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THE EFFECT OF THE ENDOVASCULAR ACCESS ON THE EFFECTIVENESS AND SAFETY OF CHEMOEMBOLIZATION OF THE ARTERIES OF THE LIVER WITH UNRESECTABLE LIVER METASTASES

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Background. *Minimally invasive surgery techniques are widely used in the treatment of primary and metastatic liver cancer.* ***Objective.*** *The goal was to evaluate the effect of the endovascular access on the efficiency and safety of chemoembolization of liver arteries (CELA) in patients with unresectable liver metastases.* ***Methods.*** *In 30 patients with unresectable liver metastases, CELA was performed using the transradial and transfemoral approaches. The microcatheter technique was used for superselective chemoembolization of the liver arteries with introduction of drug-saturated microspheres (HepaSphere). All the digital material was statistically processed using the STATISTICA 6.0 software package (StatSoft, 2001). The results were considered statistically significant at $p<0.05$.* ***Results.*** *In the normal type of the blood supply to the liver, only the left radial access with only the right hepatic artery embolization demonstrated a significantly shorter duration of CELA and fluoroscopy, which amounted to 33±4.3 min and 9.9±1.3 min, respectively ($p<0.05$). When performing CELA by means of microspheres 50–100 um from the right femoral access with embolization of only the right hepatic artery, the above assessment criteria were the highest — 67±11 min and 19.1±5.3 min, respectively, but without a significant difference between the other options for the puncture access. During the first CELA using a femoral access, the postoperative hospital stay in the studied group of patients was 7±0.8 days, and the postembolization period lasted 1.43±0.5 days, which is significantly longer (at $p\leq0.05$) in comparison with the same parameters for the right radial arterial access, for which they were 3±0.6 days and 1.15±0.4 days, respectively, and for the left radial arterial access, for which they were 4±0.5 days and 1±0.001 days,respectively.* ***Conclusion.*** *The use microspheres as a embolization material allowed the application of the microcatheter technique for hqTACE, and expanded the possibilities of the transradial access. A significantly better tolerance and safety of the transradial access was proven in 76.2% of the studied patients in whom it was applicable. The repetitions of CELA donot affect the severity of the post-embolization period, partially due to a lowered use of the contrast medium and superselective embolization of the affected areas of the liver with the preservation of a more intact parenchyma.*

Keywords: *transradial access, superselective chemoembolization of the liver arteries, drug-saturated microspheres.*

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BACKGROUND

In recent years, minimally invasive surgery methods have been widely used in the treatment of unresectable hepatocellular carcinoma and hepatic metastases of colorectal cancer, and the results obtained are promising. The most modern X-ray endovascular technique is transarterial chemoembolization with drug-saturated microspheres (hepatic arterial chemoembolization [HACE], hqTACE). Sufficiently significant experience has already been achieved with its use in patients with hepatocellular carcinoma [1]. With metastatic liver damage, additional clinical cases are required to establish an evidence base regarding the use of drug-saturated microspheres in this pathology.

The use of endovascular techniques is impossible without assessing the characteristics of the arterial blood supply to the metastatic nodes. Liver neoplasms mainly obtain this blood supply from the arterial bloodstream, and a healthy liver parenchyma is supplied by 2/3 of blood flow from the portal vein system. Hence, chemoinfusion and chemoembolization of the liver arteries are provided most commonly for the treatment of primary and metastatic liver cancer [2]. Hepatocellular carcinoma is known to have a well-developed vasculature, whereas metastases are not adequately or moderately supplied with blood [3, 4]. This must be taken into account when choosing embolization material and directly during the chemoembolization procedure itself. However, questions about the effect of variants of the liver arterial anatomy on the technical success of X-ray endovascular intervention and on the clinical efficacy of regional chemotherapy remain poorly understood. Repeated courses of regional chemotherapy are accompanied by repeated exposure to both mechanical (arterial catheter, guide) and chemical agents (chemotherapeutic agent, contrast agent) for the intima of the arteries. This can lead to the development of stenosis and occlusion of the branches of the hepatic artery and to the formation of collateral blood flow, which significantly hinders or prevents further treatment. Simultaneously, the frequencies and causes of hemodynamically significant stenosis and occlusion of the liver arteries during repeated courses of regional chemotherapy are presented as single messages. For transarterial chemoembolization procedures, transfemoral approach is traditionally used. However, in recent years, several publications have been established, assessing the role of transradial approach for the embolization of arteries with different localizations [5]. The methodology of performing and the number and severity of complications of transradial vascular approach during chemoembolization of the hepatic artery with drug-saturated microspheres in metastatic liver cancer have not been studied.

