLD) flap mobility is limited by including multiple perforators. Here, we describe a novel operative technique that lengthens the rotation arc of RLD muscle flaps. The surgical technique is as follows: RLD is elevated based on lower perforator of intercostal artery and veins (usually including two of the eighth–11th perforators); thoracodorsal artery and vein are ligated; and the flap is mobilized toward the defect. When RLD was not reachable to the defect, the far aspect of the intercostal artery and vein from the defect was ligated and the perforator was elevated with the near aspect of the intercostal artery and vein from intercostal space. Because the intercostal space measured between approximately 3 cm and 4 cm, this dissection gained 3–4 cm of rotational arc per intercostal space. Moreover, because the lower ribs follow a medio-cranial to latero-caudal direction, this dissection enabled the flap to extend latero-caudally or medio-cranially while maintaining its blood supply. Other applications using this technique may involve expanding the RLD flap arc caudally, ventrally, and ipsilaterally. We believe this new technique provides a reliable alternative for lower back reconstruction.
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Lower lumbar reconstruction remains a challenge to the surgeon. There are several locoregional flap options for reconstruction for this area[1–4]; however, especially in the midline, flap mobility often prevents these flaps from reaching the whole defect, and postoperative complications may therefore become a concern. Moreover, free flap reconstruction is not easy to perform in this area due to the difficulty of postoperative management and lack of suitable recipient vessels. The latissimus dorsi (LD) flap with the minor pedicles (perforators of the intercostal artery and veins, PICAVs), known as a reverse LD (RLD) flap,[5–11] is a crucial option for reconstruction of the lower back; however, this flap has a relatively unstable blood supply because it includes only one pedicle. To stabilize the blood flow of an RLD flap, Grinfeder[5] recommended including two or more pedicles; however, this may limit the flap arc. Kwang[6] pointed out the bulk of its pedicle when including multiple perforators. Giesswein[7] described supercharging the RLD flap by anastomozing the thoracodorsal artery and vein in the recipient site. To overcome these drawbacks, we introduce a novel technique to lengthen the RLD flap arc while maintaining the blood supply, in which PICAVs are dissected and freed from the intercostal space.

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SURGICAL TECHNIQUE OF LENGTHENING RLD

The surgical technique of lengthening RLD is performed as follows (Fig. 1): RLD is elevated based on the lower PICAVs (usually including two of the eighth–11th perforators), and either of the intercostal perforators is dissected until it runs into the intercostal artery and vein (ICAV). Then, the far aspect of the ICAV from the defect is ligated, and the perforator is elevated with the near aspect of ICAV, which is dissected from the intercostal space until

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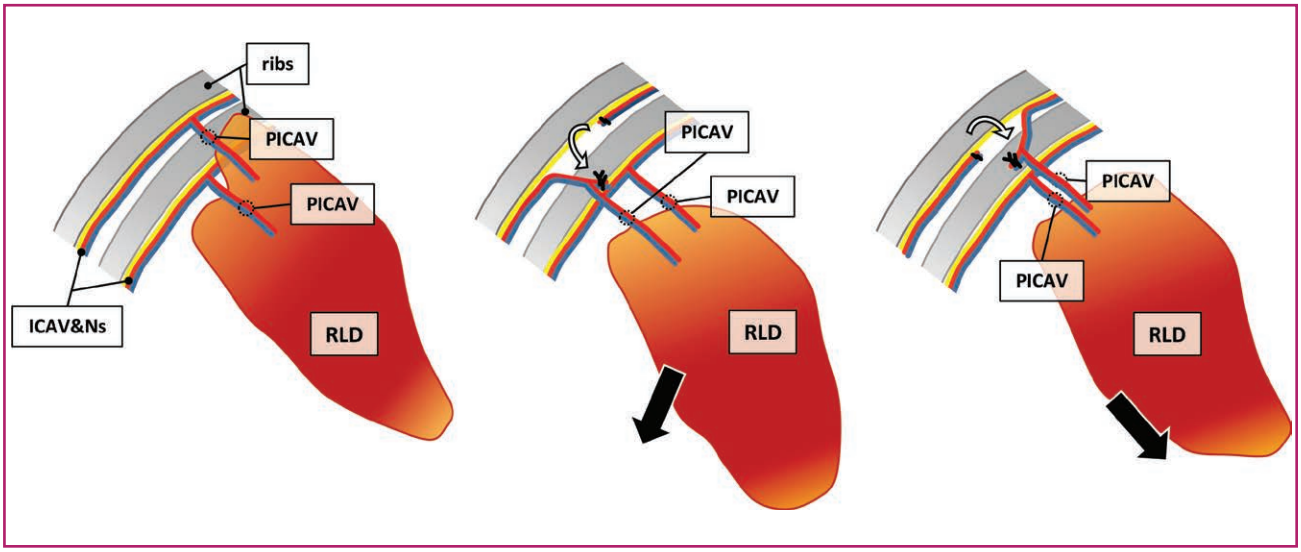

