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Short Communication

Feeding artery characteristics and enhancement patterns of hepatoblastoma patients treated with transarterial chemoembolization (TACE): Digital subtraction angiography evaluation

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Abstract

Hepatoblastoma is one of the most common primary malignant liver tumors in children. The incidence of hepatoblastoma has been increasing, reaching 1.2 per million children now. The transarterial chemoembolization (TACE) procedure is one of the most practical and effective treatment options besides surgery. Digital subtraction angiography (DSA) is performed as the first step of the TACE procedure. The aim of this study was to provide information about the feeding arteries and enhancement pattern of the hepatoblastoma that was assessed by DSA before the TACE procedure. A retrospective study was conducted among hepatoblastoma cases that had undergone DSA on the TACE procedure to obtain information on the vascularity of the tumor. A total of 26 hepatoblastoma cases who had DSA examination as a part of their first TACE procedure were included, consisting of 15 boys and 11 girls, aged between 1–15 years. All cases were stage III and IV according to the Pre-Treatment Extent of Tumor (PRETEXT) staging classification. All hepatoblastoma cases had multiple feeding arteries, most of which were branches of the right hepatic artery. The largest diameter of the feeding artery was 1.82 mm, and the smallest was 0.63 mm. Most cases (84.62%) had strong contrast absorption, and spread evenly, either at the edges or in the center of the tumor. DSA is believed to be an accurate procedure to provide a detailed description of the feeding artery; enhancement patterns of hepatoblastoma were influenced by an adequate TACE.

Keywords: Hepatoblastoma, tumor enhancement, digital subtraction angiography, feeding artery, TACE

Introduction

Hepatoblastoma (HB) is one of the most common primary malignant liver tumors in children [1,2]. Based on the United States Surveillance, Epidemiology, and End Results (SEER) data, in the last 30 years, the incidence of HB has increased from 0.6 to 1.2 per 1,000,000 children. The incidence of HB is common in 0–5-year-old children and it is the second most common primary malignant liver tumor in children after hepatocellular carcinoma (HCC) [3].

Several HB treatment and procedure options have been developed and used such as partial or complete surgery (hepatectomy), transplantation, systemic chemotherapy, and transarterial chemoembolization (TACE) [4,5]. Treatment options are determined based on the clinical

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conditions of the patients and the stage of the disease using the Pre-Treatment Extent of Tumor (PRETEXT) staging. PRETEXT I and II stages of the HB usually have a fairly good success rate if surgery is performed. While the PRETEXT III and IV stages are usually not operable, because of the size and locally advanced tumor. TACE can bridge non-operable tumors to be operated on or transplanted by shrinking tumor size and controlling intra-operation bleeding [4,5].

TACE is the minimally invasive procedure that is the most effective treatment option for HB besides surgery. The advantage of TACE is that it provides maximum absorption of the chemotherapy agent by the tumor as well as minimal systemic side effects [5,6]. A previous study in Japan reported that 90% of the surgical procedures of HB patients after TACE were successful with better results [7]. The TACE steps consist of the vascular and tumor mapping procedure with digital subtraction angiography (DSA) followed by a chemoembolization procedure [4,5]. The identification of the feeding artery (FA) includes the size and the origin of the branch, and the assessment of tumor tissue includes the contrast enhancement pattern. However, DSA findings may differ from previous computed tomography (CT) scans or magnetic resonance imaging (MRI) findings [8,9]. The information related to FA and the enhancement pattern of HB will be used to determine the suitable size of the intra-arterial catheter, and the target location of the embolization. The aim of this study was to determine the FA and enhancement patterns of HB patients that were assessed by DSA.

Methods

Study design and setting

A retrospective study was conducted at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. The study was conducted by analyzing (re-interpreting) the results of the DSA examinations that were conducted on HB patients. The data was retrieved in the form of the digital imaging and communication (DICOM) raw data from DSA examinations.

Patients and criteria

The samples of the study were HB patients who underwent the first TACE procedure. A total of 26 patients (15 boys and 11 girls) were included during the study period, aged 0–15 years from patients who had the first TACE procedure during 2012–2021. The samples were collected using total sampling of all patients who met the inclusion criteria.

The inclusion criteria for this study were: (1) HB patients who underwent a DSA prior to the first TACE procedure at Dr. Soetomo General Hospital Surabaya, Indonesia during the period January 2012 and September 2021; and (2) had never undergone a liver surgery procedure before. The patients who had a liver tumor other than HB were excluded.

Digital subtraction angiography (DSA) procedure

After informed consent was obtained, the sedation was administered. Local anesthetic was provided before the Seldinger technique into the femoral artery, followed by the insertion of a catheter sheath (6 Fr) and 0.018-inch of a guidewire. A catheter (5 Fr) was inserted, and non-ionic contrast iodine diluted with 5% dextrose solution was injected under fluoroscopy monitoring. A microcatheter (2.7 Fr) was inserted to reach the prior hepatic artery (PHA), right hepatic artery (RHA), and left hepatic artery (LHA). The presence of the FA and contrast enhancement pattern of the tumor were assessed.