METHODS

Conditions

This study was conducted in the Department of X-ray Methods of Diagnosis and Treatment (head of the department is A.V. Staferov, PhD) of the Federal Scientific and Clinical Center for Specialized Types of Medical Care and Medical Technologies of the Federal Medical and Biological Agency (hereinafter FSCC; the director general is A.V. Troitsky, Professor, MD, PhD) in patients with metastatic liver cancer to optimize the surgical technique and surgical approach for endovascular intervention with the complex introduction of drug-saturated microspheres.

Patient characteristics

To perform selective chemoembolization of the arteries of the liver with drug-saturated microspheres, the study included 30 (10 men [33.3%] and 20 women [66.7%]) patients with unresectable metastatic lesions of the liver who were treated at the FSCC from 2013 to

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2019. Patients were divided according to the localization of the primary process. Thus, there were 12 patients with colon cancer (43.34%), 5 with pancreas cancer (16.67%), 2 with stomach cancer (6.67%), 2 with prostate cancer (6.67%), 2 with pulmonary cancer (6.67%), and 1 each for the cancer of the small intestine, rectum, ovaries, uterus, breast, oropharynx, cholangiocarcinoma (3.33%). According to the histological type, adenocarcinoma and neuroendocrine cancer were detected in 22 and 8 patients, respectively. The studied patients had several types of liver metastatic lesions, namely, 27 patients with bilobar multiple focal liver damage, 1 patient with single metastasis in the central part of the right lobe of the liver, and 2 patients with metastases with an infiltrative nature of growth along the bile ducts (parabiliary metastases of colorectal cancer). At the time of the first chemoembolization, the average age of the patients was 61.3 ± 11.6 (28 to 81) years, with the average ages of men and women being 64.0 ± 8.6 (53 to 81) and 59.5 ± 11.7 (28 to 78) years, respectively.

Description of medical intervention

For chemoembolization, we used HepaSphere microspheres of 50–100 microns (Merit Medical, USA) with the possibility of drug saturation up to working sizes of 200–400 microns. The superabsorbent microspheres were saturated with doxorubicin or irinotecan immediately before administration and were introduced with the use of a microcatheter. The right femoral artery, right radial artery, left radial artery, and left ulnar artery were used to provide access to the arterial vascular bed. Angiographic data were also compared with data on the localization of metastases obtained from noninvasive studies, which determined the choice of arteries for performing chemoembolization.

The procedure of chemoembolization was performed by sequential superselective catheterization with a microcatheter of the target arteries and the administration of a sufficient number of drug-saturated microspheres with doxorubicin or irinotecan to reach the control point.

To confirm the treatment of the tumor with a mixture of medicinal substances and complete chemoembolization, all patients underwent control arteriography. The procedure for the administration of microspheres with a cytostatic was performed under the control of the general condition of the patient, including monitoring of heart rate, pulse, and blood pressure. Prior to surgery, all patients underwent premedication with sedative drugs.

Ethical considerations

The clinical study was approved by the ethics committee of A.I. Evdokimov Moscow State University of Medicine and Dentistry (Conclusion No.: 83-DK-S-I of 06/23/2017).

Statistical analyses

Quantitative assessment of indicators was performed according to generally accepted methods of statistical data processing using the STATISTICA 6.0 software package (StatSoft, 2001). Results were considered statistically significant at $p < 0.05$.

RESULTS

Primary study outcome

All patients underwent visceral angiography to select the optimal scenario for HACE and the necessary X-ray surgical instruments and to study the arterial anatomy of the liver. To ensure the performance of the right-sided approach, patients were placed on the operating table with their heads near the detector. While performing the left-sided approach, if technically feasible, the patient was positioned with his or her feet to the detector. Subsequently, replacing the personnel was not required,

which was important when observing the randomization of surgical procedures.

HACE was performed once for 20 patients (5 men and 15 women), 10 patients (5 men and 5 women) required a repeated procedure, and the duration of HACE 1 was from 2.07 to 12.37 months (average, 7.06 ± 3.7 months) (7.67 ± 3.8 months in men, from 3.63 to 12.37 months, and 6.54 ± 2.9 months in women, from 2.07 to 10.33 months). HACE 3 was performed in two men, with the periods from HACE 1 being 8.83 months for one patient and 29.83 months for the other patients. Moreover, the periods from HACE 2 were 4 and 18.87 months, respectively.

