What can we learn from cases of internal mammary artery damage in coronary artery bypass graft?

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From July 1997 to April 2017, 286 cases of internal mammary artery (IMA) damage were recorded out of the 10,360 coronary artery bypass graft (CABG) operations with IMA harvest, with an incidence up to 2.7%, which is relatively high. The main reason for such high incidence might be the surgeons’ experience and the learning curve. Although one surgeon (Huang FJ) performed all these operations, the cases were operated in many different hospitals, and more than 200 surgical assistants who were young and inexperienced harvested the IMA. Therefore, we provide here some tips for young surgeons:

1. Differentiate the left internal mammary artery (LIMA) anatomy. When the LIMA is tightly adhered to the sternum or is far from the sternum proximally and kinks significantly, it can easily be damaged. Therefore, attention should be paid to this characteristic.

2. We recommend using coagulation output power of 20 W during IMA harvest for young surgeons.

3. Keep electrocautery from the IMA at least 0.5 cm away and shorten the time as much as possible. We also recommend radiosurgery, which is an atraumatic method, to harvest IMA rather than electrosurgery.\(^1\)

4. If the clip has been placed in the branch of the IMA, using electrocautery can cause thermal damage conducted by the clip. Therefore, we recommend using a pair of scissors or not touching the clip with the electrocautery.

5. Be careful during intraluminal operation. The use of metal probes and retrospective injection of papaverine to dilate spastic IMA may cause IMA dissection. We do not recommend using these procedures. If their use cannot be avoided, caution should be taken.

6. Do not use the Bulldog clamp to clamp the IMA before full heparinization in case of thrombosis.

Based on our protocol, we used different approaches to deal with IMA damage, considering its pathological reason and injury position. If the reason for the damage was endothelial disruption or stenosis, free IMA grafts were used for proximal damage. For distal damage, skeletonized IMA was used, or the length of the IMA was increased with the great saphenous vein (GSV). In terms of middle damage or dissection, if patients were older than 60 years, the GSVs were applied instead of the IMA. Otherwise, the radial artery (RA) or right IMA (RIMA) was applied separately, according to the narrow position of the left anterior descending artery (LAD). For bleeding IMA, we sutured it directly or applied a GSV patch. Free IMA grafts were also used when the IMAs’ length was not sufficient. Concerning potential damage, if the LIMA-LAD pulsatility index (PI) is higher than 5 and flow is lower than 15 mL/min by transit-time flow measurement (Medistim VeriQ, Oslo, Norway) detected near the anastomosis, additional GSV from aortic to LAD would be applied. Otherwise, no further modifications are performed.

One postoperative death occurred because of extensive thrombosis in the LIMA and GSV grafts. Two cerebral infarctions occurred postoperatively. An intra-aorta balloon pump was used in two cases. One minimally invasive incision was converted to a normal middle sternum incision, and one off-pump coronary artery bypass (OPCAB) was converted to on-pump CAB because of ventricular fibrillation while anastomosing the GSV to the posterior descending artery (PDA). One acute cardiac infarction occurred 4 h postoperatively. Adverse events occurred in eight (2.8%) cases with seven being major adverse cardiovascular and cerebrovascular events (MACCEs).

The past decades have witnessed the growth of the minimally invasive direct CAB (MIDCAB) and RobECAB techniques. Once LIMA damage occurs and results in the conversion to normal incision from minimal access coronary procedure, the effectiveness of minimally invasive CAB grafting is significantly impaired. Therefore, it is imperative to develop strategies to minimize or avoid LIMA damage. By improving the surgical skills and techniques, the incidence of LIMA damage can be significantly reduced, leading to better surgical outcomes.
invasive techniques is reduced. In our protocol, after the LIMA is damaged, we are forced to convert minimally invasive incisions to normal middle sternum incisions. Athanasiou et al. presented a management protocol to avoid conversion to sternotomy in MIDCAB and RobECAB cases for LIMA damage according to the location of LIMA injury: axillary bypass is applied for proximal LIMA, a shunt is made for mid-LIMA repair, and extension is used for distal LIMA.

Although long-term follow-up is lacking, there is no evidence to show the patency of the anastomosis between the LIMA and GSV. In one of our cases, 8-year postoperative angiography showed excellent flow in the conduit of the LIMA and GSV. This might be a valuable method of preserving the LIMA whose length is short. Moreover, placing the anastomosis closer to the origin of GSV can maintain the LIMA more effectively. In another case of IMA, stenosis occurred at the injured site (which was sutured directly with an 8–0 propylene suture) 6 months postoperatively. Therefore, we adopted a free IMA graft rather than suturing the injury directly once the injury reached half or more than the IMA’s diameter. In summary, our protocol is effective when IMA damage happens.

Conflicts of interest
None.

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How to cite this article: Chen M, Huang FJ, Wu Q, Zou YX, Zhu EJ, Zhang JW, Zhou Y, Yu JB, Cai KQ, Han B. What can we learn from cases of internal mammary artery damage in coronary artery bypass graft? Chin Med J 2019;132:377–378. doi: 10.1097/CM9.000000000000023