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Original article

METHODS FOR VASCULAR CONTROL IN LIVER RESECTIONS DUE TO COLORECTAL METASTASES - IMPACT ON RESIDUAL PARENCHYMA

МЕТОДИ ЗА ВАСКУЛАРНА КОНТРОЛА ПРИ РЕСЕКЦИИ НА ЦРН ДРОБ ПОРАДИ КОЛОРЕКТАЛНИ МЕТАСТАЗИ - ВЛИЈАНИЕ ВРЗ РЕЗИДУАЛНИОТ ПАРЕНХИМ

Stefan Petrovski[1], Elena Arabadzhieva[2], Saso Bonev[2], Dimitar Bulanov[2], Valentin Popov[2] and Violeta Dimitrova[2]

[1]Department of Surgery, Clinical Hospital-Shtip, Republic of Macedonia, [2]Clinic of General and Hepato-pancreatic Surgery, UMBAL "Aleksandrovska" - Sofia, MU - Sofia, Republic of Bulgaria

Abstract

Introduction. Massive blood loss while performing resections of the liver continues to be a serious problem with potentially lethal outcome. Therefore in the last 2-3 decades there has been a significant developement of techniques for vascular control during liver resections.
Methods. In the period from 01.01.2006 to 31.12.2015 in KOCPH UMBAL "Aleksnadrovska" a total of 239 patients with colorectal liver metastases underwent surgery of whom: 179 patients were radicaly operated on and 57 patients were subjected to Pringle maneuver. Using the statistical software SPSS-19 we analyzed various factors that may affect the early postoperative results.
Results. In resections of colorectal liver metastases there was a significant difference in the postoperative functional parameters (AST, ALT), which correlated with the degree of liver damage, in patients with Pringle and without Pringle maneuver 265.32 vs. 448 (p=0.001), and 300.53 vs. 481.91 (p=0.002),-respectively. There was no significant difference in the postoperative results in comparisson of resections <15 minutes, performed without Pringle and with Pringle maneuver. The blood loss is another factor that affects the postoperative complications (p = 0.048), and it was lowest in the Pringle group <15 min.
Conclusion. Pringle maneuver is a simple and effecttive method for vascular control. As a result of its use we can observe the damage of the residual liver volume from the continuous ischemia to the reperfusion period. Thus, in liver resections, due to colorectal metastasis, vascular control strategy should be individual and corresponding to the extent of the procedure and associated diseases of the liver-fatty liver, cirrhosis, chronic hepatitis and others.

Keywords: colorectal liver metastases, liver resection, vascular occlusion of hepato-duodenal ligament, ischemia, residual parenchyma.

Correspondence to: Stefan Petrovski, Department of Surgery at Clinical Hospital-Shtip, R. Macedonia; E-mail: stefan.petrovski@ugd.edu.mk

Апстракт

Вовед. Масивната загуба на крв при извршување ресекции на црн дроб продолжува да биде сериозен проблем со потенцијално летален исход. Затоа, во последните две-три децении, значително се развиваат техниките за васкуларна контрола при ресекции на црниот дроб.
Методи. Во периодот од 01.1.2006 г. до 31.12.2015 г. во КОЦПХ УМБАЛ (КОСРН UMBAL) "Александровска" се оперирани 239 пациенти со колоректални метастази на црниот дроб, радикално се оперирани 179 пациенти, а кај 57 пациенти е направен Pringle maneuver. Со статистички софтвер SPSS-19 беа анализирани различни фактори коишто може да влијаат на раните постоперативни резултати.
Резултати. При ресекции на црниот дроб поради колоректални метастази постои сигнификантна разлика на постоперативните функционални параметри (AST, ALT), коишто корелираат со степенот на оштетување на црниот дроб, кај пациенти без Pringle и со Pringle-соодветно 265,32, наспроти 448 (p=0,001) 300,53, наспроти 481,91 (p=0,002). Нема значајна разлика на постоперативните вредности при споредба на ресекции без Pringle и со Pringle под 15 мин. Загубата на крв е друг фактор којшто влијае на постоперативните компликации (p=0,048), таа е најниска во групата со Pringle <15 мин.
Заклучок. Pringle maneuver претставува прост и ефективен метод за васкуларна контрола. Како резултат од неговата употреба може да се набљудува оштетување на резидуалниот волумен на црниот дроб од продолжителната исхемија и периодот на реперфузија. Затоа, при ресекции на црниот дроб, поради колоректални метастази, стратегијата за васкуларна контрола треба да

биде индивидуална и да кореспондира со екстензитетот на процедурата и со асоцираните болести на црниот дроб-стеатоза, цироза, хроничен хепатит и др.

