Volume 1 Issue 2
www.escientificlibrary.com
ES Journal of Surgery

Pringle Maneuver and Blood Loss in the Surgical Treatment of Liver Hemangioma (Lh)

Research Article

E. Nikolaev[1]*, N. Nikolov[1], D. Kostov[1], N. Vladov[2], I. Takorov[3], V. Mutafchiiski[4], M. Valcheva[1], I. Mircheva[5]

[1]Clinic of Surgery of MMA, Varna at the Military Medical Academy, Sofia
[2]Clinic of Liver - Pancreatic Surgery and Transplantology MMA, Sofia
[3]Clinic of Abdominal Surgery, Military Medical Academy, Sofia
[4]Clinic of Endoscopic Surgery, Military Medical Academy, Sofia
[5]Faculty of Public health, Medical University, Varna

Received: July 22, 2020; **Accepted:** July 29, 2020; **Published:** Aug 03, 2020

***Corresponding author:** E. Nikolaev, Clinic of Surgery of MMA, Varna at the Military Medical Academy, Sofia

Key words: Pringle maneuver (PM), SHVO, blood loss, hepatic hemangioma, anatomical resection, atypical resection, enucleation

Abstract

Introduction: Regardless of the type of surgical intervention to remove LH, massive blood loss remains the "Achilles heel". Therefore, the preventive imposition of a tourniquet on the hepatoduodenal ligament (PM) should be performed in all patients without exception, but without tightening.

Objective: To study the effect of Pringle maneuver on blood loss in surgical treatment of LH.

Materials and methods: For the period 2006 - 2018, 101 patients with LH were operated on in the MMA surgery clinics, and 111 tumors were removed. 84 resections and 27 enucleations were performed, and in 36% (n = 35) of the cohort PM was used. The advantages and disadvantages of PM, its influence on blood loss and ischemic reperfusion trauma are analyzed.

Results: In the study group we studied, blood loss ranged from 20 to 400 ml, with an average value of 173.5 ml. When using PM, the average blood loss is 223.7 ml. In other operations, the average blood loss was 146.8 ml. In operations using PM, blood loss was greater by an average of 76.82 ml ($p <0.000$). Of the 59 anatomical resections performed, 14 (23.7%) underwent PM. Blood loss with the use of PM in anatomical resections (with direct parenchymal transection) was on average 126.4 ml higher than in anatomical resections (controlled hepatectomy) without the use of PM ($p <0.000$). 45 anatomical resections without PM and 21 atypical resections and enucleations with PM were performed. Blood loss in atypical resections and enucleations with PM was on average 42.1 ml higher than in anatomical resections without PM, the difference being statistically significant ($p = 0.045$).

Discussion: With the use of modern technologies and thanks to advanced techniques for the anatomical separation of gleason and caval structures, when performing large-scale anatomical resections, a significant reduction in intraoperative blood loss is achieved without using the Pringle method. At the same time, in patients who have received the Pringle method in combination with non-anatomical resections or enucleations, blood loss reaches 800 ml and more. There is no bleeding during the parenchymal transection, but after declamation the bleeding reaches 300 ml and more.

Conclusion: Prolonged anatomical parenchymal transection results in significantly less intraoperative bleeding and shortens the time for final hemostasis.

Introduction

Hemangiomas are more likely to be benign tumors of the liver. Despite the proven benign nature of the process, the presence of hemangiomas is associated with a risk of rupture and acute bleeding. When the process is localized in the area of the hepatitis gate and when its elements are involved in the process, the development of thromboembolism of the trunk of the pulmonary artery or its branches is possible. Impaired portal circulation is possible, even with a small hemangioma. The treatment strategy for LH is controversial and is closely related to the size, location, symptoms and concomitant diseases of the patient. There are two main methods for surgical treatment of hepatic hemangiomas: liver resections of different sizes and enucleation. Regardless of the type of surgical intervention to remove HF, massive blood loss remains the "Achilles heel". Afferent clamping of the structures of the hepatoduodenal ligament was introduced into surgical practice by the Irish surgeon Pringle in 1908 and is known as the Pringle method (Pringles maneuver). Massive and uncontrollable intraoperative bleeding, often occurring in extensive liver resections, leads to severe multiorgan failure, coagulopathy, which in turn leads to an unfavorable outcome. Therefore, preventive imposition of a tourniquet on the hepatoduodenal ligament (PM) should be performed in all patients without exception, but without tightening.