Fig. 1. Schema of the operative technique. The flap is elevated based on two PICAVs. Dorsal side of ICAV is ligated, and the perforator is elevated with the ventral side of ICAV (white arrow). As lower libs run medio-cranial to latero-caudal direction, this dissection enables the perforator vessels to reach latero-caudal direction (black arrow). The ventral side of ICAV is ligated, and the perforator is elevated with the dorsal side of ICAV (white arrow). This dissection enables the perforator vessels to reach mediocaudal direction (black arrow). PICAV: perforator of intercostal artery and vein, ICAV: intercostal artery and vein.

the flap gets enough mobilization to cover the defect. Because the intercostal space measures approximately between 3 cm and 4 cm, this dissection gained 3–4 cm of rotational arc per intercostal space. During vessel dissection, the intercostal nerve was carefully dissected and preserved, freeing the vessels from the intercostal space.

CASE REPORTS

Case 1

A 45-year-old woman with a large soft tissue tumor located in the lower back region in the erector spinae muscle at the 11th and 12th rib level was diagnosed with myxofibrosarcoma. The defect following tumor resection included the 11th and 12th ribs, the transverse process of the first to third lumbar vertebrae, the paravertebral muscle, and the peritoneum. The fascia lata was fixed to repair the peritoneum, and then the RLD flap was elevated based on the ninth and 10th PICAVs. (**See figure 1, Supplemental Digital Content 1,** which displays intraoperative photograph of case 1, which demonstrates that the peritoneum is reconstructed by fascia, and RLD flap is elevated. RLD:reverse latissimus dorsi flap, F:fascia lata. **http://links.lww.com/PRSGO/B683**.). The flap did not extend to cover the entire defect; further mobilization was obtained by dissecting the ninth ICAV from the intercostal space. The dorsal aspect of the ICAV was ligated, and the ninth PICAV was elevated with the ventral aspect of ICAV from the intercostal space. (**See figure 2, Supplemental Digital Content 2,** which displays intraoperative photograph of case 1, which demonstrates that the RLD flap is lengthened. RLD:reverse latissimus dorsi flap, PICAV: perforator of intercostal artery and vein, ICAV: intercostal artery and vein. **http://links.lww.com/PRSGO/B684.**) The flap was successfully transferred to fill the defect. A local flap was used to cover the defect, and two suction drains were placed under the RLD flap and local flap. The patient was observed on the bed with alternating air pressure. The postoperative course was uneventful, and suction drains were removed on postoperative day 12. The patient was discharged from the hospital on postoperative day 20. At 4 months postoperatively, tumor recurrence with rapid growth was observed. At 7 months postoperatively, the patient died without wound-related complications.

Case 2

An 82-year-old woman suffered from a vertebrae compression fracture and underwent posterior thoracic spinal fusion between the ninth thoracic and third lumbar vertebrae. Postoperative wound dehiscence occurred, partially exposing the instrument. After 4 weeks of negative pressure wound therapy, the instrument was covered with granulation tissue, and reconstruction was performed. Following debridement, RLD was elevated based on the 10th and 11th PICAVs (Fig. 2). (**See figure 3, Supplemental Digital Content 3,** which displays the intraoperative photograph of case 2, which shows the defect after debriedement. **http://links.lww.com/PRSGO/B685**.) Because RLD was not accessible and did not cover the whole defect, the ventral aspect of the 10th ICAV was ligated, and PICAV was elongated with dissection of the 10th ICAV (Fig. 3). Finally, a local flap was used to cover the RLD, and the wound was closed. (**See figure 4, Supplemental Digital Content 4,** which displays intraoperative photograph of case 2, after the closure by local flap. **http://links.lww.com/PRSGO/B686**.) Two suction drains were placed under the local flap and the donor site of RLD. The patient was observed on the bed with alternating air

