Perioperative Management

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18.1 Preoperative Preparation

18.1.1 Routine Preparation

The operation time of patients with pelvic malignancies is long and commonly needs 4–6 h or longer, and the amount of blood transfusion often exceeds 1600 ml. It's of significance for patients to receive a full assessment of the general situation including the examinations of metabolic disease, cardiovascular diseases, and respiratory disease. Radiotherapy or other conservative treatment should be adopted for patients with poor surgical tolerance and high risk of receiving surgical intervention. After the improvement of general status, surgical intervention could be considered. Surgery without perfect preoperative preparation often causes high level of intra- and postoperative risk, recurrence of tumor, or even the death of patients.

Early stage of infection is commonly caused by bacteria or fungus from the intestinal system or urogenital system, and these infection factors must be dispelled preoperatively. The most significant preoperative preparation is bowel preparation including the use of enema and laxative. Deep infection of wound is inevitable once there are intestinal damages during operation without a full preoperative bowel preparation. Commonly enema and laxative are adopted. Patients take fluids and laxative 2 days and 24 h preoperatively, respectively, and accept cleaning enema the night before surgery. If patients have high probability to receive intestinal surgery during operation, the preoperative bowel preparation should be more regular. Total parenteral nutrition can be applied for patients several days preoperatively for the purpose of keeping intestinal clean and saving strength. Huge retroperitoneal tumors often invade retroperitoneal viscera such as the ureter, colon, and rectum. For most of these cases, urethra shunt, nephrectomy, and colectomy should be adopted before surgery. If the ureter is invaded by tumor and difficult to be separated, ureteral catheterization should be adopted for the purpose of avoiding accidental injury of the ureter. If there is a probability to perform colectomy combined with colostomy or urethra shunt during surgery, surgeons of general surgery and urology should be involved in the surgical planning together. Although not all cases need these treatment measures during surgery, teamwork is a key factor and prerequisite for the success of pelvic tumor surgery.

Surgery for patients with pelvic lesions commonly encounters long surgery time and needs a large amount of blood transfusion. The surgery time and volume of operative blood loss for patients with pelvic lesions commonly varied depending on the different experience of practiced surgeon, locations of tumors, and pathological types. Autologous blood transfusion can only be adopted for individual cases, while for most of cases, sufficient blood supply should be prepared for intraoperative and postoperative use. When anticipated blood loss volume exceeded 2000 ml, fresh frozen plasma should be prepared to avoid coagulation dysfunction (anticipated blood loss volume Table 18.1).

Table 18.1 Anticipated blood loss volume of surgery for pelvic tumor

Type of resection	Intraoperative blood loss (ml)	Postoperative blood loss (ml)
Traditional hindquarter amputation	800–3500	300–600
Internal hemipelvectomy	1500–5000	300–800
Region I resection	400–2000	200–300
Region II resection		
Prosthetic replacement	1500–3000	400–600
Arthrodesis	2000–4000	300–600
Region III resection	400–2000	100–300
Sacrectomy	1000–3000	400–800
Total sacrectomy	3000–6000	400–1000

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18.1.2 Technique of Vascular Occlusion

The pelvic ring of the human body is a complicated and irregular area full of crucial vessels and highly vascularized. Surgery for patients with tumors located in this area leaves surgeons a chief difficulty: a large amount of intraoperative blood loss. Because of the irregular and complicated anatomical structure around the pelvis and sacrum, surgery for huge tumors located in the pelvis and sacrum commonly causes a large amount of intraoperative blood loss which may even influence the implementation of the operation plan. What's more, a large amount of blood loss and blood transfusion can also influence internal environment of the human body which raises the related risk of postoperative complications. Thus, reducing the intraoperative blood loss is the key factor for the success of surgery.

18.1.2.1 Intraoperative Ligation of Ipsilateral Internal Iliac Artery and Temporal Occlusion of Abdominal Aorta or Ipsilateral Common Iliac Artery (Fig. 18.1)

Before the application of abdominal artery balloon occlusion, intraoperative ligation of ipsilateral internal iliac artery and temporal occlusion of abdominal aorta or ipsilateral common iliac artery are often adopted for complicated surgeries of sacral and pelvic tumors. The patients are placed in a lateral position on the contralateral side and the barley incision is adopted. Then the musculus obliquus externus abdominis, musculus obliquus internus abdominis, and musculus transversus abdominis are incised layer by layer to reveal ipsilateral common iliac vessels and ipsilateral iliac arteriovenous. Confirm and ligate the ipsilateral internal iliac artery, and ligate the contralateral internal iliac artery if necessary. Detach upstream to reveal abdominal aorta, and place a nail file slipping into a rubber hose at 1 cm above the bifurcation of the common iliac artery for the purpose of preparing to occlude the abdominal aorta. This method of controlling intraoperative bleeding is still adopted for those patients with high risks of receiving aortic balloon occlusion such as advanced-aged patients with hypertension or diabetes.