Objective

To study the influence of the Pringle maneuver on blood loss in surgical treatment of LH.

Materials and methods

The study included 101 patients with cavernous hemangiomas radically operated in the Clinics of Surgery of the Military Medical Academy for the period 2006 - 2018. Of these, 52 were operated in the Clinic of Surgery at MMA, Varna, 43 were operated in the Clinic of Liver - Pancreatic Surgery and Transplantation Sofia, 4 were operated on in the Clinic of Endoscopic Surgery Sofia and 2 in the Clinic of Abdominal Surgery Sofia.

Patients treated at the Surgery Clinic of MMA, Varna were followed prospectively (n = 52) and the rest (n = 49) retrospectively.

Gender: 37% men (n = 37), 63% women (n = 64), mean age 54. 101 patients with LH were operated on and 111 tumors were removed. 84 resections and 27 enucleations were performed, and in 36% (n = 35) of the cohort PM was used. The advantages and disadvantages of PM, its influence on blood loss and ischemic reperfusion trauma are analyzed.

According to the surgical technique used, anatomical liver resections are divided into controlled hepatectomy and resection with primary parenchymal transection. Controlled hepatectomy requires prior disruption of portal triad elements by extrahepatic intrafascial access (SHVO; extrahepatic dissection, intrafascial approach; Couinaud 1989). In primary parenchymal transection, the elements of the portal triad are interrupted during or at the end of the parenchymal transection (intrahepatic glissonean pedicle approach - intrahepatic exrta - glissonian technique Launois and Jamieson 1992). Vascular control is considered a key to the successful implementation of operational intervention. Several variants are known - control of afferent blood flow, control of efferent blood flow and total vascular exclusion. For the needs of our study, the afferent blood flow was examined - afferent vascular clamp, which is selective and non-selective.

The non-selective afferent vascular clamp (Pringle maneuver) is a clamping of lig. hepatoduodenale with a tourniquet or vascular clamp, which aims to stop afferent blood flow to the liver. It is mainly used in resections with primary parenchymal transection and in patients with enucleation. It is divided into continuous and intermittent. The intermittent one is mainly used due to the better tolerance. It is used in liver resections that require an ischemic time of more than 30 minutes. It is recommended that the duration of the intermittent clamping be within 15 - 20 minutes, followed by a declamation of 5 minutes. To protect the parenchyma from prolonged ischemic

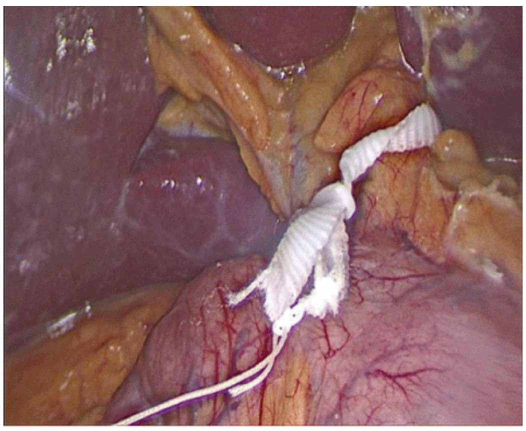

Figure 1: Applying a textile tape around the lig. hepatoduodenale (Pringle maneuver)

Figure 2: Clamping of lig. hepatoduodenale during parenchymal transection - left lateral sectiononectomy

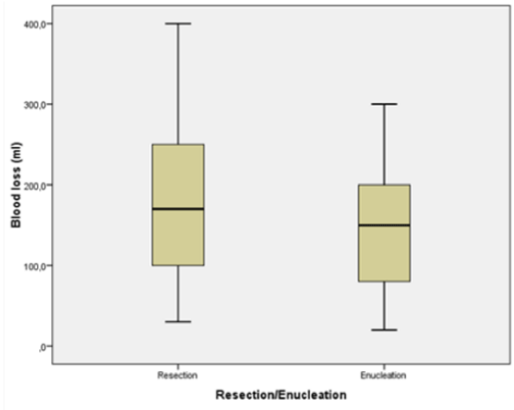

Figure 4: Blood loss in ml during resection and enucleation

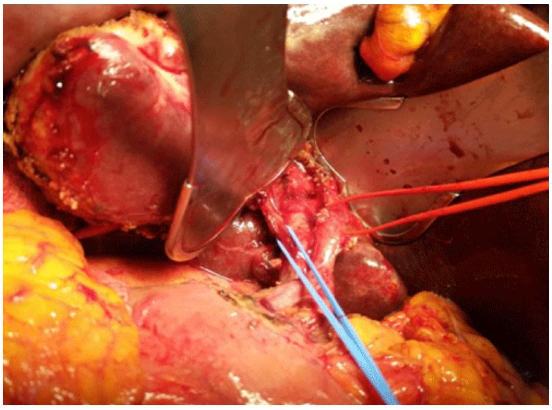

Figure 3: Preparation of the structures of lig. hepatoduodenale for selective afferent clamping.

