

Original Article

Selective arterial embolization combined with lower abdominal aortic-balloon blocking to control bleeding during pelvic and hip joint tumor surgery

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Abstract: Background: The purpose of this study was to evaluate application of the selective preoperative blocking techniques of the tumor artery embolism combined with lower abdominal aorta balloon in reducing intraoperative bleeding and decreasing risk of operation. Methods: 57 cases of the patients diagnosed as tumor in the pelvis and hip joint with surgical treatments were collected from our hospital from January 2000 to January 2013. The average follow-up was 62.4 ± 16.3 months (range, 28-171 months). They were divided into a group of balloon blocking (A group) and a conventional operation group (B group). The intra operative bleeding, operation time, blood transfusion and postoperative complications of the patients were analyzed and compared between the two groups. The post-operative recurrence rate and metastasis rate of tumor were evaluated. Results: The respective average amounts of the intraoperative bleeding in the A group and the B group were 473.23 ± 54.32 ml and 1846.45 ± 87.56 ml. Intraoperative bleeding, operation time, blood transfusion in the A group were significantly less than those in the B group. There were also significant differences in the average postoperative drainage volume, the average hospitalization time and the rate of the complete tumor resection. The mean postoperative follow-up time was 5.2 years, and there was no difference in the recurrence rate or metastasis rate. Conclusions: Selective preoperative blocking techniques of the tumor artery embolism combined with lower abdominal aorta balloon can effectively reduce intraoperative bleeding in the resection of tumor of pelvis and hip and decrease the operation risk and hospitalization time.

Keywords: Selective embolization, balloon blocking, one-stop operation, pelvic tumor

Introduction

The incidence rates of the tumor of the pelvis and hip joint bone have increased significantly in clinical application in recent years. Due to the fact that the tumor have the characteristics of late discovery and diagnosis, generally large volume, complex structure, and abundant blood supply [1], and malignant tumor are more common, operation is difficult, and it has high risk, with many postoperative complications and a high recurrence rate [1]. Furthermore, it remains unknown whether or not the prognosis of the primary malignant tumor of pelvis and acetabulum is closely related to the complete resection in the early stage.

Ever since Feldman first reported the treatment of bone tumor with arterial embolization in 1975, the blocking technique of the lower

abdominal aorta balloon evolved from which has become a mature, stable and reliable intervention operation, which has greatly reduced the intraoperative bleeding and decreased the operation risk in the application of the resection of tumor in the pelvis and sacrum. At the same time, highly selective arterial embolization has also become possible, and the blood supply of the preoperative embolization of tumor by artery may be used to roughly understand the ranges of tumor invasion and blood supply [2]. The objective of the present study was to combine and apply the highly selective artery embolization and lower abdominal aorta balloon blocking technique in the resection of tumor of the pelvis and hip bone, in order to explore the intraoperative blood loss and the improvement of the postoperative complications, which has clinical promotion and application values for interventional operation.

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Table 1. Comparison of the general information in the two groups

	Balloon embolization group (23)	Conventional operation group (34)	P value
Gender:			
Male	13	15	0.674
Female	10	19	
Ages	44.36 ± 13.34	45.41 ± 15.77	0.821
BMI	22.35 ± 2.02	23.21 ± 3.12	0.702
Location of tumors			
Pelvis	11	18	0.353
Sacrum	7	9	0.732
Acetabulum	5	7	0.467
Types of tumors:			
Chondroma sarcomatosum	9	13	0.346
Osteosarcoma	4	6	0.273
Embryonal-cell lipoma	2	3	0.326
Chordo-epithelioma	3	4	0.138
Giant cell tumor of bone	3	3	0.853
Others	2	5	0.735

Materials and methods

Patients

This study has been approved by the Ethical Committee of Daping Hospital and the Research Institute of Surgery. 57 cases of patients with tumor resections of the pelvis and hip joint were collected in our hospital from January 2000 to January 2013. The A group had 23 cases of patients with preoperative arterial embolization of tumor and lower abdominal aorta balloon blocking technique. The patients of the 34 cases in the B group had undergone conventional tumor resection, among which there were 28 male patients and 29 female patients, with an average age of 16-67 years. The pathological examination after operation confirmed that there were 6 cases of osteoclastoma, 7 cases of chordoma, 10 cases of osteosarcoma, 22 cases of chondrosarcoma, 5 cases of liposarcoma, and 7 cases of metastatic tumor (Table 1).