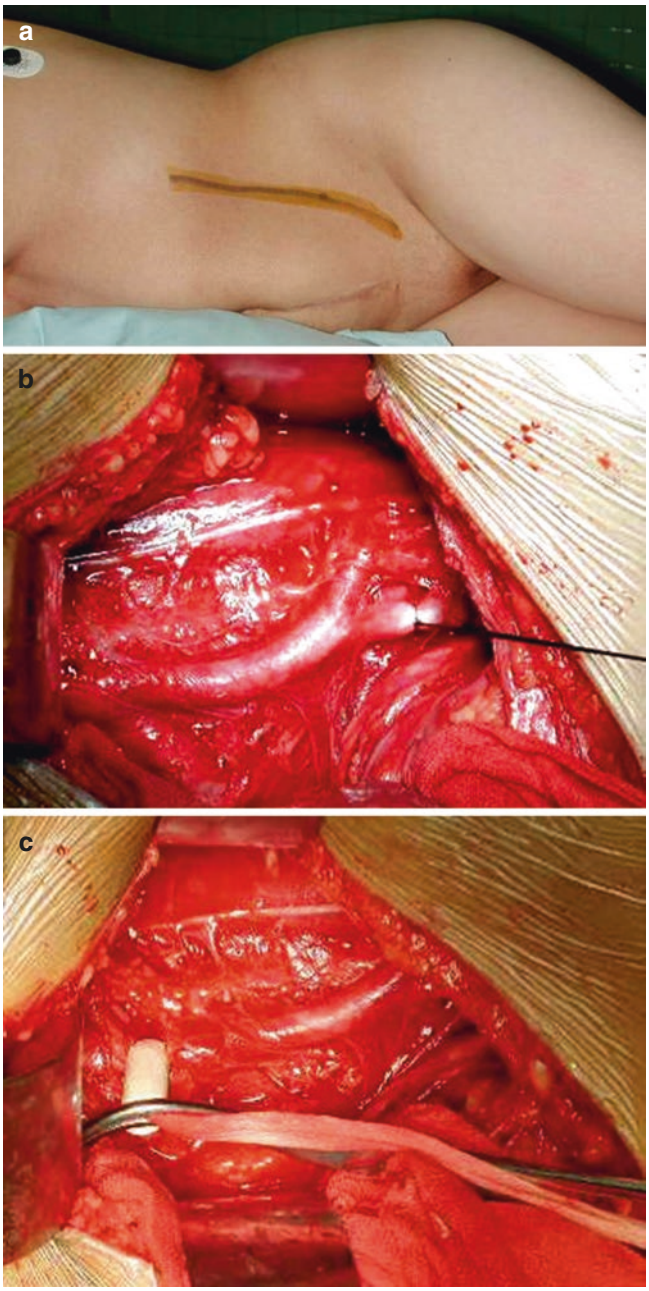

Fig. 18.1 (**a**) The patients are placed in a lateral position on the contralateral side and the barley incision is adopted. (**b**) Intraoperative ligation of ipsilateral internal iliac artery. (**c**) Temporal occlusion of abdominal aorta

18.1.2.2 Embolism Under Digital Subtraction Angiography (DSA)

With the ability of showing the blood supply of tumors definitely and occluding the blood supply by the means of embolism, DSA has gradually become a significant auxiliary means for pelvic surgery. Preoperative angiography and selective endovascular embolization under DSA as a common and important part of preoperative preparation of surgery for pelvic and sacral tumors can definitely show the blood supply within the extent of tumors and reduce the intraoperative blood loss.