Feeding artery (FA) and contrast enhancement patterns

The endpoints of the study were FA of tumors and patterns of contrast enhancement of the tumors based on DSA results. Both of the endpoints were assessed by two interventional radiologists with more than 15 years of experience. Three components of FA were assessed: (1) number, (2) size and (3) branch and origin. The enhancement pattern was measured in terms of its qualitative strength and distribution.

Statistical analysis

The obtained data from the study were presented descriptively based on the frequency and the percentage.

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Results

Patients' characteristics

The basic characteristics of the 26 patients included in this study are presented in **Table 1**. The suggested that more boys (57.07%) than girls (42.03%) although this is not significant. Most of the patients aged 0–≤10 years (88.5%) and only 11.5% aged between 11 and 15 years (**Table 1**).

Table 1. Demographic characteristics of the included patients who underwent a DSA examination during the first TACE procedure

Characteristics	n	Proportion (%)
Gender		
Male	15	57.70
Female	11	42.30
Age (Years)		
0–≤10	21	88.50
>10–≤15	5	11.50

Feeding arteries (FA) and enhancement patterns

The lumen sizes of the FA ranged between 0.634 mm and 1.82 mm (mean 1.208 mm, standard deviation (SD) 0.317 mm). All patients had multiple FAs, which were between 3 and 5 arteries. The distribution was 3 FAs (34.62%), 4 FAs (42.31%), and 5 FAs (23.08%). The origin of FA were multiple branches from RHA (69.32%), multiple branches from both left hepatic artery (LHA) and right hepatic artery (RHA) (19.23%), multiple branches from LHA (7.69%), and 3.85% had branches from proper hepatic artery (PHA) (**Table 2**).

Table 2. Feeding artery (FA) characteristics and enhancement patterns of hepatoblastoma (HB) patients based on digital subtraction angiography (DSA) examination results

Feeding arteries (FA) and enhancement pattern	n	Proportion (%)
FA assessment of the tumor tissue		
The number of FA		
3 feedings	9	34.62
4 feedings	11	42.30
5 feedings	6	23.08
FA size (mean, mm)	1.208	-
Minimum FA size (mean, mm)	0.634	-
Maximum FA size (mean, mm)	1.817	-
FA branch and origin		
Single FA originating from the RHA or LHA	0	0.00
Multiple FAs originating only from the RHA	18	69.23
Multiple FAs originating only from the LHA	2	7.69
Multiple FAs originating from both RHA and LHA	5	19.23
Multiple FAs originate from multiple arterial branches (RHA and LHA) and may involve PHA	1	3.85
Multiple FAs originating from multiple arterial branches and involving CHA, LGA, and/or SMA	0	0.00
Multiple FAs originating from several arterial branches and involving other extrahepatic arteries such as thoracic arteries and others	0	0.00
Enhancement pattern of the tumor tissue		
Qualitative assessment		
Strong	22	84.62
Prominent	3	11.54
Weak	1	3.85
Distribution of the enhancement pattern		
Partial	10	34.46
Full	15	57.69
Peripheral	1	3.85

CHA: common hepatic artery, LGA: left gastric artery, LHA: left hepatic artery, PHA: proper hepatic artery, RHA: right hepatic artery, SMA: superior mesenteric artery.

Out of total patient, contrast degradation enhancement was classified as strong in 84.62% of them, prominent (11.54%), and weak (3.85%) (**Table 1**). The contrast distributions in tumor tissue were classified as spread evenly, partial spreading, and peripheral spreading (**Figure 1**).

Out of the total patients, 57.69% had spread evenly either at the edges or in the center of the tumor, 38.46% had partial spreading, and 3.85% had peripheral spreading (**Table 1**).