Preoperative arterial embolization technique

The Selding technique was used in femoral artery puncture from the left or right side 24 hours before surgery. The 5F pigtail catheter was introduced. Radiography was conducted at the crotch of abdominal aortic to display the feeding artery and tumor range of the tumor. The catheter of 5F Yashiro was used to accu-

rately intubate to the feeding artery of the tumor. The gelatin sponge particles of 1.0*1.0*1.0 mm in size were used in the embolism of the feeding artery of the tumor until the large part of the range of tumor occupying was no longer developed (Figure 1).

Low balloon blocking technique

The abdominal aortography was carried out again after the embolism of the tumor feeding artery. The diameter of the abdominal aortic was measured to determine the artery opening site of the renal artery and mesenterium. The balloon with a diameter of more than 1-2 mm

than that of the aorta abdominalis was selected for blocking. Radiography was conducted to ensure that the blocking site was at the artery opening site of the renal artery and mesenterium. The diluted contrast medium was poured into the balloon to ensure that the balloon expanded slowly until it did not flow with the blood flow. Reexamination of angiography showed that the abdominal aorta blood stream was completely blocked, and the artery imaging of the renal artery and mesenterium was good. The fluctuation of the arteriae dorsalis pedis disappeared in the examinations. The contrast medium in the balloon was slowly retracted, its dose was recorded, and the catheter was fixed firmly.

Reconstruction of pelvis and hip joint

Assessment of operation risk and damage control was conducted before operation, and routine CT three-dimensional reconstruction inspection was carried out to clarify the relationship between the tumor range and surrounding structures and to design the artificial pelvis. Vital signs and blood oxygen saturation during operation were monitored, and at the same time the pulse of the dorsalis pedis artery was also monitored. Routine sterilization draping was used to reveal the operation site and the incision of the placed catheter. After the balloon placing was satisfactory, the tumor of

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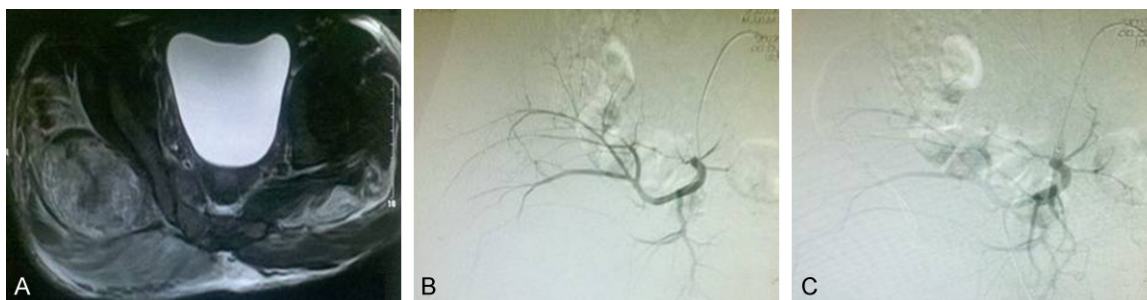


Figure 1. A is the general range of tumors by the preoperative MRI examination. B is the preoperative arteriography. C is the selective arterial embolization.

the patients was removed completely according to the conventional method, and the tumor tissues were sent for pathologic examination. The ilium, acetabulum, part of the pubis and ischium invaded by tumor were excised before reconstruction of the pelvis. The femoral neck osteotomy site was at least 3-5 cm from the tumor margins for the patients that required hip replacement. After completing the resection of tumor and pelvic tissues, the proximal part of the pelvic prosthesis was fixed at the sacroiliac joint or sacrum with screws. The distal part was fixed at the pubis and ischium. The principle of reconstruction of the pelvis was that the uninvolved bone was kept as much as possible at the premise of complete resection of tumor [3]. The angle of the replacement of the artificial hip joint should be appropriate, to prevent the occurrence of dislocation of hip joint after operation.