The method of preoperative embolism for internal iliac artery is as follows: the catheter is inserted retrograde and craniad using the Seldinger technique via the percutaneous femoral arterial catheterization and then inserted into unilateral or bilateral internal iliac artery to investigate the location, character, extent, and blood supply of tumors after abdominal aortography. Embolize unilateral or bilateral internal iliac artery (commonly we choose the more severe side) and other target vessels using gelfoam particles or

Fig. 18.2 (**a**) The blood supply mainly comes from bilateral internal iliac arteries. (**b**) The blood supply decreases obviously after embolization of bilateral internal iliac arteries

stainless steel coils, and finally determine the embolization effect by abdominal aortography. Lateral circumflex femoral artery should be embolized by gelfoam particles for those cases tumors locate in front of acetabulum or ilium and semi-pelvic prosthesis replacement or hip replacement is considered. Retrograde the catheter back to the level of aorta abdominal or common iliac artery, and check the branches from the fourth and fifth lumbar arteries to the pelvis, and then embolize them selectively for those cases tumors locate in the rear of ilium. Strengthen packing of the puncture site after finishing the embolization, and carry out the surgery of the pelvis or sacrum within 24 h.

Commonly bilateral internal artery occlusion is applied before complicated pelvic surgery (Fig. 18.2). There are three disadvantages with this traditional method: the first is that patients may suffer from discomfort of lower abdomen such as acute abdominal pain, the second is that the hemostatic effect commonly is not that satisfying, and the third is that patients often suffer poor wound healing. All the phenomenons above are based on the anatomical structure below.

There are two groups of vascular networks within iliac blood vessels. One is vessel anastomosis between bilateral internal iliac arteries. This vascular network full of abundant anastomosis traffic branches containing the component from other vessels of enterocoelia and pelvic cavity is responsible for the blood supply of area around the pelvis especially gluteus maximus and lateral pelvic wall. The superior gluteal artery originates from the internal iliac artery. That's the reason why patients often suffer from discomfort of the lower abdomen and poor wound healing after bilateral internal iliac artery occlusion. Full occlusion of unilateral or even bilateral internal iliac artery is confirmed riskless for the reason that this vascular network contains numerous origins and anastomosis. Most of surgeons focus on the character of these vascular anastomosis branches and regard bilateral internal iliac artery occlusion as a routine method of iliac blood vessel embolism. The other important but undervalued vascular network is the vessel anastomosis between ipsilateral internal iliac artery and external iliac artery. This vessel anastomosis is mainly comprised of iliolumbar artery from the internal iliac artery and deep iliac circumflex artery from the external iliac artery and also has the component from lateral femoral circumflex artery and some branches from lumbar artery. This vessel anastomosis is responsible for the blood supply of pelvic medial wall and muscles around where the area is often invaded by tumors and operated on. Because of the existence of this vessel anastomosis, the hemostatic effect commonly is not that satisfying when bilateral internal iliac arteries are occluded. Thus, this vessel anastomosis is of great significance to the blood supply of pelvis.

18.1.2.3 Aortic Balloon Occlusion (ABO)

Blood volume loss during sacral tumor resection is mainly influenced by the location of the tumor, volume of the tumor, and tumor blood supply. Large pelvic tumors located anterior to the ilium or sacroiliac joint covering the surface of iliac vessels often hinder surgeons from ligating internal iliac artery or occluding the common iliac artery temporarily. In these situations, the ABO is necessary preoperatively for the surgical treatment of pelvic tumors.

Because of the existence of the second vessel anastomosis elaborated above, the hemostatic effect commonly is not that satisfying when unilateral or even bilateral internal iliac arteries are embolized. For those complicated cases with large sacral or pelvic tumors, preoperative aortic balloon occlusion is necessary. Commonly patients receive embolism the day before the surgery and receive preoperative aortic balloon implantation just before the surgery the next day. Sometimes embolism and surgery are planned to be implemented on the same day, and the aortic balloon is implanted just after the embolization. We should confirm repeatedly if obvious abnormity of segment between femoral artery and inferior abdominal aorta such as aortic aneurysm and aortic dissection exists. Severe artery diseases such as aortic aneurysm and aortic dissection are taken as contraindications for applying of ABO, while aortic plaque is acceptable for this operation.

The method of preoperative balloon dilation catheter implantation is as follows: the catheter is inserted retrograde and craniad using the Seldinger technique via the percutaneous femoral arterial catheterization and then inserted into the abdominal aorta. Confirm that there is no obvious abnormity of aorta that exists, and determine the location of bilateral renal artery and the bifurcation from the abdominal aorta to the common iliac artery. Commonly the bilateral renal artery is located on the level of L1, and the bifurcation is located on the level of L4–5. The balloon should be implanted between these two anatomical positions and commonly is located on the level of L3 (Fig. 18.3). Never prolong a single occlusion interval more than 90 min. When a longer occlusion period was needed, the balloon was deflated for 10–15 min after 90 min and then was reinflated. Before the operation, bilateral dorsalis pedis arteries should be labeled for the purpose of checking if femoral artery thrombus exists after the extraction of balloon and artery sheath.