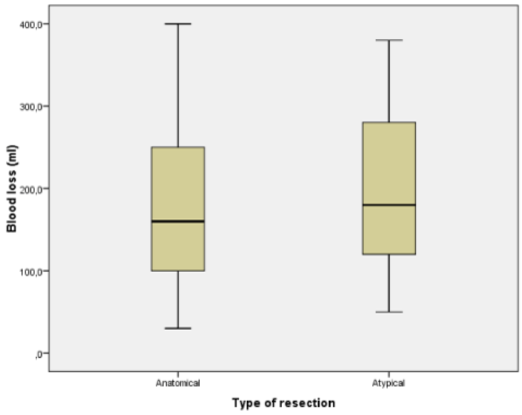

Figure 5: Blood loss in anatomical and atypical resection.

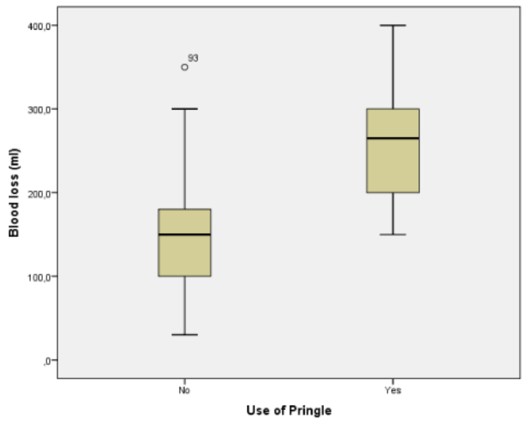

Figure 6: Blood loss in anatomical resections with and without Pringle

injury, instead of continuous afferent vascular clamping, permanent clamping after ischemic preconditioning is used - clamping the ligament for 10 minutes followed by reperfusion for 10 minutes, after which the clamping can continue until the end of the parenchymal transaction (Figure 1 & 2).

Selective afferent vascular clamping (SHVO) - used mainly in large anatomical liver resections (left or right hepatectomy, trisectionectomy). In this type of clamp, the left / right portal triads (Gleason pedicles) are separately prepared, clamped or ligated before the parenchymal transection, thus aiming to preserve blood flow in the residual liver parenchyma (Figure 3).

Results

Blood loss is different for different types of interventions. For the whole sample it varies from 20 to 400 ml, the average being 173,515 ml; (SD = 89,352). Resection was performed on 80 (79.21%) patients. In resections, blood loss ranged from 30 to 400 ml, with a mean blood loss of 180.938 ml (SD = 90.432). Enucleation was performed on 21 (20.79%). In enucleations, blood loss ranged from 20 to 300 ml, with a mean blood loss of 145,238 ml (SD = 80,970)

(Figure 4). 59 anatomical resections were performed. Their blood loss varies from 30 to 400 ml. The mean blood loss was 177,881 ml; (SD = 90,864). 21 atypical resections were performed. Their blood loss varies from 50 to 380 ml. The mean blood loss was 189,524 ml; (SD = 90,856) (Figure 5).

PM was used in 35 (35.65%) of the operations. When using PM, the average blood loss was 223,714 ml; (SD = 93,308). In other operations, the average blood loss was 146,894 ml; (SD = 75,181). Of the 59 anatomical resections performed, 14 (23.7%) underwent PM. Blood loss when using PM varies from 150 to 400 ml. The mean blood loss was 274,578 ml; (SD = 77,431). In cases where PM is not used, blood loss varies from 30 to 350 ml. The mean blood loss was 147,889 ml; (SD = 72,351) (Figure 6). Of the 21 atypical resections performed, 8 (38.1%) underwent PM.

