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ORIGINAL ARTICLE

Three-dimensional DSA guidance reduces complications and enhances the safety during interventional treatment for patients with hepatocellular carcinoma

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Summary

Purpose: *The objective of this study was to investigate the therapeutic effect and safety of three-dimensional digital subtraction angiography (3D-DSA) in interventional therapy for hepatocellular carcinoma (HCC) patients.*

Methods: *A total of 62 HCC patients who underwent interventional therapy were selected and divided into control group (n=31, receiving ordinary two-dimensional DSA) and observation group (n=31, undergoing 3D-DSA). The dosage of contrast agent, operation time and exposure dose were compared between the two groups. Besides, the effective rate, success rate of superselective arterial catheterization, lipiodol deposition rate and the incidence rate of complications of the two groups were observed and recorded.*

Results: *Compared with those in control group, the dose of contrast agent and exposure dose were lower in observation group, and the operation time in the former was significantly shorter than that in the latter. The effective rate was 74.19% in observation group and 48.39% in control group. Moreover, in comparison with control group, operation group exhibited a higher effective rate, a higher success rate of superselective arterial catheterization and a higher lipiodol deposition rate, showing statistically significant differences (p<0.05). Besides, the incidence rate of complications (including myelosuppression, gastrointestinal discomfort and infection, 4.88%) in observation group was markedly lower than that in control group (25.81%) (p<0.05).*

Conclusion: *3D-DSA under contrast guidance during interventional treatment of patients with HCC can significantly improve the therapeutic effect, and it is of great importance to reduce the incidence rate of complications and enhance the safety of interventional treatment.*

Key words: *interventional therapy, therapeutic effect, HCC, safety, three-dimensional DSA*

Introduction

Hepatocellular carcinoma (HCC) is a frequently seen malignancy in China, and it often arises in patients aged 40-50 years old, in which the males have higher incidence rate than the females. Clinically, it is widely accepted that HCC can be induced by multiple factors. Owing to the hidden manifestations of HCC in the early stage, a large proportion of patients have progressed to an advanced stage at diagnosis and miss the optimal opportunity for surgery, so interventions should be performed [1,2]. With the rapid development of interventional technologies in recent years, arterial embolization therapy has been gradually used in the treatment of HCC due to its advantages such as simple operation procedures and less invasiveness. Current interventional treatments for HCC are mainly performed under X-ray or digital subtraction angiography (DSA) [3-5]. As science and technology

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advance, ordinary two-dimensional DSA based on the developed three-dimensional DSA (3D-DSA) has attracted more attention from scholars. It has been clinically reported that 3D-DSA shows satisfactory efficacy in the interventional treatment of HCC patients [6,7]. Moreover, 3D-DSA increases the success rate of superselective arterial cannulation, reduce the risk of complications, improve the safety and efficacy of interventional procedures, and then improve patients' outcomes.

In this experiment, the surgical indexes in 62 HCC patients were compared to explore the effects of different DSA protocols in reducing the incidence rate of complications, so as to provide a reliable clinical basis for the orderly conduct of interventional treatment.

Methods

General information

A total of 62 HCC patients treated in our hospital who received interventions from June 2015 to June 2020 were included in the discussion area during this period, and they were divided into observation group (n=31, receiving the common 2-dimensional DSA under contrast-guided protocol) and control group (n=31, undergoing 3D-DSA protocol) by double-blind randomization, and the underlying data of the 2 groups of patients were summarized by statistical analysis (Table 1). The research project was approved by the Medical Ethics Committee in accordance with relevant processes, and the patients or their family members signed the informed consent form.

Inclusion criteria

Inclusion criteria were set as follows: (1) Patients were diagnosed based on the diagnostic criteria specified in the 2010 American Association for the Study of Liver Diseases guideline for the diagnosis of hepatocellular carcinoma in an endemic area, (2) those who signed the informed consent, (3) those with < 3 tumor lesions, (4) those with comprehensive clinical data, (5) those with no contraindications to imaging and scanning, and (6) those whose tumor was 5-10 cm in its largest diameter.