After the operation, the airbag was gradually pumped to recover the blood supply of lower limbs and the skin was pressed for 10-15 min to stop the bleeding. The operation time should be controlled to within 3 hours. If the time exceeded 3 hours, the operation time could be prolonged by 2 hours after intermittent blood supply for 10-15 min. Heavy injury of blood vessel nerves should be avoided during operation to reduce postoperative complications. At the same time, in order to reduce the fluctuation of the effective volume of the circulating blood during the process of charging and discharge of the balloon, the discharging of the balloon should be as slow as possible in order to fill the balloon as quickly as possible.

About the intraoperative blood loss, we count the D-value between the liquid volume of operation aspirator suction and intraoperative irri-

gation flow of fluid. At the same time, the volume of the gauze suction in the operation was evaluated (weight D-value).

Statistical analysis

All the data were analyzed by using the SPSS 18.0 software program. The data were expressed as mean \pm standard deviation. The t-test was used in the comparison between two groups. The χ^2 test was used in the comparison among three groups. A *P* value of less than 0.05 was considered a statistically significant difference.

Results

There was no significant difference in ages, gender, body weight of the patients between the A group and the B group, nor was there any significant bias in the location and types of the tumor ($P > 0.05$). The average volume of the intraoperative blood loss in the A group was 437.23 ± 54.32 mL, and the average volume of the intraoperative blood loss in the B group was 1846.45 ± 87.56 mL (Table 2). There were significant differences of the volume of bleeding in the two groups ($P < 0.05$). The average operation time in the A group was 193.28 ± 63.47 min, and the average operation time in the B group was 273.63 ± 73.31 min. There were significant differences of the operation time in the two groups ($P < 0.05$). The average blood transfusion in the A group was 387.68 ± 423.64 mL, and the average volume of blood transfusion in the B group was 1346.48 ± 873.95 mL. There were significant differences of the blood transfusion in the two groups ($P < 0.05$). At the same time, the average length of stay in hospital of the two groups was 14.38 ± 8.39 days, and the complete resection rate was 87.7% (50/57).

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Table 2. Comparison results between the two groups

	Balloon embolization group (23)	Conventional operation group (34)	P value
Intraoperative blood loss (ml)	437.23 ± 54.32	1846.45 ± 87.56	0.000
Operation time (min)	193.28 ± 63.47	273.63 ± 73.31	0.000
Amount of blood transfusion (ml)	387.68 ± 423.64	1346.48 ± 873.95	0.000
Drainage amount of postoperative wound (ml)	247.32 ± 130.71	364.56 ± 137.35	0.013
Average stay (day)	13.62 ± 5.82	15.32 ± 3.43	0.073
Complete resection rate of tumor (%)	95.7% (22/23)	82.4% (28/34)	0.021
Recurrence rate (%)	17.4% (4/23)	17.6% (6/34)	0.835
Metastasis rate (%)	13.1% (3/23)	14.7% (5/34)	0.634
Postoperative complications:			
Wound infection	0	1	0.352
Nerve damage	1	1	0.538
Ectopic embolism	0	0	0.346
Urethral injury	0	1	0.416
Others	0	0	0.421
Total	1	3	0.684

There were significant differences in the resection rate between the two groups ($P < 0.05$). A total of 4 cases had postoperative complications, including postoperative infection, nerve injury and urethral injury, of which there was 1 case in the A group and 3 cases in the B group, but there was no significant difference between the two groups ($P > 0.05$). After a median follow-up of 5.2 years, 18 cases had in situ tumor recurrence or distant metastasis, but there was no significant difference between the two groups ($P > 0.05$).