Typical arterial anatomy of the liver was noted in 26 (86.7%) of the studied patients with secondary inoperable metastatic lesions of the liver. However, one patient with a typical variant of blood supply had critical stenosis of the celiac trunk, and another patient had celiac trunk occlusion (Figs. 1 and 2). Thus, only 24 (80%) of the examined patients had a typical uncomplicated variant of the blood supply to the liver. Other (atypical) variants of liver blood supply were noted in 4 (13.3%) patients. It should be emphasized that the features of the anatomical structure of the hepatic vessels did not affect the effectiveness and completeness of the HACE procedure due to the possibility of performing a microcatheter technique for the superselective administration of microspheres (see Figs. 1 and 2).

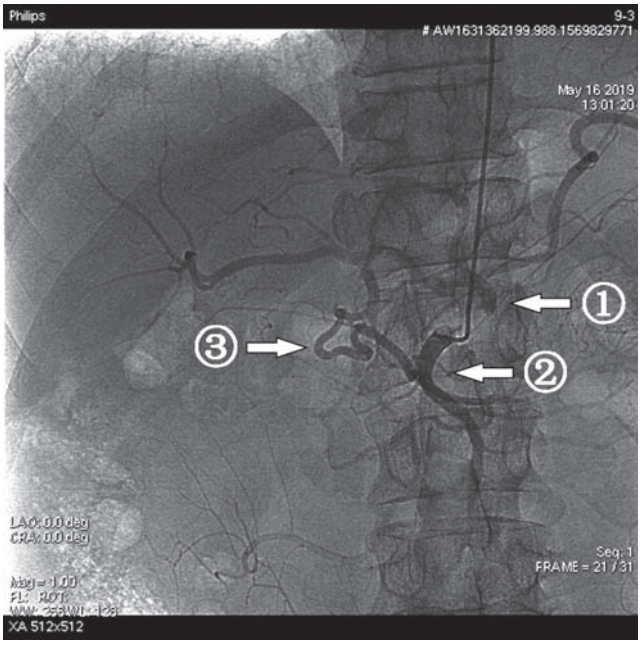
However, when planning chemoembolization of the arteries of the liver, not only various options for the blood supply to the liver but also the features of the visceral arteries must be taken into account. Thus, in one patient, an increased tortuosity of the hepatic arteries was detected, which would exclude the use of HACE in a monolobar version (Fig. 3).

Microcatheter catheterization technique performed the initial plan of approach to the distal vascular bed (Fig. 4).

The HACE microcatheter technique also increases the probability of performing the planned volume of intervention because it significantly prevents the intraoperative complications in the celiac trunk system. Hence, when performing monolobar HACE after selective catheterization of the right hepatic artery with a 5-F catheter, a pronounced spasm of the right hepatic and proper hepatic arteries was visualized on a control celiacography (Figs. 5 and 6).

Such intraoperative complications such as spasm of the arteries, their dissection and occlusion, which are often observed in patients undergoing the traditional method of performing HACE, have never been noted in HACE with the performance of the microcatheter technique. Thus, when performing chemoembolization of the arteries of the liver in patients with unresectable metastatic liver cancer, the diagnostic stage of visceral angiography is of significant importance, which is aimed at the

Fig. 1. Variant of blood supply to the liver in celiac trunk occlusion



Note. 1 — celiac trunk, 2 — superior mesenteric artery, 3 — collateral filling of the celiac trunk system from the superior mesenteric artery to *a. pancreaticoduodenalisinferior* and retrograde to *pancreaticoduodenalissuperior* and *a. gastroduodenalis*.

