

The role of embolization in radical surgery of renal cell carcinoma spinal metastases

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Abstract

Background Radical surgery of renal cell carcinoma spinal metastases carries a high risk due to potentially life-threatening extreme blood loss. Radical preoperative embolization of renal cell carcinoma metastases alone is not necessarily a guarantee of extreme blood loss not occurring during operation.

Methods A retrospective analysis of 15 patients following radical surgery for a spinal metastases of a renal cell carcinoma was performed. Eight patients were embolized preoperatively and 7 were not. We analysed features influencing peroperative blood loss: size and extent of tumour, complexity of surgical approaches and radicality of embolization.

Results The embolized and non embolized groups were not comparable before treatment. They differed markedly in size of tumour as well as the complexity of approach. In the embolized group the size of the tumour was, on average,

twice as large as that in non embolized patients and more complex approaches were used twice as frequently. Despite findings suggesting that embolization was effective, blood loss was greater in the embolized group of 8 patients (4750 ml), compared to the non-embolized group of 7 patients (1786 ml).

Conclusion Metastasis size, extent of tumour, technical complexity of surgery and the completeness of preoperative embolization had an important effect on the amount of peroperative blood loss. The evaluation of the benefits of preoperative embolization only on the basis of blood loss is not an adequate method.

Keywords Preoperative embolization · Spinal metastases · Renal cell carcinoma · Blood loss

Introduction

Chemotherapy and hormonal therapy of metastases from a renal cell carcinoma is not very effective and radio-resistant limits benefit also [9, 15]. Radical surgery is being used increasingly in the management of patients with spinal metastases of renal cell carcinoma because they increasingly present without signs of spinal cord compression [9, 12]. However a limitation in radical surgical treatment is the extreme vascularisation of many of these metastases (65–75%), involving the risk of extensive intraoperative blood loss and increased morbidity and mortality [1, 3, 5, 7–10, 15, 18]. Most authors agree that preoperative embolization significantly decreases peroperative blood loss, it makes surgery easier, facilitates radical removal and improves surgical results [1, 3, 5–7, 9–11, 14, 15]. The reported benefit of preoperative embolization on blood loss reduction led us to expand the use of radical surgery in patients with

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large metastases from a renal cell carcinoma. However, we found that preoperative embolization did not preclude the possibility of extreme peroperative blood loss. The aim of this paper is to analyse the various factors which determine the amount of blood loss during radical surgery of a renal cell carcinoma metastases and to evaluate the effect of preoperative embolization and its limitations.

Patients and methods

We identified 15 patients by careful selection from 107 patients with a spinal metastasis treated by operation. The criteria were that the diagnosis of a renal cell carcinoma was confirmed and that a radical operation had been done. The majority of operations were performed by an experienced team of two spinal neurosurgeons. Radical surgery consisted of the macroscopic removal of metastases, subsequent reconstruction and stabilisation of spinal structures.

We identified 15 patients, 11 men and 4 women treated between 1997 and 2006, ranging in age from 43 to 76 years (mean age at the time of surgery 55 years). The metastases were in the cervical spine area in 3 patients, thoracic spine in 8, lumbar in 3 and sacral in one. The patient's life expectancy before surgery (evaluated according to the Tokuhashi scale) was less than 3 months in 2 patients (0 – 5 points), in 5 patients less than 12 months (6 – 8 points) and in 8 patients greater than 12 months (9 – 12 points) [17]. The extent of metastatic spinal involvement was evaluated according to the Tomita scale [16]. Multiple spinal metastases (Tomita type 7) were seen in 2 patients and a solitary metastasis in 13 patients. The neurological deficit was evaluated according to the Frankel scale [4]. Two patients were confined (Frankel A-C) and 2 patients with slight paraparesis were able to walk (Frankel D). In 11 patients the neurological findings were normal (Frankel E) before surgery (Table 1).