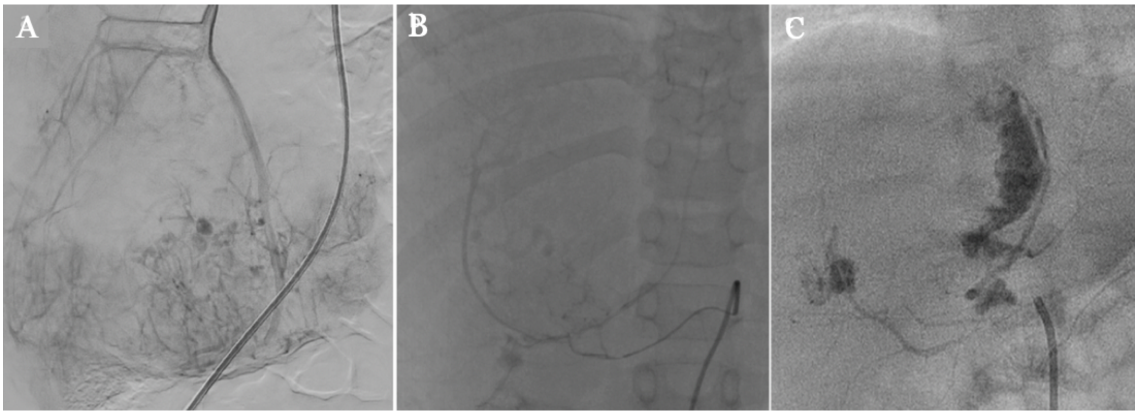

Figure 1. Assessment of the pattern of contrast distribution in hepatoblastoma (HB) patients with digital subtraction angiography (DSA) examination. The assessment of the distribution of contrast absorption based on the categories (a) the contrast is evenly/full-filled the tumor mass; (b) the contrast is only absorbed in several focal locations either peripherally or intratumorally; and (c) peripheral enhancement where the contrast is only distributed in the peripheral area of the tumor.

Discussion

HB is a very rare case but is the most common solid liver tumor in children [10]. The prevalence of HB cases is 1.5/1,000,000 children [3,10], slightly more common among boys than girls with a ratio (1.5:1) [11,12]. The prevalence of HB cases is predominant in the first decade of children (<10 years), even though also found in older age of children [11,13].

Identification of the FA branches sometimes tends to be difficult and may confuse inexperienced operators [9,14]. These are regarding the anatomic variations of the hepatic artery [15] and the large tumors that press the adjacent liver tissues; therefore, changing the anatomical structure of vessels [9]. Our data suggested that large tumors (i.e., staging PRETEXT III and IV) were likely having multiple FAs. Although a single FA may be found in small-size tumors, none of the patients in the study had a single FA. The multiple FAs were correlated with more aggressive tumor growth [16]. In the chemoembolization stage (after DSA is performed), the presence of multiple FAs could provide both advantages and disadvantages. Although the injected chemo-embolism flow will rapidly fill the tumors as a target, the disadvantage can lead to mistakes in FA identification itself and the risk of non-target arterial embolization [17]. The selection of an appropriate microcatheter that will be used on chemoembolization is determined by the lumen size of the FA. Based on our findings, the size of FA's mean value was 1.209 mm (**Table 1**). All patients in this study had the chemo-embolization by a 2.7 Fr microcatheter (diameter 0.9 mm). This means the microcatheter used was suited to the average FA size. The commonly used microcatheters in the TACE procedure are 2.4–2.9 Fr (0.8–0.93 mm) [18].

Our data indicated that most of the HB cases had multiple FAs (69.23%) which originated from RHA. Therefore, the target point of chemo-embolization should be provided at the proximal of RHA. A previous study found that HB was commonly found at the right lobe and fed by multiple FAs originating from RHA [19] and less common at the central and left lobes [19]. The accuracy of DSA interpretation by experienced TACE operators will greatly affect the identification of the FA, as well as distinguish it from normal branch variations [14]. In case the FA originates from the PHA and is designated as the target point of embolization, it is needed to ensure that gastroduodenal arteries do not carry out from the distal of the target point due to a risk of non-targeted embolization to the gastroduodenal arteries which is leading to pancreatitis [17,20].

Our data suggested that most of the contrast degradation patterns were in the strong category. The contrast degradation may be related to the hypervascularity tumor and therefore during DSA, the contrast flow will be seen rapidly filling into the capillaries and tumor tissues [21-23]. In addition, the multiple and large sizes of FA also increase the contrast flow [23].

We found that the common contrast absorption pattern classifications were spreading evenly either at the edges or in the center of the tumor (**Table 2**). This finding represents the tumor formation. With the presence of necrotic area intra-tumoral without contrast absorption, the DSA images will show as a separate focal tumor or a peripheral contrast pattern [24]. The interpretation of the tumor contrast patterns based on DSA may influence the estimation of the chemo-embolic emulsion volume that must be prepared efficiently [25].

There are some limitations of the study. Although we collected the data between 2012 and 2021, the number of patients was relatively small this is because HB is known as a rare case. The multicenter study is needed to have a larger sample size. We also did not assess any associations between patients' characteristics, clinical presentations with FA characteristics and enhancement patterns.

Conclusion

DSA is a part of the TACE procedure in HB patients, which was believed as an accurate procedure to provide detailed descriptions of FA and enhancement patterns of the tumor. We found that all patients have multiple Fas (between 3 and 5 arteries) and most of them had multiple branches from RHA. The mean size of the FAs was 1.208 mm. Such data and the enhancement pattern of HB would be important to improve the accuracy of the intra-arterial catheter size selection, and the target location of the embolization in HB patients.

Ethics approval

This study was approved by the Ethical and Health Research Committee of Dr. Soetomo Hospital, reference number: 0665/LOE/301.4.2/X/2021.

Competing interests

The authors declared that they have no competing interests.

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Not applicable.

Underlying data

Derived data supporting the findings of this study are available from the first author on request.

How to cite

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