Клучни зборови: Колоректални метастази на црниот дроб, црнодробна ресекција, клемување на хепатодуоденалниот лигамент, исхемија, резидуален паренхим

Intoduction

The significant blood loss in liver resections and the perioperative blood transfusion are associated with an increased rate of postoperative complications and mortality [1-3]. Recent studies have even shown that perioperative blood transusion increases the risk of recurrence in patients with colorectal liver metastases. [2,3] Therefore, in recent decades a number of different techniques for vascular control during liver resection are presented and described I the literature. Methods for occlusion of liver blood vessels are effective in reducing the blood loss during transection of the liver [1,3]. Their use on the other hand is associated with a potentially damaging influence to residual parenchyma due to the effect of continuous ischemia-reperfusion period [3].

Materials and methods

In the period from 01.01.2006 to 31.12.2015 in KOCPH UMBAL "Aleksnadrovska" 239 patients with colorectal liver metastases underwent surgery, of whom: 179 patients were radicaly operated on and 57 patients were subjected to Pringle maneuver. Using the statistical software SPSS-19 we analyzed various factors that may affect the early postoperative results.

Results

The study include 239 patients with colorectal liver metastases: radical intervention was done in 179 while in the remaining 60 palliative intervention was performed or only biopsy was taken-55 patients. The type of intervention applied depended significantly on the type of liver metastases ($p<0.001$). Metachronous metastases significantly more than synchronous were treated with radical intervention (93.33% vs. 56.3%). Palliatively treated or biopsied were only 6.67% metachronous and 43.7% synchronous metastases.

Tabela 1. Distribution of the types of radical interventions in synchronous and metachronous liver metastases

Type of liver resection	Liver metastases		*p-value*
	synchronus	**metachronous**	
Radical	67(56.3%)	112(93.33%)	[a] <0.001
palliative/biopsy	52(43.7%)	8(6.67%)	
Total	119	120	

[a] (Chi-square test)

In 57(23.8%) patients during liver resection Pringle maneuver was used, with an average duration of 16.37±8.3 minutes. The shortest duration of the Pringle maneuver lasted for 5 minutes, the maximum duration was 60 minutes.

The group of patients in whom the Pringle maneuver was used were divided in terms of duration of less than 15 minutes and more than 15 minutes. In 33(18.43%) patients this vascular procedure was lasted up to 15 minutes, with an average duration of 12.06±2.7 minutes. In 24(13.4%) patients the Pringle maneuver was used for more than 15 minutes, with an average duration of 22.3±9.7 minutes (Figure 1).

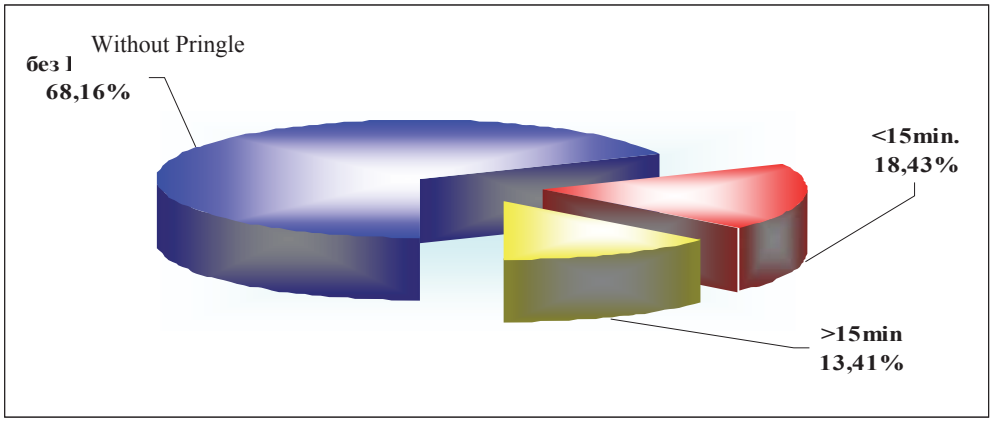

Fig. 1. Liver resections with and without Pringle maneuver

Table 2. Distribution of liver resection with and without Pringle maneuver and time of it

Types of resections of the liver	Pringle maneuver		
	without Pringle N=122	Pringle <15min N = 33	Pringle >15 min N = 24
atypical resections	49	7	1
resections of 2 segments	12	10	2
resections of 3 segments	11	5	2
resections of more than 3 segments	6	1	3
left lobectomy	11	4	0
left hemihepatectomy	2	1	1
right hemihepatectomy	3	1	8
metastasectomy	19	1	0
resections + another procedure	9	3	7

Table 2 shows the grouping of surgical interventions regarding the use of the Pringle maneuver. As it can be seen, this intervention was more frequently used in patients who underwent right hemihepatectomy (9/12) and in combined radical operations (10/19). The Pringle maneuver was used in 34.17% of large-extent operations, and in 27.12% of small-extent operations. Differences in the distribution of patients with and without Pringle maneuver, in terms of the extent of the intervention according to the number of resected liver segments showed no statistical significance (p=0.34) (Figure 2).