Preoperative embolization was performed in patients for whom radical surgery was planned. This was done when the primary source of spinal metastases was a renal cell carcinoma, the extent of metastasis was assessed as Tomita type 6 (metastases involving 2 – 3 vertebrae) and/or radical extirpation via anterior or combined approaches was planned. Embolization was carried out within 48 hours before surgery [5–7, 9, 11]. Metastases were embolized with microparticles 350–500 µm and 500–700 µm in size. Microparticles were occasionally combined with a tissue adhesive. If the extent of reduction in arterial flow of to the metastases on angiography was greater than 90%, embolization was considered to be radical; if the reduction was lower than 90% it was graded as partial.

Information was extracted retrospectively on the evidence of a renal cell carcinoma primary, the size and surgical extent of the metastases process, the complexity of the surgical procedure (anterior or combined anterior/

Table 1 Features of 15 spinal metastases from patients with a renal cell carcinoma

	Pre operative embolization	No embolized before operation
Total	8	7
Spinal location		
Cervical	1	2
Thoracic	5	3
Lumbar	1	2
Sacral	1	-
Tokuhashi score		
0–5	1	1
6–8	3	2
9–12	4	4
Frenkel Grade		
A-C	1	1
D	1	1
E	6	5
Pre operative diagnoses		
Yes	8	4
No	6	3
Average size of metastases cm ³	92±70	50±28
Tomita Scale		
1–3	0	0
4–5	1	6
6	6	0
7	1	1
Complex operation	6	3

posterior approaches), estimated peroperative blood loss, the number of blood units used, other peroperative solutions and postoperative decrease in hemoglobin. Peroperative complications and postoperative neurological status were also noted. The influence of preoperative embolization on survival after surgery was analysed using the Kaplan-Meier empirical curve.

Results

Differences between embolized and non embolized groups of patients

Preoperative embolization was performed in eight of the fifteen patients. There were two main reasons why preoperative embolization was not performed in the other seven. First, the primary source of metastasis was not known before surgery; second, a smaller surgical extent of metastasis.

Embolized and non embolized groups differed markedly in many aspects. The primary diagnosis was known before operation in all 8 patients embolised, whereas in the primary had been identified only in 4 out of the other 7 patients before surgery. In 6 of the patients embolized,

Table 2 Indices of blood loss during operation for a metastatic renal cell carcinoma

	Embolized(n=8)	Non-embolized(n=7)
Blood loss (ml)	4750±2268	1785±756
Transfusion (units)	8,1±3,4	4,0±3,7
Crystalloid (ml)	5427±1982	3186±2106
Difference between pre and postoperative haemoglobin (g/l)	56±28	31±16

BL – preoperative blood loss, BT – peroperative substitution with transfusion blood units, SC – peroperative substitution with crystalloids, DHb – difference in preoperative and postoperative Hb

metastases involved 2 – 3 vertebrae (Tomita type 6), in contrast in patients not-embolized metastases involved only 1 vertebra (Tomita type 4 and 5). In the embolized group, the size of the tumour was on average twice as large in patients who were embolized compared to those not. (92 vs 50 cm³). More complex, i.e. anterior or combined approaches were used twice as frequently in embolized patients as those not embolized (6 vs 3 patients) (Table 1). Apart from this the embolized and non-embolized groups of patients differed only minimally in respect of age, sex, pre-operation life expectancy (Tokuhashi score) and preoperative neurological deficit (Frankel; score).

Limitations of the embolization procedure

In eight patients, spinal angiography proved metastases were predominantly supplied by 3 or 4 main arterial sources. Radical embolization to stop arterial flow was successful in 4 out of 8 patients. Partial embolization was achieved in the remaining 4. Complete embolization was not possible because of common blood supply to metastases from a. spinalis ant. in 2 patients, a positive amylobarbitone test with transient paresis of lower extremities, and multiple blood supply of metastases via minor branches from a vertebral artery). Patients neither neurologically deteriorated nor improved after embolization.