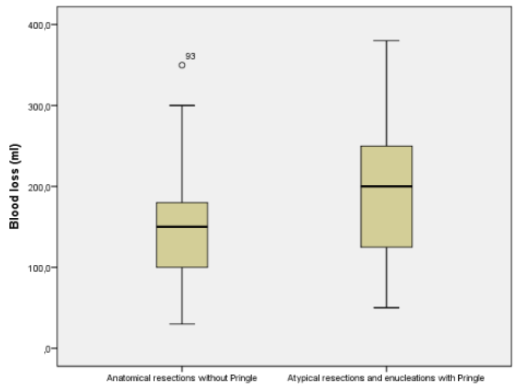

Figure 7: Blood loss in anatomical resections without Pringle and atypical resections and enucleations with Pringle

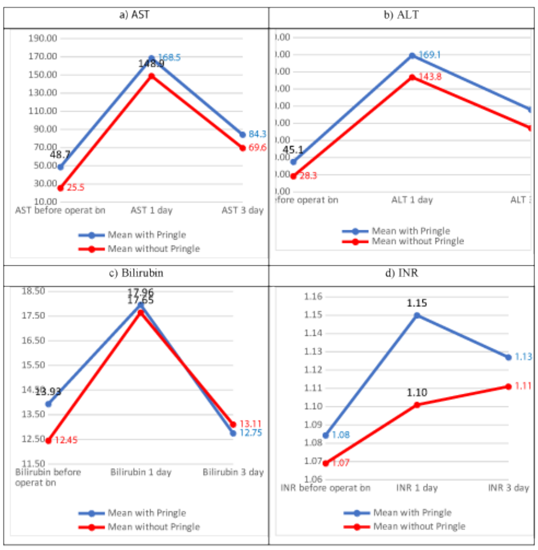

Figure 8: Trend of change in the values of different parameters before and after operations with Pringle and without Pringle

Blood loss when using Pringle varies from 80 to 380 ml. The mean blood loss was 223.75 ml; (SD = 97.239). In cases where PM is not used, blood loss varies from 50 to 300 ml. The mean blood loss was 168,462 ml; (SD = 83,551). 45 anatomical resections without Pringle and 21 atypical resections and enucleations with Pringle were performed. In anatomical resections without Pringle, blood loss varies from 30 to 350 ml; the mean blood loss is 147,889 ml; (SD = 72,351). In atypical resections and enucleations with PM, blood loss varies from 50 to 380 ml; (SD = 88.994) (Figure 7).

Figure 8 shows the trend of changes in AST, ALT, INR and bilirubin values for operations with Pringle and without Pringle before and after operations. For comparison purposes, the average values of the parameters were used.

a) Regardless of the use of PM, AST values increased statistically significantly on the first day after surgery (z = -4,553 [-7,056]; p <0,000) and decreased on the third day (z = -4,832 [-7,063]; p <0.000 The AST values on the third day were also statistically significantly higher than the baseline studies (z = -3.006 [-6.523]; p <0.003) (Table 1).

Table 1: Wilcoxon Signed Ranks Test

	AST 0 day - AST 1 day.		AST 1 day - AST 3 day		AST 0 day. - AST 3 day	
	z	p	Z	p	z	P
With Pringle	-4,553	,000	-4,832	,000	-3,006	,003
Without Pringle	-7,056	,000	-7,063	,000	-6,523	,000

Table 2: Wilcoxon Signed Ranks Test

	ALT 0 day - ALT 1st day.		ALT 1st day- ALT 3rd day		ALT 0's day. - ALT 3rd day	
	z	p	Z	p	z	p
With Pringle	-5,020	,000	-4,243	,000	-3,661	,003
Without Pringle	-7,056	,000	-7,062	,000	-6,471	,000

Table 3: Wilcoxon Signed Ranks Test

	Bilirubin 0 day - Bilirubin 1st day		Bilirubin 1st day – Bilirubin 3rd day		Bilirubin 0 day. – Bilirubin 3rd day	
	t	p	T	p	t	p
With Pringle	-4,442	,000	8,001	,000	1,284	.372
Without Pringle	-7,939	,000	10,508	,000	-1,208	,2

b) A statistically significant difference in AST values in operations with and without Pringle was found only in the initial measurements (z = -2.454; p = 0.014) (Table 2).

b) Regardless of the use of Pringle, ALT values increased statistically significantly on the first day after surgery (z = -5,020 [-7,056]; p <0,000) and decreased on the third day [z = -4,243 [-7,062]; p <0.000 The AST values on the third day were also statistically significantly higher than the baseline studies (z = -3.661 [-6,471]; p <0.000).