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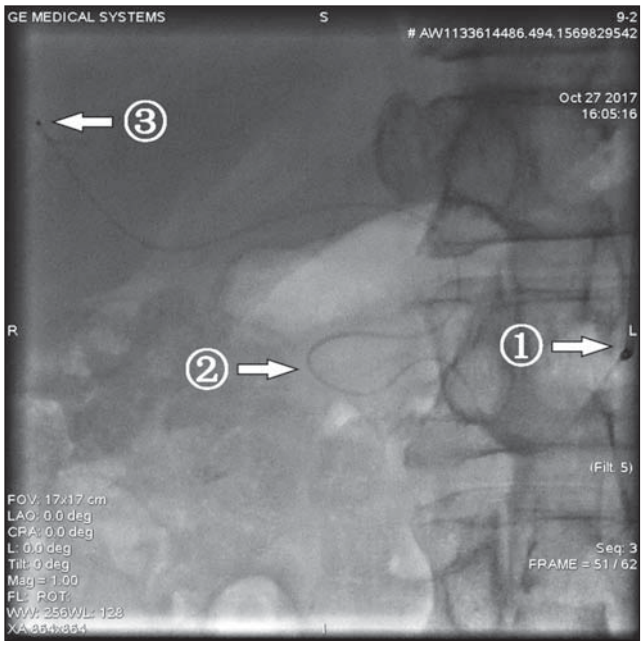
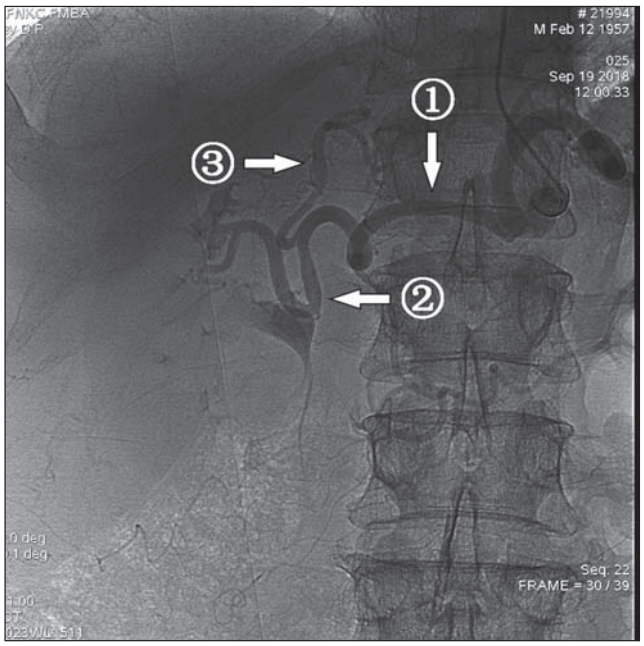
Fig. 2. Selective catheterization by microcatheter of the segmental branches of the right hepatic artery in celiac trunk occlusion



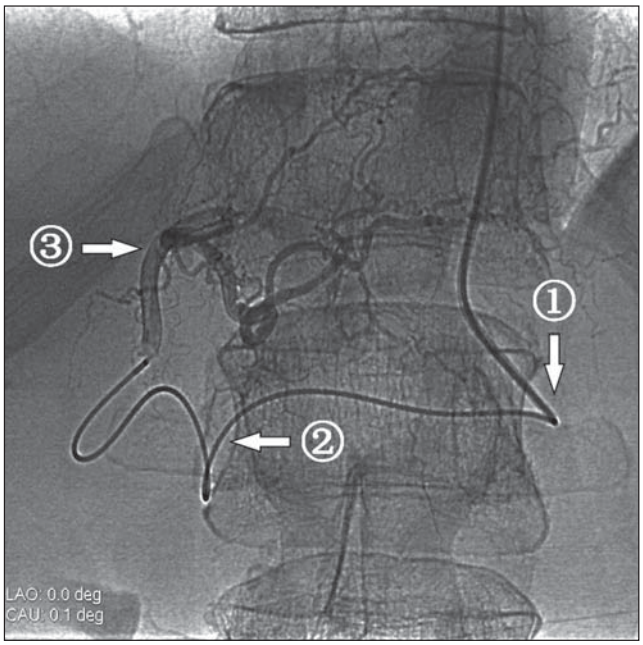
Note. 1 — angiographic 5-F catheter at the mouth of the superior mesenteric artery, 2 — microcatheter passing from the superior mesenteric artery to *a. pancreaticoduodenalisinferior* and retrograde to *a. Pancreaticoduodenalissuperior* and *a. gastroduodenalis* to the right hepatic artery, 3 — tip of the microcatheter in the segmental branch of the right hepatic artery.

Fig. 3. Variant of blood supply to the liver, pronounced tortuosity of the hepatic arteries



Note. 1 — common hepatic artery, 2 — right hepatic artery, 3 — left hepatic artery.

Fig. 4. Selective catheterization of the segmental branches of the left hepatic artery with pronounced tortuosity of the hepatic arteries