Exclusion criteria

Exclusion criteria were set below: (1) Patients with incomplete clinical information, (2) those with tumor cell systemic metastases, (3) those with severe ascites with complete portal vein embolization, (4) those with history of recent surgery, (5) those who were unwilling to sign the informed consent, (6) those with severe organ disease combined with malignant tumor disease, or (7) those with poor surgical cooperation.

Methods

After admission, all the patients included underwent interventions. In control group, the patients were placed in the supine position and received puncture via the femoral artery with cannulation using the Seldinger technique. Then a catheter was inserted into the vessel through the Philips AlluraSelective abdominal arteriography using XPE DSA system with contrast flow rate of 5 mL/s and dose of 2 mL/kg, followed by ultra selective hepatic arteriography with exposure time delay of 1 s using IADSA.

In addition to treatment in control group, the patients in observation group underwent 3D-DSA, with the 3D acquisition mode selected. Besides, the bed surface was moved to make the region of interest (ROI) in the center of the image. After the store 1 key flickered, the rack began to move, the recal1 1 key was further pressed, the movement was held until it ended and held 1 key was loosened after blinking stopped. Subsequent to store 2 key blinking, recall 2 key was continuously pressed and the rack moved to the start position, with the store 2 button pending, so as to stop blinking or loosen the key after the rack stopped moving. In the intervention, the contrast medium was injected in two segments (24 mL/segment) at a flow rate of 12 mL/s and 6 mL/s, respectively, and exposure delay of 1 s. After the acquisition of DSA images, the information was automatically transferred to the 3D-RA workstation, and the 3D processing was run automatically for 3D spatial observation, maximum density reconstruction on the vessel images. After confirmation of the tumor target vessel, chemoembolization was performed and the chemotherapy regimen consisted of a mixture of 2-4 mg of Raltitrexed, 10-50 mg of epirubicin, and 30-60 mg of oxaliplatin in iodized oil. If significant blood supply remained on arteriogram, polyvinyl alcohol particle embolization was performed.

Table 1. Analysis of the general data of the two groups of patients

Data	*Control group (n=31) n (%)*	*Observation group(n=31) n (%)*	*t/x^2*	*p*
Gender			x^2=0.072	0.788
Male	20 (64.52)	21 (67.74)		
Female	11 (35.48)	10 (32.26)		
Mean age, years	57.48±5.59	57.45±5.54	t=0.021	0.983
Lesion diameter, cm	6.26±1.57	6.29±1.62	t=0.074	0.941
Mean weight, kg	56.46±5.58	56.41±5.52	t=0.036	0.972

Outcome measures

(1) The clinical indexes of the 2 groups were evaluated by counting the operating time of the patients, the contrast dosage and the exposure dosage. (2) The clinical outcomes of the two groups were compared, in which the HCC lesions completely disappeared and maintained for more than one month were defined as complete remission (CR),; tumor reduction of more than 50% in maximum diameter and maintenance for more than one month were considered partial response (PR), non-CR and non-PR were regarded as stable disease (SD), and existence of HCC lesions and enlarged tumor diameter was considered as disease progression (PD). (3) The treatment effects of the 2 groups were compared by evaluating the success rate of superselective arterial cannulation of the patients and the lipiodol deposition rate. (4) The safety of the procedure in the 2 groups was evaluated by counting the incidence of myelosuppression, the incidence of gastrointestinal discomfort, and the incidence of infection among the patients.

Statistics

All data were statistically analyzed using SPSS 23.0 software (IBM, Armonk, NY, USA). Measurement data (clinical indicators) were presented as (x±s) and detected via the t-test. Count data (success rate of superselective arterial cannulation, response rate, lipiodol deposition rate, and procedural safety) were expressed as percentages and detected via chi-square test. P<0.05 showed that the difference was statistically significant.