No statistically significant difference in ALT values was found in operations with and without Pringle.

c) c) Regardless of the use of PM, bilirubin values increased statistically significantly on the first day after surgery (t = -4,442 [-7,939]; p <0,000) and decreased on the third day (t = 8,001 [10,508]; p < 0.000 Bilirubin values on the third day did not differ statistically significantly from baseline studies (p = 0.208 [p = 0.232]) (Table 3).

No statistically significant difference in bilirubin values was found in operations with and without PM.

d) d) Regardless of the use of Pringle, INR values increased statistically significantly on the first day after surgery (z = -2.913 [-2.525]; p <0.012). The INR values on the third day were also statistically significantly higher than the baseline studies (z = -5,160 [-7,062]; p <0.000). There was no statistically significant difference in INR values between 3 and 1 day after surgery (p = 0.162 [p = 0.486]) (Table 4).

Table 4

	INR 0 day - INR 1st day.		INR 1st day - INR 3rd day		INR 0 day. - INR 3rd day	
	z	p	Z	p	z	p
With Pringle	-2,913	,004	-1,400	,162	-5,160	,000
Without Pringle	-2,525	,012	-,696	,486	-7,062	,000

There was a statistically significant difference in INR values in operations with and without Pringle. On the first day after surgery, INR values were statistically significantly higher in patients who received Pringle (z = -2.614; p = 0.009) (Mann Whitney test).

Discussion

The liver is an organ that is sensitive to ischemia and anoxia. Loss of blood supply leads to reduced oxygen supply to the liver and to ischemia. When blood invades the ischemic liver, it will affect the activity of oxygen-dependent cells and cause damage to organ function. This is called ischemic reperfusion trauma [1]. With the improvement of surgical techniques and the accumulation of experience, it became possible to perform liver resection or enucleation for LH in more specialized units. However, the risk of massive bleeding remains, especially in giant hemangiomas> 10 cm in size, due to the likelihood of severe vascular damage [2,3]. Determining the factors that predict significant intraoperative bleeding is an important step in creating effective hemostatic strategies. These are anesthesia for low central venous pressure, hepatic vascular occlusion and the use of different types of hemostatic devices. Massive and uncontrollable intraoperative bleeding, often occurring in large-scale liver surgery, leads to severe multiple organ failure and coagulopathy, which in turn leads to an unfavorable outcome. Therefore, one of the main strategies to prevent these complications is the preventive imposition of a tourniquet on the hepatoduodenal ligament (Pringles maneuver), which should be performed in all patients, without exception. PM is a technique that achieves transient occlusion of blood flow. It is performed by dissecting and repairing the hepatoduodenal ligament, after which it is pinched with a vascular clamp or tourniquet until the hepatic arterial pulse disappears. The Pringle (PM) method and the extrahepatic, extraglissonian approach (SHVO) are two common methods of vascular control in liver surgery. Although the use of PM reduces hemorrhage in liver resection, in some cases it can cause ischemic reperfusion injury [1,4]. To avoid this complication, the SHVO technique has been developed that can reduce ischemic reperfusion trauma by blocking the blood supply to the hemihepatic area where the tumor is located and allowing normal blood supply to the contralateral lobe. SHVO is an effective method of restoring liver function without any short-term complications after surgery for patients with hepatic hemangiomas. However, this technique is complex and surgeons must have experience in dissecting the porta hepatis to protect the vessels and bile ducts from injury. In addition, they should be aware of the location and size of the lesions, as well as the index of preoperative liver function. A comparative study [5] of the two vascular control methods revealed a significant difference between the two study groups in terms of the change in systolic blood pressure and heart rate (p <0.01). This indicates that the effect on hemodynamics caused by SHVO is much smaller than that caused by PM. Transaminases and bilirubin increased significantly more in the PM group than in the SHVO group compared to preoperative results (p <0.05). These results confirm the thesis that surgery with PM can cause ischemic reperfusion damage to the liver. This was to some extent confirmed in our study by dividing patients into two groups - with and without the use of PM. The difference between the mean bilirubin values in the two types of interventions was statistically significant only in 3 days after the intervention, when the bilirubin values in enucleation (using Pringle) were higher than those in resection (without Pringle) by an average of 1.62 (p = 0, 023). This is also confirmed by the fact that in 71% of the enucleations the AST values and in 67% of the enucleations the ALT values are out of norm on the 3rd postoperative day. There was also a statistically significant difference in INR values in operations with and without Pringle. On the first day after surgery, INR values were statistically significantly higher in patients who received Pringle (p = 0.009).