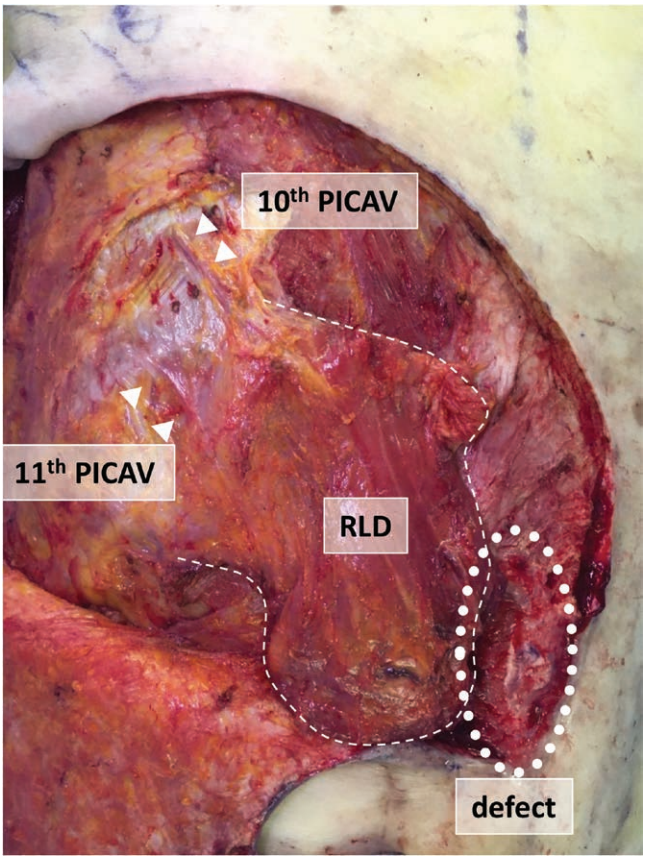

Fig. 2. Intraoperative photograph of case 2 RLD was elevated based on the 10th and 11th PICAVs. RLD is not reachable to cover the whole defect (white dotted circle).

pressure. The postoperative course was uneventful, and suction drains were removed on postoperative day 10. The patient was discharged from the hospital after 4 weeks of rehabilitation. There was no evidence of wound dehiscence or infection at the latest follow-up at 18 months.

DISCUSSION

Reverse LD flap was first described by Bostwick[8] in 1980 based on 225 cadaver investigations and has been mainly used to cover a lower lumbar region defect.[4–7,9,10] Stevenson[11] later reported that this flap could be elevated with the ninth–11th intercostal perforator of the posterior intercostal vessels that arise 5 cm lateral to the midline. One or more of these perforators can be sacrificed, depending on the flap mobility in reaching the defect. However, whether this critically affects flap survival remains unclear.

In our cases, RLDs were elevated based on two of the PICAVs. In both cases, the flaps did not fully reach the defect. Thus, we used the technique to lengthen the flap arc of RLD. In the first case, because the defect was located in the lateral lower back, we ligated the dorsal aspect of the ninth ICAV and gained the flap arc latero-caudally. Conversely, in the second case, the defect was located in the medial lower back; hence, we lengthened the flap arc of RLD mediocaudally by ligating the ventral aspect of the

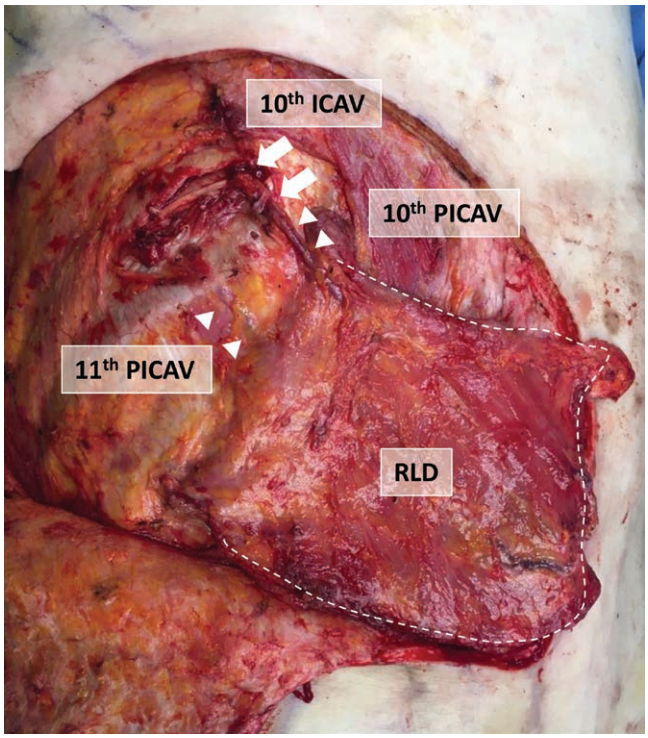

Fig. 3. Intraoperative photograph of case 2. The 10th PICAV (white arrowheads) was elongated with dissection of the 10th ICAV (white arrows). PICAV: perforator of intercostal artery and vein, ICAV: intercostal artery and vein

10th ICAV. In both cases, the flaps reached the defect successfully while maintaining blood flow. To our knowledge, our surgical case study is the first to report having applied this technique clinically.