Discussion

The onset of tumor of the pelvis and hip joint is insidious. Its discovery occurs late, and its volume is usually large. Its invasion range is wide, and it is adhered with the surrounding tissue adhesion, thus its anatomical structure is not clear [4]. The amount of intraoperative bleeding is large, and the amount of bleeding in routine operation is more than 3000 mL. The postoperative amount of blood transfusion is large, and even hemorrhagic shock may occur. In order to reduce the bleeding during operation, researchers have put forth much effort. For example, tumor resection was carried out under hypotension anesthesia or temporarily ligation of internal iliac artery was conducted, which were abandoned after clinical practices confirmed that there were large damages and many complications involved with these methods [5].

In the study, the patients were divided into groups on the basis of the CT and MIR performance. For the patients which tumor invasion were too extensive to affect the stabilization of pelvic and expected to have massive bleeding, we suggested them to perform the selective arterial embolization combined with lower abdominal aorta occluding before the surgery. Meanwhile we should take into consideration the willing of the patients and make sure them informed consent to decide whether take the preoperative intervention.

With the development of interventional techniques, highly selective artery embolization and lower abdominal aorta balloon blocking techniques become effective means to reduce intraoperative bleeding under image visual conditions. The results illustrated that the combined application of these two techniques could effectively reduce bleeding during operation, but at the same time also helped to expose the tumor edge and achieve a clear operative field. Therefore, the tumor was completely resected, the recurrence was decreased, and in situ metastasis was caused by blood pollution. Furthermore, the postoperative complications such as the damage of important nerves and organs and limb numbness caused by blood loss were also reduced accordingly. The A group in this study adopted a highly selective arterial embolization combined with a lower abdominal aortic balloon occlusion technique than the conventional surgery group, which can

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significantly reduce blood loss. Low balloon occlusion technique standalone applications or highly selective arterial embolization surgery can also reduce blood loss, but because of the pelvis and hip tumor blood supply, collateral arteries or more selective arterial embolization alone cannot completely block the tumor blood supply, the amount of bleeding of which may be more than 1000 mL [6], and the embolization should not be too large, in order to avoid the occurrence of ectopic embolism. Otherwise, the expected results cannot be reached, the surgical field is not clear, and it may be necessary to extend the operation time. In addition, using balloon occlusion of the lower abdominal aorta alone, without preoperative tumor development and blocked arteries, the blood supply to the tumor area and lack of a more comprehensive understanding of the complete removal of the tumor will increase the difficulty of operation.

By far, most of the major medical centers adopt selective arterial embolization or lower abdominal aorta balloon occluding technique independently to control the intraoperative hemorrhage. Because of the pelvic tumor tend to be quite vascular and structure complex, the amount of intraoperative hemorrhage still exceeded 1000 mL when we just apply selective arterial embolization technique. The corresponding operating time prolonged due to unclear of the operation field. If we perform the lower abdominal aorta balloon occluding technique independently before surgery, the aorta balloon need to intermittent release once or twice as a result of the limitation of operation time. In the intermittent duration, the operation field would be blurred due to the massive of bleeding. In this study, so we combined the two measures to control the operative bleeding loss and shorten the operation time. Moreover the complications will not increase. Although the application of two technique might raise the medical expenditure, the method still have the application value.

The high selectivity tumor feeding artery embolization technology has been widely applied in the resection of hepatocellular carcinoma, lung cancer and metastatic spinal tumor [6], including digital angiography (DSA) diagnosis and vessel embolism of these two parts [7]. Due to the fact that pelvic tumor were provided with blood by internal iliac artery, middle sacral

artery and arteriae lumbales and other multiple arteries, the preoperative DSA diagnosis is particularly important, as it can improve the accuracy of embolism, and avoid missing embolism and erroneous embolism. Preoperative embolization of the tumor artery can promote degeneration, necrosis of tumor and narrowing of tumor sizes, which is conducive to the complete resection of tumor. In this study, the strips and particles of gelatin sponge were both used for embolization. First, the microvessels in the tumor were embolized by gelfoam particles, then the large arterial trunk was embolized by gelatin sponge strips, so that the effect of the embolization could be confirmed [1].