Blood loss during surgery

In patients treated by embolisation, postembolization angiography showed a marked reduction in blood flow to the metastasis and there was evidence at operation of multiple ischaemic lesions in the metastases. Nevertheless, in the eight embolized patients the average blood loss was 4750±2268 ml and 8.1±3.4 were units of transfused blood together with 5750±1982 ml of substitute solutions. The haemoglobin decrease after surgery was on average 56±28 g/l (Table 2). In the seven patients which did not receive preoperative embolization, the average blood loss during surgery was 1786±765 ml. This blood loss was replaced with an average of 4.0±3.7 transfusion blood units together with 3186±2106 ml of substitute solutions. The haemoglobin decrease after surgery was, on average, 31±16 g/l (Table 2).

Complications of operation and clinical outcome

One embolized patient died as a consequence of haemorrhagic shock, blood loss in total of 7000 ml occurred during this operation and adequate volume resuscitation was not achieved. The decision to perform radical transthoracic surgery of an extensive metastasis (6×6×5 cm) was influenced by the radiologist's evaluation that angiography after embolization showed complete occlusion of blood flow in the metastasis. Surgery was complicated by sudden extreme blood loss in two patients who were not embolized. In one patient, the source of metastasis had not been known before surgery.

None of the embolized patients improved, nor did any deteriorate. One patient who had not been embolized improved after operation. No patients in this group deteriorated clinically. The Kaplan-Meier survival curve (Fig. 1) did not differ between the embolized and non-embolized groups.

The effect of completeness of embolization and size on tumour on blood loss

In four radically embolized patients (blood flow reduction greater than 90%), the average peroperative blood loss was 5380±3150 ml. In four partially embolized patients (blood flow reduction less than 90%), the average peroperative

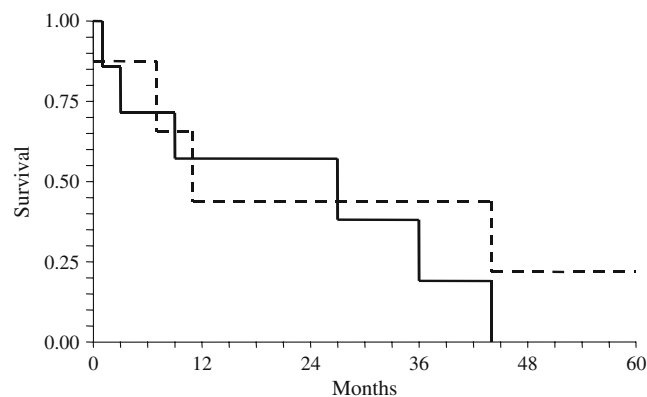


Fig. 1 The Kaplan-Meier empirical curve for survival after surgery in a spinal metastases from a renal cell carcinoma (embolized – full line, non-embolized – interrupted line)

blood loss was only 4130 ± 1030 ml. The average size of metastases in radically embolized patients was 123 cm^3 , in contrast to 54 cm^3 in partially embolized patients. A complex operation via anterior approach involving thoracotomy or laparotomy was carried out in all 4 patients embolized radically. More simple surgery via a posterior approach was carried out in partially embolized patients. The size of the tumour and technical complexity of surgery had an important effect on the amount of peroperative blood loss.

Discussion

Embolization is usually used if there is a risk of substantial blood loss [1, 6, 11] during an operation. Opinions differ about how embolization affects blood loss, reflecting reports being limited to small and non-comparable groups, ranging from 14 to 30 patients [3, 5–7, 14]. Most papers include metastases of different histological origins [3, 9, 11, 13]. Reports on spinal metastases from a renal carcinoma often present only limited control groups without embolization and the effect of embolization on blood loss is evaluated empirically [3, 5, 6, 11, 14]. Some reports include patients treated by a palliative procedure, which will have significantly smaller blood loss than a radical operation [6, 7, 10]. Reductions in peroperative blood loss have been estimated as between 30–50% following embolization, but data from a control group is lacking [5–7, 9].