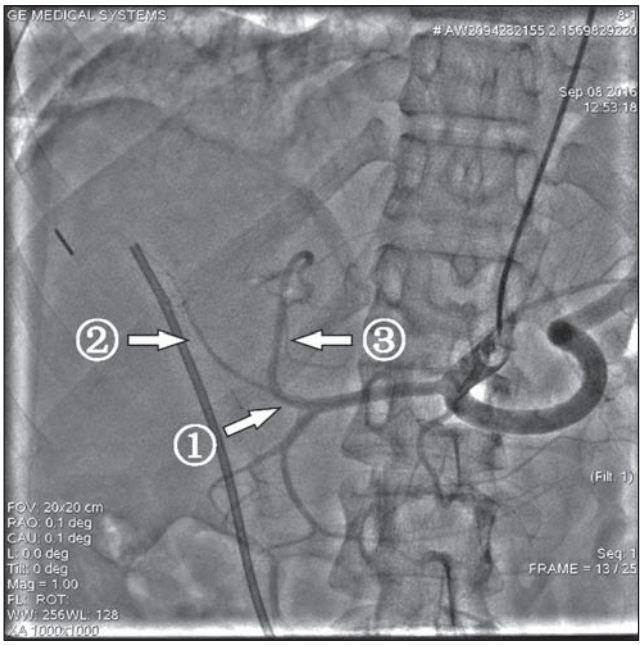
Note. 1 — angiographic 5-F catheter at the mouth of the celiac trunk, 2 — microcatheter passing from the celiac trunk to the left hepatic artery, 3 — segmental branches of the left hepatic artery.

assessment of the variant of blood supply to the liver in a particular patient and the identification the individual characteristics of the state of the vessels or the reactive response from the vessels in the form of spasm to the insertion of the instrument and administration of the contrast medium.

We also analyzed the effect of various surgical approaches and volumes of HACE. We were able to identify that with a normal variant of blood supply to the liver, only the left radial approach with an intervention volume at the level of embolization of only the right hepatic artery demonstrated significantly shorter duration of HACE and X-ray examination, which amounted to 33 ± 4.3 and 9.9 ± 1.3 min, respectively ($p < 0.05$). With the right radial approach, the durations of HACE and X-ray examination in the case of embolization of only the right hepatic artery reached 45 ± 8.4 and 16.9 ± 1.5 min, respectively, and in the case of embolization of the branches of both the right

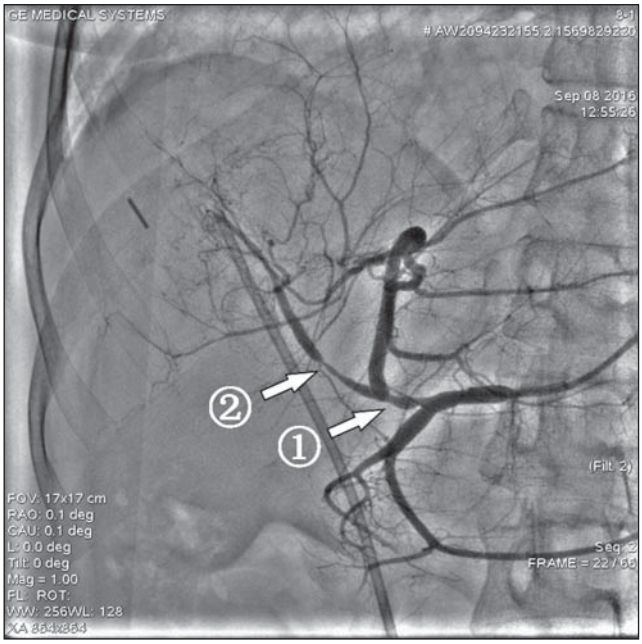
and left hepatic arteries, the durations were 50 ± 7.9 and 15.4 ± 3.4 min, respectively. When performing HACE from the right femoral approach with an embolization volume of only the right hepatic artery, the above assessment criteria were the highest (67 ± 11 and 19.1 ± 5.3 min, respectively), but had no significant difference between the other puncture approach options.

Fig. 5. Initial celiacography: the difficulty of catheterization of the segmental branches of the hepatic arteries with the development of spasm



Note. 1 — proper hepatic artery, 2 — right hepatic artery, 3 — left hepatic artery.

Fig. 6. Control celiacography after selective catheterization of the right hepatic artery: the difficulty of catheterization of the segmental branches of the hepatic arteries with the development of spasm



Note. 1 — spasm of the proper hepatic artery, 2 — spasm of the right hepatic artery.

Significantly, the largest amount of contrast medium was required during the embolization of the right hepatic artery through the right femoral approach, which amounted to 216.7 ml among the other approach options with the normal variant of blood supply to the liver ($p < 0.05$). Additionally, patients with femoral approach with the normal anatomical variant of blood supply had the longest post-embolization period and the number of postoperative bed days, which were 1.33 ± 0.02 days and 5 ± 0.6 days with monolobar embolization and 1.6 ± 0.07 days and 6 ± 1.8 days with bilobar HACE ($p < 0.05$), respectively.

Depending on the revealed variants of liver blood supply, the optimal arterial approach was selected for the most successful tumor embolization by the highly selective administration of HepaSphere. Table 1 presents the main approach variants that were used in our patients during all HACE procedures.