The lower abdominal aorta balloon occlusion technique has been regarded as the most mature intervention means, and is commonly used in the treatment of pseudoaneurysm [8]. Due to the fact that the operation is not difficult, and its safety rate is high, it is extensively applied. For operations that require blocking of the artery blood flow of the pelvis and both lower limbs, it is superior to the traditional ligation of unilateral internal iliac artery and other methods, as its blocking range is wide with fewer trauma. It is noteworthy that close coordination is required between the anesthesiologist and operation personnel when conducting the blocking of the lower abdominal aorta, to keep the blood pressure stable and strictly control the time for blocking and recovery of the blood supply. The average operation time in this study was 235.71 ± 124.52 min, and all were completed within 5 hours. Three hours after the operation began, the blood supply was restored for 15 min, and then the operation was resumed. There was no ischemia or reperfusion injury symptom after operation.

During the resection of tumor of the pelvis and hip joint, the combined application of selective tumor artery embolization with the lower abdominal aorta balloon occlusion technique could effectively decrease intraoperative bleeding, and at the same time there was no increase of risk involved in the operation [9]. Although the preoperative blocking time was lengthened accordingly, the operation incision was increased, and the operation cost was also increased, thus there was less bleeding, vision was clearer, the intraoperative operation time was shortened, and the resection of the tumor was complete. This study demonstrated that

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Figure 2. A is the range of tumor revealed by X-ray radiograph of the preoperative pelvic anteroposterior; B is the X-ray radiographic results of the reconstructed and resected pelvic tumor.

the patients benefited more from the combined use of these two techniques than the traditional resection of bone tumor.

Chondrosarcoma has the highest incidence rate in the primary pelvic malignant tumor, followed by Ewing's sarcoma and osteosarcoma. Extensive resection of the diseased tissue is still the most important step of the treatment. Combined with extensive resection through chemotherapy, patients can obtain strong effects in the early stages. Pelvic tumor are often involved in acetabulum, so that the patients often visited doctors as movement limit of the hip joint was accompanied with pain. Reconstruction of pelvis and replacement of artificial hip joints could be conducted on the above patients under the conditions of interventional operation supporting, and the amount of bleeding was significantly less than that of the conventional method. The main reasons for the failure of conventional pelvic reconstruction were infection and absorption of the transplanted bone, and the decreasing of the intraoperative bleeding could significantly reduce the occurrence of these two types of complications [10]. It is noteworthy that conventional ureter catheterization should be conducted under cystoscope before resection of the complex pelvic tumor. Due to the fact that the invasion scope of tumor is wide, the location of the ureter can be confirmed after catheterization to prevent and treat the intraoperative and erroneous injury and reduce postoperative complications (Figure 2).

In this study, the intraoperative blood loss of the patients in the A group was significantly lower than that of the B group, but there were the drawbacks of high expenses and time consumption. In clinical practice, the preoperative examination of CT reconstruction may clear the invasion ranges of tumor and assess the amount of intraoperative bleeding in advance. For patients with small size, clear boundary, integrity capsule and good basic conditions, the conventional method can be chosen to resect tumor. At the same time, the preoperative damage control and standardized administration in the perioperative period are also key factors affecting the operation success. For elderly patients with basic diseases, pathologic fracture and high risks, they should be adjusted to an operation-tolerable state before operation. It remains to be further investigated whether local chemotherapy is combined during the preoperative or intraoperative embolization process [11].

The defects of this study included that the number of patients was a little few and lack of homogeneity. Besides this retrospective study span last 15 years, the development of medical technique might have influences on the result of study.

Conclusions

It has positive significance in the application of the resection of the complex pelvis and hip joint tumor to combine with the selective tumor feeding artery embolism and lower abdominal

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aorta balloon occlusion technique, which not only can reduce the intraoperative bleeding and risk of operation, but can also increase the complete resection rate of tumor and reduce hospitalization time. With the development of interventional techniques, the selective tumor feeding artery embolism combined with the lower abdominal aorta balloon occlusion technique should be routinely applied in the resection operation of complex tumor and extended to other operations with much bleeding by preoperative assessments.

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Disclosure of conflict of interest

None.

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