Radical surgery should not be undertaken on a patient with an extensive renal cell carcinoma metastases without preoperative embolization. Nevertheless, despite preoperative embolization we recorded a 2.7 times higher average blood loss in embolized in comparison to non-embolized patients. However the two groups of patients differed in many aspects (size, extent of metastases and complexity of surgery), so it is not possible to draw firm, clear conclusions on effectiveness of embolization based on differences in blood loss.

Some authors have assessed the efficacy of preoperative embolization only on the basis of peroperative blood loss, without considering the completeness of preoperative embolization [5, 7, 10, 13]. Others use various, 3 or 5 degree scales for evaluating the extent of embolization [6, 11, 14, 15]. Some report complete cessation of blood flow in the metastases in most or all patients [3, 6], others in approximately half of the patients [11]. We recorded a somewhat higher blood loss (5380 ml) in the completely embolized patients than in those partially embolized (4130 ml) but the groups were not comparable in many aspects. Thus in the radically embolized patients the tumour was almost 2.5 times larger and complex surgery via an anterior approach was performed twice as often.

Hess reported 2 patients in whom surgery was aborted due to uncontrollable bleeding, and 1 of an epidural haematoma in the operated area, complicated by paraplegia [7]. Other authors have reported similar experience in the surgery of metastases done without pre-operative embolization [5, 9, 10, 15]. If blood loss is not adequately controlled during surgery the consequences can be disastrous. In 2 of our patients in whom preoperative embolization was not performed because we had underestimated the vascularisation of the metastases, surgery had to be aborted because of uncontrollable bleeding. As a consequence we now perform embolization even in patients selected for a simple procedure.

Conclusion

Radical resection of a hypervascularized renal cell carcinoma spinal metastases often involves life-threatening blood loss. The amount of blood loss depends on a combination of several parameters: the extent of hypervascularity, the size and extent of the lesion, and the complexity and duration of surgery. These complicate the assessment of the effect of embolization. Many reports contain only small numbers of patients and a cooperative study would be useful to gain more knowledge of the factors influencing the value of preoperative embolization.

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References

1. Berkefeld J, Scale D, Kirchner J, Heinrich T, Kollath J (1999) Hypervascular spinal tumors: influence of the embolization technique on preoperative hemorrhage. *AJNR* 20: 757–763
2. Bowers TA, Murray JA, Chamsangavej C, Soo CS, Chuang VP, Wallace S (1982) Bone metastase from renal carcinoma: the preoperative use of transcatheter arterial occlusion. *J Bone Joint Surg (Am)* 64:749–754
3. Breslau J, Eskridge JM (1995) Preoperative embolization of spinal tumors. *J Vasc Interv Radiol* 6(6):871–875
4. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, Vernon JD, Walsh JJ (1969) The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. Part 1. Paraplegia 7:179–192
5. Gellad FE, Sadato N, Numaguchi Y, Levine AM (1990) Vascular metastatic lesions of the spine: preoperative embolization. *Radiology* 176:683–686
6. Guzman R, Dubach-Schwizer S, Heini P, Lovblad KO, Kalbermatten D, Schroth G, Remonda L (2005) Preoperative transarterial embolization of vertebral metastases. *Eur Spine J* 14:263–268