Based on Table 1, preference was given to radial approach, which we used in 73.3% of patients during HACE 1, in 80% of patients during HACE 2, and in 100% of patients during HACE 3. It is worthy to mention that we did not change the radial approach during each subsequent HACE. We only changed the approach side due to the technical aspects of the X-ray apparatus in five patients. According to Table 1, femoral approach was used at the beginning of our study in 2013, with HACE 1 in 23% of patients and in 20% of patients during the repeated procedure. The choice of approach at that time was reasonable because only femoral approach was traditionally used for oil transarterial embolization, and the introduction of HepaSphere into clinical practice

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Table 1

Variants of approach in the studied patients during hepatic arterial chemoembolization

Years of conduct	Variants of approach	HACE 1		HACE 2		HACE 3	
		Number of patients					
		n	%	*n*	%	*n*	%
2013–2015	Arterial right femoral	7	23.3	2	20	-	-
2016–2019	Arterial right radial	13	43.3	6	60	1	50
2017–2019	Arterial left radial	9	30	2	20	1	50
2019	Arterial left ulnar	1	3.3	-	-	-	-
2019	Arterial right brachial	-	-	1	10	-	-

Note. HACE—hepatic arterial chemoembolization

expanded the possibilities of using the radial approach.

The ulnar approach was only used in one patient due to the anatomical feature of the radial artery, in which the use of radial approach was impossible. An attempt to perform HACE through the brachial approach was made once.

Analyzing the aspects of HACE depending on the alternative approach, we compared the indicators characterizing the execution procedure, namely, the average amount of contrast agent, duration of the procedure, complications, length of the postoperative period, and the number of bed days (Table 2). Based on the data obtained, it is clearly observed that the duration of HACE with radial approach is less than that with the femoral approach, that is, by 16% with the right radial approach and by 23% with the left one compared with the arterial right femoral approach. Moreover, when using radial approaches, a smaller amount of contrast medium was required, that is, by 18% with the right radial approach and by 33% with the left radial approach, with almost identical X-ray examination time with the femoral and right radial approaches (15.8 ± 6.4 and 15.7 ± 5.2 min, respectively). However, when performing the left radial approach, the time of X-ray examination in patients was the shortest at 11.9 ± 4.8 min.

During HACE 1 using the femoral approach, the number of postoperative bed days in the studied patients was 7 ± 0.8, and the post-embolization period lasted for 1.43 ± 0.5 days, which is significantly longer (at $p \leq 0.05$) compared to similar indicators with the arterial right radial approach (3 ± 0.6 days and 1.15 ± 0.4 days, respectively) and the arterial left radial approach (4 ± 0.5 days and 1 ± 0.001 days, respectively). The postoperative period with the arterial left elbow approach was not analyzed due to a non-representative sample (one patient).

As can be observed from Table 2, HACE 1 procedure was optimally performed with the radial approach, which we performed in 22 patients. That is, the amounts of contrast medium, HACE durations, X-ray examination times, numbers of bed days, and post-embolization periods with the right and left radial approaches were 123.1 ± 34 and 100 ml, 49 ± 8 and 40 ± 15 min, 15.4 ± 3.2 and 10.9 ± 2.8 min, 3 ± 0.6 and 4 ± 0.5 days, and 1.15 ± 0.4 and 1 ± 0.001 days, respectively.

When performing the femoral arterial approach in seven patients, the amount of contrast medium was 150 ± 65 ml, the duration of HACE was maximum and amounted to 59 ± 18 min, the time of X-ray examination was 16.3 ± 6.4 min, and the post-embolization period and

Table 2

Indicators characterizing hepatic arterial chemoembolization 1 procedure, dependent on the approach used

Approach variants	HACE volume, qty (%)	Contrast agent, ml	HACE duration, min	Term of Ro-scopy, min	Intraoperational complications, complaints	Post-embolization period, days	Bed days
Arterial right femoral, *n*=7	RHA 3 (42.9) RHA+LHA 4 (57.1)	150 ± 65	59 ± 18	16.3 ± 6.4	No	1.43 ± 0.5*	7 ± 0.8*
Arterial right radial, *n*=13	RHA 3 (23.1) RHA+LHA 10 (76.9)	123.1 ± 34	49 ± 8	15.4 ± 3.2	1 (nausea and epigastric pain)	1.15 ± 0.4*	3 ± 0.6*
Arterial left radial, *n*=9	RHA 6 (66.7) RHA+LHA 3 (33.3)	100 ± 0.001	40 ± 15	10.9 ± 2.8	1 (severe nausea)	1 ± 0.001*	4 ± 0.5*
Arterial left ulnar, *n*=1	RHA+LHA 1(100)	200	75	19.5	No	1	2

Note. *Significant differences in indicators depending on the approach used at $p < 0.05$. HACE — hepatic arterial chemoembolization, RHA/LHA — right hepatic artery/left hepatic artery

the number of bed days were significantly the longest (1.43 ± 0.5 days and 7 ± 0.8 days, respectively) ($p < 0.05$).