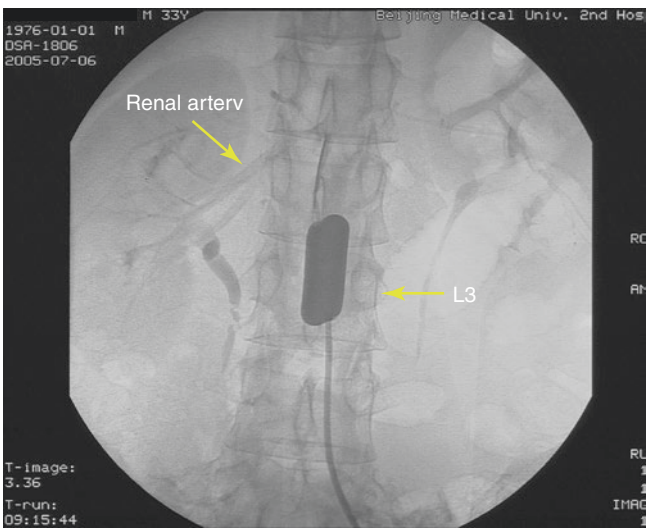

Fig. 18.3 Aortic balloon occlusion at the level of L3

Different levels of occlusion for the abdominal aorta bring different influences on systematic hemodynamic and visceral ischemia reperfusion injury. The low-level abdominal aorta occlusion applied for the surgery of sacral and pelvic tumors is a relative security. Implantation of the balloon at the level of the distal abdominal aorta and upstream of bifurcation of bilateral common iliac arteries doesn't occlude the blood supply for organs sensitive to warm ischemia such as the liver, kidney, and medulla spinalis. The feeding arteries of some lower abdominal organs sensitive to warm ischemia such as testis and ovary derive from abdominal aorta slightly below the renal arteries. Thus, the testicular arteries or ovarian arteries are excluded from the occluded list, and the blood supply for testis or ovary is unaffected by abdominal occlusion.

When patients return back to the ward or intensive care unit (ICU) after surgery, the volume of drainage should be recorded every single hour or even every half an hour to evaluate if active bleeding still exists. Active bleeding should be highly suspected if the drainage volume increases every single hour, the color of drainage presents bright red, heart rate increases even combined with decrease of blood pressure, and the hemoglobin decreases continuously. In these situations, the balloon and the arterial sheath should not be pulled out for the reason that the balloon can be reinflated to control the postoperative active bleeding and the arterial sheath can be used to implement postoperative embolization. Active bleeding is considered controlled if the postoperative drainage volume decreases every single hour gradually and the heart rate, blood pressure, and hemoglobin stay stabilized. The balloon and arterial sheath can be pulled out in this situation on the night of the operation day.

Do palpate the bilateral dorsalis pedis arteries after the extraction of the balloon and the artery sheath. Sometimes the dorsalis pedis arteries pulse weakly because of the femoral artery spasm. There is no evidence of lower limb ischemia if the oxygen saturation numerical value and waves of the second toe can be detected by pulse oximeter and if the lower limb has no dysfunction of motor and sensory. It is highly suspected of femoral artery thrombus if the ipsilateral dorsalis pedis artery is impalpable combined with no oxygen saturation detected and the lower limb gradually presents the symptoms of 5P syndrome: pain, paresthesia, paralysis, pulselessness, and pallor. In this situation, a lower limb arterial ultrasonic Doppler data has to be done, and an emergency operation of femoral arterial embolectomy should be carried out if the femoral arterial thrombus is detected by the lower limb arterial ultrasonic Doppler. Patients should receive parcel oppressed stanch at the punc-

ture site for 8 h, and the ipsilateral lower limb should be kept immobilized for 24 h.

18.2 Intraoperative Monitoring

The operation time for pelvic or sacral tumors always lasts long, and patients should be placed in a comfortable surgical position to avoid neural impairment. Body regions like the head, neck, and joints should be protected, and a cushion should be placed under the axilla when patients are placed in a lateral position.