Over the last decade, with the use of modern technology and thanks to advanced techniques for the anatomical separation of gleason and caval structures, large-scale anatomical resections have achieved a significant reduction in intraoperative blood loss without using the Pringle method. At the same time, in patients who have received the Pringle method in combination with non-anatomical resections or enucleations, the blood loss in some reported series reaches 800 ml and more [6]. During parenchymal transection bleeding was absent, but after declamation the bleeding reached 300 ml and more compared to the control group, in which the bleeding was about 50 ml after removal of the resect (p <0.01). In addition, the time to reach final hemostasis in the group without PM is 4 times shorter. In the group we studied, blood loss ranged from 20 to 400 ml, with an average value of 173,515 ml; (SD = 89,352). In resections, blood loss ranged from 30 to 400 ml, with a mean blood loss of 180,938 ml (SD = 90,432). In enucleations, blood loss ranged from 20 to 300 ml, with an average blood loss of 145,238 ml (SD = 80,970). No statistically significant difference was found in blood loss between the two interventions (resection and enucleation). No statistically significant difference in blood loss was found between atypical and anatomical resection. PM was used in 35 (35.65%) of the operations. When using Pringle, the average blood loss was 223,714 ml; (SD = 93,308). In other operations, the average blood loss was 146,894 ml; (SD = 75,181). There was a statistically significant difference in blood loss with the use of PM and without the use of PM. In operations using Pringle, blood loss was greater by an average of 76.82 ml (p <0.000). Of the 59 anatomical resections performed, 14 (23.7%) used Pringle. There was a statistically significant difference in the amount of blood loss in anatomical resections with and without the use of Pringle (p <0.000). Blood loss with Pringle in anatomical resections (with direct parenchymal transection) was on average 126.4 ml higher than in anatomical resections without Pringle (controlled hepatectomy). 45 anatomical resections without Pringle and 21 atypical resections and enucleations with Pringle were performed. There was a statistically significant difference in the amount of blood loss in the two compared groups (p = 0.045). Blood loss in atypical resections and enucleations with PM averaged 42.1 ml more than in anatomical resections without Pringle. A statistically significant relationship was found between the use of PM and the type of operation. Pringle was used statistically significantly more in enucleations (p = 0.003). The chance of using Pringle in enucleations is 4.3 times higher than in resections. In enucleations, the duration (in minutes) of PM is on average 12.5 minutes longer than in resections.

Conclusion

Prolonged anatomical parenchymal transection results in significantly less intraoperative bleeding and shortens the time for final hemostasis. With the use of modern technologies and thanks to the advanced techniques for the anatomical separation of the Gleason and Kaval structures, when performing large-scale anatomical resections, a significant reduction in intraoperative blood loss was achieved without using the Pringle method.

Refernces

1. Weigand K, Brost S, Steinebrunner N, Büchler M, Schemmer P, Müller M. Ischemia / reperfusion injury in liver surgery and transplantation: pathophysiology. HPB Surg. 2012; 2012: 176723

2. Jiang H., Chen Z, Prasoon P. et al. Surgical management for giantliver hemangiomas greater than 20 cm in size // Gut Liver. - 2011. —Vol. 5. - P. 228–233.

3. Xia F, Lau WY, Qian C, et al. Surgical treatment of giant liverhemangiomas: enucleation with continuous occlusion of hepaticartery proper and intermittent Pringle maneuver. World J Surg.2010; 34: 2162–2167.

4. Huang Z, Zhang P, Wang H, Yan L, Wang W. Comparing outcomes of twovascular inflow occlusion techniques and treatment without vascularocclusion during major hepatectomy in patients with hepatitis B-related hepatocellular carcinoma. PLoS One. 2014; 9: e107303.

5. Minghao Li, Chunyan Zhang, Tao Zhang et al. Outcome using selective hemihepatic vascular occlusion and Pringle maneuverfor hepatic resection of liver cavernous hemangioma Li et al. World Journal of Surgical Oncology (2015) 13: 267DOI 10.1186 / s12957-015-0680-9

6. Anisimov, Andrei Yurievich et al. Endovascular embolization of multiple cavernous hemangiomas of the liver. Department of Disaster Medicine (Head - Prof. Sh.S. Karatay) of the Kazan State Medical Academy of Postgraduate Education, 2 Interregional Clinical and Diagnostic Center (General Director - Candidate of Medical Sciences RN Khairullin) Ministry of Health of the Republic of Tatarstan, Kazan. Kazan medical journal. 2008, Volume 89, №4