Thus, the indices characterizing the procedure of HACE 1 in patients who underwent the radial approach were significantly more adequate compared with those in patients who underwent the femoral approach. Additionally, the number of bed days and the post-embolization period were significantly lower in patients undergoing the radial approach than those in patients undergoing the femoral approach. The course of the operational period with the development of complications in the form of nausea and epigastric pain did not affect the duration of the post-embolization and postoperative periods.

The analysis of the compared criteria during HACE 2 demonstrated the following.

The duration of the procedure and the time of X-ray examination (38 ± 2.1 and 9.7 ± 1.3 min, respectively) were shorter in patients undergoing HACE 2 with the femoral approach than those in patients undergoing the right radial (53 ± 13.8 and 17.1 ± 3.2 min, respectively) and left radial (38 ± 3.2 and 14.4 ± 4.1 min, respectively) approaches. Simultaneously, X-ray examination was significantly less performed in patients undergoing the right femoral approach than in patients undergoing the left femoral approach. Any significant differences in the indices between the groups with the right and left radial approaches were not observed. Simultaneously, the number of bed days when using the right femoral approach was 6.5 ± 1.3 days, and the numbers of bed days with the right and left radial approaches were 2.8 ± 0.3 and 3.5 ± 0.4 days, respectively, which are significantly less than that in the right femoral approach (with $p < 0.05$). However, the post-embolization period proceeded in all patients from 1 to 2 days with a significant difference only when performing the right radial approach, where it was 1 day.

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Thus, during HACE 2 procedure, the femoral approach through the right femoral artery was performed in two patients only, whereas the X-ray examination duration was significantly shorter in patients undergoing the femoral approach than that in patients undergoing the radial approach. Concurrently, the number of bed days in patients undergoing the femoral approach was significantly greater than that in patients undergoing the radial approach through the radial arteries. However, considering that our study has a small sample size, we cannot interpret these data as a statistically significant fact.

When performing HACE 3 in two patients, only radial approaches were performed, where the average volume of the contrast medium was 150 ml, the average procedure time was 82.5 min, the average duration of X-ray examination was 18.9 min, and the average number of bed days was 1. The post-embolization period was 2 days, and intraoperative complications were not observed.

The technique of chemoembolization with microspheres saturated with a chemotherapeutic drug combines regional chemotherapy and persistent arterial occlusion due to the ability of microspheres to increase in volume. However, to ensure adequate and reliable transportation of microspheres to the metastatic focus, taking into account the complex anatomical structure of the vascular blood supply to the liver, a significant attention is paid to the technical possibilities of such approach and, in particular, the performance of the microcatheter technique. In our study, we widely used the microcatheter in accordance with the technique described previously. Table 3 presents a comparison of the main indicators of HACE in the group of studied patients with/without the use of the microcatheter.

According to Table 3, the use of a microcatheter has a direct correlation with the amount of a contrast medium used. In patients undergoing HACE 1 with the use of a microcatheter, a higher amount (up to 128.8 ± 15.8 ml) of contrast medium was used than in patients undergoing HACE 1 without the use of a microcatheter (100 ml). In patients undergoing HACE 2 with the use of a microcatheter, a higher amount (112.5 ± 13.8) of contrast medium was used than in patients undergoing HACE 2 without the use of a microcatheter (100 ml). In patients undergoing HACE 3 with the use of a microcatheter, a total of 150 ± 17.7 ml of contrast medium was used.