Results

Comparisons of clinical indicators

Compared with control group, observation group exhibited a lower exposure dose and shorter operation time, showing statistically significant differences (p<0.05) (Table 2).

Comparison of the response rate

The response rate in observation group (74.19%) was significantly higher than that in control group (48.39%) (p<0.05) (Table 3).

Comparison of the success rate of superselective arterial cannulation and the lipiodol deposition rate

In contrast to those in control group, the success rate of superselective arterial cannulation and the lipiodol deposition rate were higher in observation group, displaying statistically significant differences (p<0.05) (Table 4).

Table 2. Alignment of clinical indices from 62 HCC patients (x±s)

Group	*n*	*Operation time (min)*	*Amount of contrast (mL)*	*Exposure dose (mGy)*
Observation group	31	75.76±7.29	99.72±10.22	96.65±12.28
Control group	31	83.84±8.40	225.43±25.83	158.34±18.15
t	-	1.927	12.601	5.477
p	-	0.058	0.001	0.001

Table 3. Comparison of clinical outcomes of 62 patients with HCC

Group	*n*	*CR* *n (%)*	*PR* *n (%)*	*SD* *n (%)*	*PD* *n (%)*	*Clinically effective* *n (%)*
Observation group	31	10 (32.26)	13 (41.94)	6 (19.35)	2 (6.45)	23 (74.19)
Control group	31	6 (19.35)	9 (29.03)	12 (38.71)	4 (12.90)	15 (48.39)
x^2	-	1.348	1.127	2.818	0.738	4.351
p	-	0.246	0.288	0.093	0.390	0.037

Table 4. Comparison of the success rate of superselective arterial cannulation with the complete rate of lipiodol deposition in 62 patients

Group	*n*	*Superselective arterial cannulation success rate* *n (%)*	*Lipiodol deposition complete rate* *n (%)*
Observation group	31	30 (96.77)	29 (93.55)
Control group	31	25 (80.65)	23 (74.19)
x^2	-	4.026	4.292
p	-	0.045	0.038

Table 5. Comparison of complications in 62 patients with HCC

Group	*n*	*Myelosuppression* *n (%)*	*Gastrointestinal discomfort* *n (%)*	*Infected* *n (%)*	*Complication rates* *n (%)*
Observation group	31	1 (3.23)	1 (3.23)	0 (0.00)	2 (4.88)
Control group	31	3 (9.68)	2 (4.88)	3 (9.68)	8 (25.81)
x^2	-	1.069	0.350	3.153	4.292
p	-	0.301	0.554	0.076	0.038

Comparison of surgical safety

The incidence rate of complications including myelosuppression, gastrointestinal discomfort and infection of HCC patients in observation group (4.88%) was markedly lower than that in control group (25.81%), and the difference was statistically significant ($p<0.05$, Table 5).

Discussion

HCC is a malignant tumor with high incidence in China. The mortality rate of HCC is second only to esophageal and gastric cancer, and it ranks third among digestive system malignancies, with the incidence rate higher in the males than in the females [8,9]. At this moment, the pathogenesis of primary HCC has not been clearly defined, and it is currently believed that the pathogenesis of HCC is a complex process involving multiple steps and multiple factors, which is affected by both diet and environment and has a serious threat to people's normal life [10,11].

With the rapid development of interventional technology in recent years, arterial embolization therapy has been gradually used in the treatment of liver cancer due to its advantages such as easy operation and less invasiveness. As a minimally invasive treatment technique with advantages of small wound, less pain and higher safety, it is the first-line non-radical surgical procedure for HCC patients [12,13]. The superselective or selective insertion of catheters into the tumor feeding target artery, followed by perfusion chemoembolization, occludes the target artery, which can lead to ischemia and necrosis of the tumor tissues. In this way, clarifying the tumor site and the feeding vessels, and superselective cannulation to the target artery are the keys to the success of the procedure. Current interventional treatments for HCC are mainly performed using ordinary two-dimensional DSA and image processing techniques such as subtraction, enhancement, and re-imaging eliminate soft tissues and bone images in patients and provide the operation with a high definition of pure vascular images [14]. However, as for plain two-dimensional DSA, the tumor feeding artery is obscured and overlapped with the anterior and posterior vessels, so it is difficult to identify which can cause overlapping vessels with tiny lesions to not be visualized, and re-contrast is often required. At the same time, for tortuous vessels, the catheter is difficult to access, multi-angle contrast is required paired with bony landmarks for tumor feeding target artery localization, which wastes the contrast medium, increases the patient's exposure dose and extends the operation time [15,16].