Tabela 3. Comparison of blood loss volume and the length of applications of Pringle maneuver with patients operated without clamping technique

Pringle maneuver	The operation extent according to the number of segments resected liver		*p-value*
	major resections	minor resections	
no	79(65.83)	43(72.88)	0.34
yes	41(34.17)	16(27.12)	

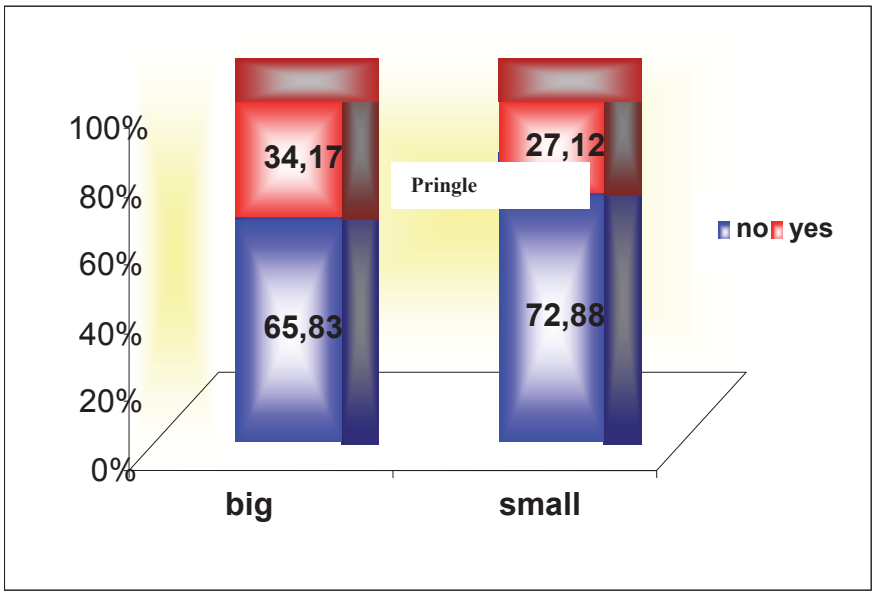

Fig. 2. Extent of surgical intervention according to the number of resected liver segments

There were more complications in patients with synchronous metastases compared to matachronous (6.72% vs 4.17%); with unilateral localized metastases compared to bilateral (7.75% vs 2.73%), and patients with advanced age and associated liver disease such as cirrhosis , steatosis, chronic hepatitis and others.

Blood loss is another factor that affects the postoperative morbidity and mortality. When comparing patients with observed complications postoperatively with patients without complications we noticed that the first group had a

Table 4. Difference in values of AST and ALT pre- and postoperatively depending on the application and duration of Pringle maneuver

	Pringle	Average value	Statistical deviation	Average statistical error	P
Blood loss	without Pringle	488.10	170.509	18.604	0.972
	Pringle >15 min	486.96	123.599	25.772	
Blood loss	without Pringle	488.10	170.509	18.604	0.000
	Pringle <15 min	319.35	55.793	10.021	
Blood loss	Pringle >15 min	486.96	123.599	25.772	0.000
	Pringle <15 min	319.35	55.793	10.021	

significantly higher blood loss-537.50 ml compared to 441.67 ml (p=0.048). For this reason we analyzed the amount of blood loss when we divided patients into groups with and without Pringle maneuver compared to the duration of blood vascular occlusion-under and over 15 minutes. The lowest blood loss was observed in the group of patients with Pringle <15 min (Table 4).
The extent of damage of residual parenchyma postoperatively is closely monitored through the measurement of serum transaminases and their comparison before and after surgery (Table 5). Raised values are usually a result of surgical trauma and ischemic injury of the liver due to techniques of vascular control. The analysis of patients with resections of colorectal liver metastases showed no significant difference in postoperative functional status in patients without Pringle and with Pringle maneuver. The difference between the preoperative and postoperative AST values in patients without Pringle and with Pringle maneuver was 265.32 vs. 448 (p=0.001), and ALT-300.53 vs. 481.91, respectively (p=0.002). There was no significant difference of postoperative ALT values comparing resections without Pringle and Pringle maneuver with duration less then 15 min.