We dissected only one of two pedicle ICAVs; however, dissection of both ICAVs may provide an enhanced rotation arc and, theoretically, several other methods may exist to mobilize this flap to other directions (Fig. 4); the lower ribs follow a medio-cranial to latero-caudal direction, enabling the flap to move from its original position caudally or laterally (ventrally) with ligation of the dorsal aspect of the ICAV. When the ventral aspect of the ICAV is ligated, the flap moves toward the midline or the contralateral side. This elevation can be undertaken through either dorsal or ventral ligation because the ICA derives from both the thoracic aorta and the internal thoracic artery.[12] The areas to be covered using the flap (lower back, lateral abdomen, and midline) are often challenging to reconstruct,[4,13] and this alternative technique may provide a new method to reconstruct these areas.

Finally, limitations for this procedure should be discussed. Although there were no wound complications in our cases, dissection of ICAV may cause vascular damage or spasm that results in partial/total necrosis of the flap. This dissection also may evoke intercostal nerve injury. Careful maneuver is demanded upon dissection.

CONCLUSIONS

To perform an RLD flap reconstruction for a lower back defect, we dissected the PICAV and freed them from the intercostal space. This enabled the flap to extend

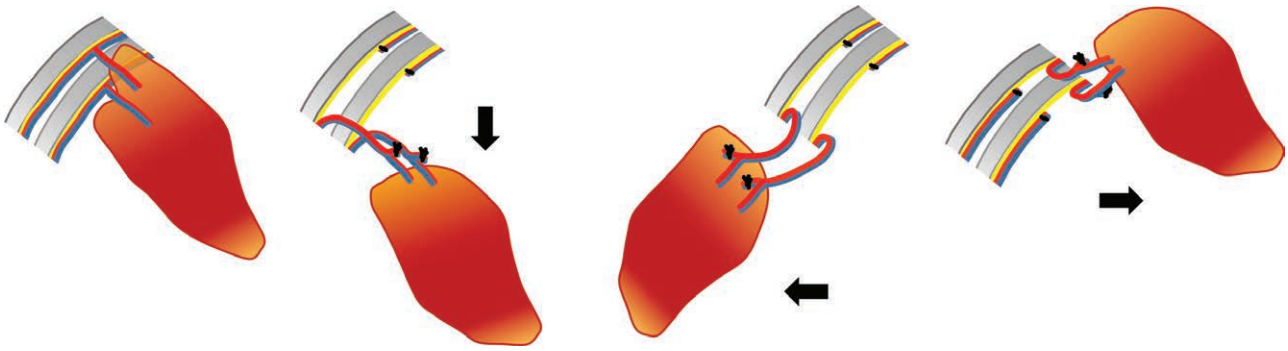

Fig. 4. Schema of the surgical procedure of gaining rotation arc. Microdissection of ICAV from intercostal space enables the flap to move from the original position toward the caudal side or lateral (ventral) side when ligating the dorsal side of ICAV and move toward the midline or contralateral side when ligating ventral side of ICAV.

caudally while maintaining its blood supply. Other applications using this technique may involve expanding the RLD flap arc caudally, ventrally, and contralaterally.

SUMMARY

Reconstruction of the lower lumbar region is challenging for surgeons due to limited locoregional flap options, with the latissimus dorsi muscle flap as the mainstay of reconstruction; however, there are several limitations, including that the dominant thoracodorsal artery and vein pedicle-based flap is not accessible for lumbar region reconstruction and that the PICAVs pedicle-based (RLD) flap mobility includes multiple perforators. Here, we describe a novel operative technique that lengthens the rotation arc of the RLD muscle flap. The surgical technique was performed as follows: the RLD was elevated based on the lower PICAVs (usually including two of the eighth–11th perforators), the thoracodorsal artery and vein were ligated, and the flap was mobilized toward the defect. When the RLD was not able to reach the defect, the far aspect of ICAV from the defect was ligated, and the perforator was elevated with the near aspect of ICAV from the intercostal space. Because the intercostal space measures approximately between 3 cm and 4 cm, this dissection gained 3–4 cm of rotational arc per intercostal space. Moreover, because the lower ribs follow a medio-cranial to latero-caudal direction, this dissection extended the flap latero-caudally or medio-cranially while maintaining its blood supply. Other applications using this technique may involve expanding the RLD flap arc caudally, ventrally, and ipsilaterally. We believe this new technique provides a reliable alternative for lower back reconstruction.

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