7. Hess T, Kramann B, Schmidt E, Rupp S (1997) Use of preoperative vascular embolization in spinal metastases resection. *Arch Orthop Trauma Surg* 116:279–282
8. Chatziioannou AN, Johnson ME, Pneumaticoc SG, Lawrence DD, Carrasco CH (2000) Preoperative embolization of bone metastase from renal cell carcinoma. *Europ Radiol* 10:593–596
9. Manke Ch, Bretschneide T, Lenhart M, Strotzer M, Neumann C, Gmeinwieser J, Feurbach S (2001) Spinal metastases from renal cell carcinoma: effect of preoperative particle embolization on intraoperative blood loss. *AJNR (Am) J Neuroradiol* 22:997–1003
10. Olerud C, Jonsson H, Lofberg AM, Lorelius LE, Sjostrom L (1993) Embolization of spinal metastases reduces peroperative blood loss. 21 patients operated on for renal cell carcinoma. *Acta Orthop Scand* 64(1):9–12
11. Prabhu VC, Bilsky MH, Jambhekar K, Panageas KS, Boland PJ, Lis E, Heier L, Nelson K (2002) Results of preoperative embolization for metastatic spinal neoplasms. *J Neurosurg (Spine 2)* 98:156–164
12. Řehák S, Málek V, Náhlovský J, Odrážka K, Ryška P, Kaltofen K, Česák T, Melichar B, Kanta M (2004) Chirurgická léčba metastatického onemocnění páteře. *Acta Spondylologica* 3:15–23
13. Smith TP, Gray L, Weinstein JN, Richardson WJ, Payne CS (1995) Preoperative transarterial embolization of spinal column neoplasms. *J Vasc Interv Radiol* 6(6):863–869
14. Sun S, Lang EV (1998) Bone metastase from renal cell carcinoma: preoperative embolization. *JVIR* 9:263–269
15. Sundaresan N, Scher H, DiGiacinto GV, Yagoda A, Whitmore W, Choi IS (1986) Surgical treatment of spinal cord compression in kidney cancer. *J Clin Oncol* 4:1851–1856
16. Tomita K, Kawahara N, Kobayashi T, Yoshida A, Murakami H, Akamaru T (2001) Surgical strategy for spinal metastases. *Spine* 26(3):298–306
17. Tokuhashi Y, Matsuzaki H, Toriyama S, Kawano H, Ohsaka S (1990) Scoring system for the preoperative evaluation of metastatic spine tumor prognosis. *Spine* 15(11):1110–1113
18. Ungermann L, Krajina A, Lojik M, Urban K, Málek V, Chovance V, Raupach J, Mašková J (2005) Embolizace nádorů kostí – retrospektivní analýza 8 letých zkušeností. *Čes Radiol* 59(1):27–31

Comment

Rehak et al. retrospectively analyzed 15 cases of spinal renal cell carcinoma metastases, operated on during a 9 year period. One major problem of this kind of secondary tumour manifestation close to the spinal cord is its hypervascularization, which risks extensive, sometimes life-threatening, bleeding and/or post-operative neurological deterioration. Therefore, pre-operative embolization is favoured by many surgeons prior to attempting complete tumour removal or even before decompressive surgery. The available scientific literature on pre-surgical embolization does suggest lower operative complication rates and better patient outcomes after pre-surgical embolization. Unfortunately, past reports are based on small case series and have not led to any widely accepted recommendations about when or when not to embolize RCC metastases. The strength of this paper from Rehak et al. is that it begins to develop reflections on the process of decision making concerning pre-operative tumour embolization, its effectiveness and limits, and the risk of blood loss despite embolization of metastases. Even with embolization, surgery with the aim of complete removal of a hypervascularized spinal tumour remains a risky procedure, as the 1 mortality from 8 embolized patients in the authors' series showed. The authors did not find any statistically significant predictors of whether or not to embolize, except the estimated risk of intraoperative blood loss according to the surgeon's personal opinion. Thus, 2 of 7 cases without embolization had to be stopped before complete tumour removal because of extreme blood loss. So what we can learn from this study is that surgeons should seriously consider pre-operative embolization, at least when there are hypervascularized spinal metastasis exceeding the bony structures of the affected vertebra with infiltrating paravertebral tumour extension, and when the surgical aim is complete resection via a combined dorso-ventral approach. But it still remains unclear whether there is any benefit from embolization for smaller tumours (which can be removed via a posterior approach alone). Rehak et al. have made a valuable contribution by reporting their cases and initiating renewing discussion on the surgical treatment of RCC metastases. Now studies with larger sample sizes or metaanalyses of past studies are needed to determine more clearly the benefits and risks of performing pre-operative embolization or not.

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