Table 5. Difference in values of AST and ALT pre- and postoperatively depending on the application and duration of Pringle maneuver

	Pringle	Average value	Statistical deviation	Average statistical error	*P*
Difference in pre- and postoperative values of AST	without Pringle	265.32	258.467	28.201	0.001
	with Pringle	448.00	322.816	43.930	
Difference in pre- and postoperative values of ALT	without Pringle	300.53	240.603	26.252	0.002
	with Pringle	481.91	371.606	50.569	
Difference in pre- and postoperative values of AST	without Pringle	265.32	258.467	28.201	0.006
	with Pringle >15 min	464.74	296.907	61.909	
Difference in pre- and postoperative values of ALT	without Pringle	300.53	240.603	26.252	0.009
	with Pringle >15 min	518.09	348.598	72.688	
Difference in pre- and postoperative values of ALT	without Pringle	300.53	240.603	26.252	0.081
	with Pringle <15 min	455.06	391.278	70.276	

Discussion

Intraoperative bleeding and perioperative blood transfusion are assotiated with increase in postoperative morbidity and mortality [4]. Also, blood transfusions increase the recurrent rate in patients treated with liver resection due to malignancy [2,5-7]. Pringle first described the efficacy of vascular occlusion of hepatoduodenal ligament in patients with liver damage in 1908 [8]. His maneuver it has been used routinely in the practice and it is very easy method for vascular control of the afferent blood flow to the liver [1,3]. Nevertheless, the Pringle maneuver poses no risk to the general hemodynamic damage of the liver and bowel congestion, especially in patients with chronic liver disease [3]. Using the Pringle maneuver in duration less than 15 min. we found no statistically significant increase in the impairment of the residual parenchyma, which was demonstrated by the ghange of postoperative transaminase levels. At the same time, blood loss in this group of patients was the lowest, presenting this method to be sufficiently effective. This is also associated with the experience of the surgeon and the ability to perform transection of the liver in a shorter period. Patients who require a prolonged period for the Pringle maneuver pose a problem. Belghiti *et al*. [5] reported that intraoperative blood loss during parenchymal transection was higher, in intermitentniot PM 230 ml vs 530ml, the intraoperative transfusion is higher 28% vs 32%, but there are better results in terms of tolerance and stabilization of hepatic function of healthy and sick liver compared to continuous PM. Petrowsky *et al*. [9] compared the ischemic preconditioning preparation (PM-10 min. 30-reperfusion) with CPM and IPM in large hepatectomy observing less blood loss during liver transection (146 vs. 250 ml) and shorter transection time (40.4 vs 50.6 min). Makuuchi *et al*. [10] proposed hemihepatic pedicular occlusion technique to reduce the level of visceral stasis and general hepatic ischemia. In a randomized tria Fu *et al.* [11] compared the hemihepatic occlusion of the liver with CPM and IPM and found that the operating time was shorter in the Pringle group; the three groups were different in terms of intraoperative blood loss and postoperative mortality, but the Pringle group had a significantly more severe ischemia-reperfusion injury of the liver, a greater number of complications and longer intrahospital period. Hemihepatic occlu-

sion is particularly useful in patients with liver cirrhosis and peripheral lesions due to lower ischemia- reperfusion injury of the liver [11]. Heneay *at al.* [12] were the first who described the total hepatic vascular exclusion (THVE). It combines the control of vascular inflow and outflow and vascular occlusion of the lower and upper part of v. cava inferior. Chen *et al.* [13] modified the technique of THVE and proved the difference between PM and modified THVE, in terms of intraoperative blood loss and transfusion (750 ml vs. 350 ml and 46.5% vs 13.3%), but no significant difference in terms of postoperative functional stabilization of liver enzymes AST, ALT, bilirubin and morbidity rate (29.3% vs. 31.6%). Selective hepatic vascular exclusion (SHVE) limits the branches with vascular occlusion with extraparenchymal control of hepatic veins, but without interrupting the caval flow. Thus, this method is not associated with haemodynamic and biochemical deficiencies of THVE [14,15]. Selective vascular exclusion compared to PM had less intraoperative blood loss and transfusion (420 ml vs. 880 ml), but there was no significant difference in terms of postoperative morbidity (49% vs. 52%) [16]. Man *et al.* [17] showed that resection with vascular occlusion compared to resection without vascular occlusion resulted in significantly less blood transecion surface (12 vs. 22 ml/cm^2), after a short time of transection (2 vs. 2.8 min/cm^2) and less post-operative complications (26% vs. 30%). These results are similar to other showing no significant difference in intraoperative blood loss, percentage of hemotransfusion and between postoperative morbidity and no difference mortality. [18]

Conclusion

The Pringle maneuver is a simple and effective method for vascular control. It helps in monitor the damage to the residual volume of the liver from the continuous ischemia and reperfusion period. Therefore, in liver resections due to colorectal metastasis, vascular control strategy should be individual and corresponding to the extent of the procedure and associated diseases of the liver- fatty liver, cirrhosis, chronic hepatitis and others.

Conflict of interest statement. None declared.

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