Before surgery, multiple venous access should be established to facilitate intraoperative blood transfusion and fluid infusion. Central venous and radial artery catheter should be applied to monitor intraoperative circulatory system well-timed. Both surgeons and anesthetist should pay close attention to the volume of intraoperative blood loss and perform blood transfusion without delay because the real volume of intraoperative blood loss is often underestimated. Timely blood transfusion is beneficial in avoiding coagulation dysfunction and circulatory failure.

Intraoperative controlled hypotension is reported to decrease the volume of blood loss by 50% and be more effective than intraoperative hemodilution. Nitrates such as sodium nitroprusside and nitroglycerin are the most commonly used antihypertensive drugs. Another method to control intraoperative blood loss is hemodilution including preoperative hemodilution (isovolemic hemodilution) and hypervolemic hemodilution. Isovolemic hemodilution means letting blood from arteries or veins and transfusing equivoluminal colloid solution and/or crystalloid solution at the same time after the anesthetic with the purpose of reducing hematocrit (Hct) rather than blood volume. The blood drew out is transfused back after the massive hemorrhage is controlled. Hypervolemic hemodilution means alleviating the central venous pressure (CVP) to the high limit of normal value (10–12 cm H_2O) by transfusing crystalloid solution and colloid solution (1:1) after the anesthetic to expand the volume of endovascular and extracellular fluid. The expansion of endovascular and extracellular fluid leads to hemodilution (Hct $\geq$ 30%) which decreases the loss of blood cell components and strengthens the ability of defending against hemorrhagic shock when massive hemorrhage is encountered.

Intraoperative monitoring of the abdominal aortic balloon catheter: commonly we use arterial piezometer for dynamic monitoring of the whole course. An ambulatory blood pressure monitoring device is connected to the catheter after successful puncturing. We can indirectly keep track of the situation and parameters of lower limb arteries by comparing the parameters to that of radial arteries. The arterial waveform breaking to a straight line and arterial number reducing to a low fixed numerical value mean the blood supply for the main arteries of lower limbs is excluded and the operation can be performed under the occlusion. Surgeons can master the effect of occlusion by intermittent observation of the numerical value. Intermittent trace of heparin saline pumped through the catheter can effectively avoid the formation of femoral thrombosis.

18.3 Postoperative Management

The removal of huge tumors by surgery of sacral or pelvic tumors always leaves huge dead spaces, and the management for the dead spaces is of significant. The dead spaces are packed with blood clot in the initial phase after the surgery, and secondary infection is common due to hematoma formation and incomplete drainage. Infection is a disaster for surgery with artificial medical implantations. Commonly we use unrevealed gauzes to oppress the dead spaces outside of the wounds and lace the patients with elastic corset. Patients with sacral tumors are placed to a horizontal position to oppress the dead spaces by weight. After the active bleeding is controlled, small quantities of negative pressure drainage should be applied if the dead spaces exist or definite effusions are found sealed in the wounds.

The third-generation cephalosporin is commonly applied until the drainage tube is pulled out without signs of infection. The drainage tube should be retained until the drainage volume is less than 50 ml/24 h. Bacterial culture of the terminal of the drainage tube should be routinely performed when the drainage tube is pulled out for the purpose of selecting sensitive antibiotic once some bacterial is detected. Blood tests such as blood routine, ESR, and CRP should be tested every 2 or 3 days, and the trend of WBC, NEU%, ESR, and CRP should be observed closely. The antibiotic should be upgraded if the numerical values above keep a high level combined with high temperature.

Patients who received hindquarter amputation are encouraged to be ambulant as soon as possible, and commonly within 1 week is recommended. Young patients are able to walk with the assistance of crutches, while aged patients commonly walk with mobility aid after they can stand steady supported by others. It is not necessary for most of aged patients to be fitted with an artificial limb, while young patients are encouraged to use it. Postoperative management for patients who received region I/III resection is roughly the same as that of hindquarter amputation because there is no pelvic reconstruction for these patients. Reconstruction for pelvic integrity and function of hip joint is always required for patients who received region II resection, and optional

methods include saddle prosthesis, modular hemipelvic prosthesis, and arthrodesis. Periacetabular soft tissue reconstruction is essential for patients who received modular hemipelvic prosthesis, and it is necessary for these patients to lie in bed for at least 6 weeks to increase the stability of hip joint. Patients who are treated with bone graft should lie in bed for at least 8 weeks. Patients are able to practice standing after gradual stabilization of hip joint and gradually increase the bearing weight on the affected extremity. Periacetabular soft tissue scarring 3 months after surgery may enhance the stability and prevent dislocation of hip joint.