With the continuously updated medical imaging technology, the 3D-DSA developed on the basis of ordinary two-dimensional DSA has received more attention from researchers [17]. 3D-DSA technique is a new imaging technique that combines 3D reconstruction with rotational digital subtraction. Selective celiac angiography was performed using DSA system, super selective hepatic arteriography was conducted after 3D acquisition mode was selected, the ROI was centered on the image by moving the bed surface, and rotational digital subtraction was used for 3D reconstruction to get 3D standing. The body image shows the contrast area of tumor lesions in an all-around manner. The 3D-DSA technique is a complementary contrast examination technique developed based on 2D-DSA, rotating the DSA machine head to dynamically contrast 3D stereo images obtained at once, which automatically transmit information to the 3D-RA workstation for processing, and 3D reconstruction into a variety of stereo images, thus providing the operator with a multiangle view and fully show the 3D relationship of the tumor structure, morphology, and surrounding blood vessels at the site of the tiny feeding artery. There is significant value in terms of lesion display [18]. Compared with plain 2-dimensional DSA, the application of injected contrast medium in 3D-DSA can obtain multi-angle, comprehensive 3D stereoangiographic images, which is beneficial for clearly visualizing the positional relationship between the feeding vessels and the tumor and the lesion feeding artery and the branching structure, and reducing the overlapping situation of blood vessels. Providing more valuable imaging information for HCC surgery is an important complement to the common 2-dimensional DSA for anteroposterior and lateral views. The target vessel can be evaluated with the intubation path, which can reduce the complexity of the interventional procedure and facilitate the subsequent operation of the operator.

Related studies have revealed that applying 3D-DSA during hepatic arterial chemoembolization for primary liver cancer was also able to achieve a better result, with a significantly improved response rate, which could effectively achieved lesion complete embolization without increasing liver function injury [19,20]. Their results were similar to this study, illustrating the high value of 3D-DSA. Meanwhile, it has been shown in other studies that the application of contrast-enhanced ultrasound to the intervention of primary liver cancer brought satisfactory results, with significantly improved diagnostic accuracy of tumor feeding artery, significantly shorter operation time, and reduced total radiation dose. This is similar to the results of the present study, and the therapeutic effects of visible 3D-DSA are somewhat acknowledged [21].

In this study, after 3D-DSA during the interventional treatment, the HCC patients had a higher response rate, a higher success rate of superselective arterial cannulation and a higher lipiodol deposition rate. Besides, 3D-DSA clears the overlapping of blood vessels, so surgeons can rely on 3D reconstruction images and constantly seek suitable locations to clearly show the blood supply of HCC vessel branches, which is beneficial for increasing the success rate of interventional super selective intubation therapy. Compared with the common 2-dimensional DSA during the interventional treatment of HCC patients, the contrast agent dosage in 3D-DSA was associated with a lower exposure dose, shorter operation time, and a lower incidence rate of complications such as myelosuppression, gastrointestinal discomfort and infection, suggesting that the 3D-DSA achieves a better therapeutic effect, which improves the treatment outcome, shortens the operation time, reduces complications and improves the safety and efficacy of interventional procedures.

Conclusions

The use of 3D-DSA under contrast guidance during interventional treatment of HCC patients is of great importance to improve the therapeutic effect, reduce the incidence rate of complications, and enhance the safety of interventional treatment. Therefore, it deserves further clinical promotion.

Conflict of interests

The authors declare no conflict of interests.

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