The duration of HACE 1 without the use a microcatheter was significantly shorter

Table 3

Features of hepatic arterial chemoembolization in the studied patients with the use and without the use of a microcatheter

Assessment criteria	For HACE 1		For HACE 2		For HACE 3	
	M (-) *n*=4	M (+) *n*=26	M (-) *n*=2	M (+) *n*=8	M (-) *n*=0	M (+) *n*=2
Average age, years	54,7±3,5	61,96±9,5	69±6,7	55,63±5,5	-	61±3,5
Contrast agent, ml	100±0,0001	128,8±15,8	100±0,0001	112,5±13,8	-	150±17,7
HACE duration, min	24±6,5*	53±12,3*	43±3,5*	49±11,2*	-	82,5±13,4*
Ro-scopy time, min	6,7±0,4*	15,5±2,4*	12±0,4*	15,8±0,8*	-	18,8±0,9*
Post-embolization period, days	1,25±0,04	1,15±0,08	1,5±0,03	1,11±0,09	-	1±0,0001
Bed days	3,5±0,06	3,54±0,03	4,5±0,1	3,9±0,07	-	2±0,03

Note. *Significant differences of values in the compared categories at $p < 0.05$. HACE — hepatic arterial chemoembolization, M (+)/M (-)—with/without the use of a microcatheter

(24 ± 6.5 min) ($p < 0.05$) than that with the use of a microcatheter (53 ± 12.3 min). Moreover, the durations of HACE 2 and HACE 3 with the use of a microcatheter were 49 ± 11.2 min and 82.5 ± 13.4 min, respectively ($p < 0.05$). In general, the duration of all HACEs with the use of a microcatheter was longer than that in all HACEs without the use of a microcatheter.

Similar findings were also observed between the duration of X-ray examination and the use of a microcatheter. The duration of X-ray examination was lower in patients undergoing HACE 1 without the use of a microcatheter (6.7 ± 0.4 min) ($p < 0.05$) than that in patients in the other groups. During HACE 2, X-ray examination was performed for 12 ± 0.4 min ($p < 0.05$). The durations of X-ray examination in patients undergoing HACE 1, HACE 2, and HACE 3 with the use of a microcatheter were 15.5 ± 2.4 min, 15.8 ± 0.8 min, and 18.8 ± 0.9, respectively ($p < 0.05$).

However, an opposite result was noted in determining the duration of the post-embolization period, which was shorter in patients undergoing HACE with the use of a microcatheter than in patients undergoing HACE without the use of a microcatheter. Thus, the post-embolization periods in HACE 1, HACE 2, and HACE 3 with the use of a microcatheter were 1.15 ± 0.08, 1.11 ± 0.09, and 1 days, respectively. Moreover, the post-embolization periods in HACE 1, HACE 2, and HACE 3 without the use of a microcatheter were 1.25 ± 0.04, 1.5 ± 0.03, and 1.5 ± 0.03 days, respectively.

CONCLUSION

To ensure the high effectiveness of the procedure that was achieved in our study, it is necessary to carefully study the options for blood supply to the liver in each patient before the HACE procedure. In general, in the group, various options of arterial blood supply to the liver do not affect hqTACE. However, it should be keep in mind that in our study, 86.7% of patients showed a typical structure of the arterial bed supplying the liver with blood. Under conditions of typical arterial blood supply to the liver, HACE of the right hepatic artery performed with the left transradial approach showed the best results with respect to the duration of the procedure (33 min) and the duration of X-ray examination (9.9 min). Moreover, in patients undergoing the transfemoral approach, the durations of the procedure and X-ray examination were 67 and 19.1 min, respectively.

With the use of the HepaSphere embolization material, the use of a microcatheter when performing hqTACE expanded the possibilities of the transradial approach. Significantly better tolerance and safety of the transradial approach was confirmed in 76.2% of the studied patients, where this procedure was applicable.

The optimization of the method of chemoembolization of the liver arteries with drug-saturated microspheres from a superabsorbent polymer is achieved due to the lack of planned repeats of the procedure, the possibility of choosing transradial approaches, and the use of a microcatheter.

In patients with unresectable metastatic liver tumors, all HACEs performed did not result in the so-called major complications, the average duration of the post-embolization period was 1.19 days, and the postoperative number of bed days was 3.57 days. The multiplicity of HACE does not affect the severity of the post-embolization period, due to the less use of contrast medium and the superselective embolization of the affected areas of the liver with the preservation of more intact parenchyma.

CONTRIBUTION OF AUTHORS

D.P. Lebedev performed surgeries and created and analyzed a patient database; D.A. Astakhov performed the management of patients as an attending physician, prepared the primary material for analysis, and edited

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the article; E.A. Zvyozdkina created the database of patients, performed the analysis of angiograms, and prepared the primary material for analysis; V.V. Kosyi performed the management of patients as an attending physician and prepared the primary material for analysis; A.G. Kedrova performed the management of patients as an attending physician and prepared the primary material for analysis; Yu.V. Ivanov analyzed the patient database and edited the article; and D.N. Panchenkov analyzed the patient database and edited the article.

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CONFLICT OF INTERESTS

No conflict of interest was reported by the authors.

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