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Portal Vein Embolization: Correlation of Future Liver Remnant Hypertrophy to Type of Embolic Agent Used

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Abstract

Purpose: The purpose of this study was to compare the effectiveness of portal vein embolization (PVE) with different embolic agents used at our centre. Specifically, the effectiveness of N-butyl cyanoacrylate (NBCA) glue is compared with that of polyvinyl alcohol (PVA) particles.

Methods: We performed a retrospective chart review of all patients (N = 77) who underwent PVE at our institution over a 5-year period. Pre- and postprocedural computed tomography or magnetic resonance imaging, when available, were used to measure the volume of total liver volume and future liver remnant (FLR). The absolute values obtained were used to calculate percentage of FLR. The growth in FLR was determined 4–6 weeks after PVE. Technical details of the procedure including the type and amount of embolic agent used were obtained from the chart reviews, electronic patient records, and radiology reports. Statistical analysis was performed using Kruskal-Wallis test, Wilcoxon rank sum test, and the Spearman correlation coefficient with post hoc analysis. Results are expressed as mean \pm SD ($P < .05$ considered statistically significant).

Results: NBCA (n = 29) produced a mean change in FLR of 14.8% compared with 9.3% for PVA particles (n = 24; $P = .007$). Mean change in FLR was 10.1% in the group where a combination of NBCA and PVA particles was used (n = 24). The effect of glue volume and glue-to-lipiodol ratio on the outcome was not found to be statistically significant ($P = .5$ and $.7$, respectively).

Conclusions: We conclude that NBCA glue is a better embolic agent than PVA particles in inducing liver hypertrophy.

Résumé

Objet : La présente étude vise à comparer l'efficacité des différents agents utilisés à notre centre pour l'embolisation de la veine porte. En particulier, elle compare l'efficacité de la colle de cyanoacrylate de n-butyle à celle des particules de polyalcool de vinyle.

Méthodes : Nous avons effectué un examen rétrospectif du dossier de tous les patients (n = 77) qui ont subi une embolisation de la veine porte à notre établissement sur une période de cinq ans. Nous avons utilisé les images de tomodensitométrie ou de résonance magnétique prises avant et après l'intervention pour mesurer le volume du volume total du foie et du futur foie restant (FFR). Les valeurs absolues obtenues ont servi à calculer le pourcentage du FFR. L'hypertrophie du FFR a été déterminée de quatre à six semaines après l'embolisation. Les données techniques de l'intervention, notamment le type et la quantité d'agent d'embolisation utilisés, proviennent des dossiers examinés, des dossiers électroniques des patients et des rapports de radiologie. Pour l'analyse statistique, nous avons utilisé le test de Kruskal-Wallis, le test de Wilcoxon et le coefficient de corrélation de rang de Spearman avec comparaison a posteriori. Les résultats sont exprimés sous la forme suivante: \pm ÉT moyen ($P < .05$ considéré comme significatif sur le plan statistique).

Résultats : Le cyanoacrylate de n-butyle (n = 29) a provoqué un changement moyen du FFR de 14,8 %, par rapport à 9,3 % pour les particules de polyalcool de vinyle (n = 24; $P = .007$). Dans le groupe de patients pour lesquels une combinaison de cyanoacrylate de n-butyle et de particules de polyalcool de vinyle a été utilisée (n = 24), le changement moyen du FFR atteignait 10.1 %. L'effet du volume de la colle et du rapport colle-lipiodol sur les résultats n'a pas été jugé significatif sur le plan statistique ($P = .5$ et $.7$, respectivement).

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Conclusion : Le cyanoacrylate de n-butyle est un agent d'embolisation plus efficace que les particules de polyalcool de vinyle pour provoquer l'hypertrophie du foie.

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Key Words: Portal vein embolization; Future liver remnant; Liver hypertrophy; Glue

Portal vein embolization (PVE) is a procedure used before major hepatic resection. It allows the operator to occlude the main blood supply to the portion of the liver that will be resected and redirect it to the portion that will remain after surgery; the future liver remnant (FLR). FLRs that are small or marginal in size are known to have a complicated postoperative course with an increased risk of liver failure. This procedure allows individuals with small FLRs, who would otherwise not be suitable for surgery, to become surgical candidates.

Although local ablative techniques such as thermal ablation and percutaneous ethanol injection can be curative for small (especially <3 cm) primary liver malignancies, surgical resection plays an important role in the curative treatment of a significant proportion of patients with both primary and secondary liver malignancies. However, a significant portion of these patients are not surgical candidates, particularly those with underlying liver cirrhosis. The resectability rate for hepatocellular carcinoma is about 20%–30% in patients with a normal liver, and is even lower for those with cirrhosis [1]. The primary cause for the poor prognosis is postoperative liver failure, especially in those patients with a high disease burden requiring a major liver resection. The remnant liver volume plays a significant role in determining whether a patient is a surgical candidate as insufficient remnant volume further increases the risk of postoperative liver failure.

Portal vein occlusion has been shown to cause atrophy of the occluded portion of the liver while resulting in hypertrophy of the contralateral lobe [2]. Although exact mechanisms remain unknown, redistribution of blood flow and increase in hepatic growth factor (HGF) and transforming growth factor are thought to play a role in the hypertrophy [2,3]. Since the first report on a human in 1986, the efficacy of this procedure has been demonstrated in several studies [4–6]. Clinical success rate of portal vein embolization was recently reported to be 96.1% in a systematic review by Van Lienden et al [7].

The techniques employed vary across institutions, but the primary principle remains the same: to occlude portal vein flow to the diseased liver which is to be resected. Limited data have been published on the effect of different embolic materials used during the procedure. The purpose of our study is to determine the optimal embolic agent by comparing liver hypertrophy response from N-butyl cyanoacrylate (NBCA) and polyvinyl alcohol (PVA) particles.

Materials and Methods

Study Design

Institutional ethics board approval was obtained before initiation of the study protocol. Informed consent was waived

for this retrospective study. For this type of study, a formal consent is not required. The inclusion criteria were all patients who underwent PVE from 2008–2013. Referral for the procedure was made upon case discussion at multidisciplinary hepatobiliary rounds. No exclusion criteria were set. The study population consisted of 77 patients.

Patient Demographics

A total of 77 patients were part of the study. Patient demographics are presented in Table 1. The majority of patients were over the age of 50 years. An approximately 2:1 male-to-female ratio was noted in our study population. The primary pathology in 73 (95%) patients was colorectal cancer with metastatic disease to the liver. Three (4%) patients had a history of cholangiocarcinoma and 1 (1%) patient had liver disease from a carcinoid tumour.

Data Collection

Demographic and clinical data were obtained from the electronic patient records and the institutional hepatic surgical database.

Volumetric Analysis

Using IMPAX (IMPAX 6.6.1; Agfa, Mortsel, Belgium) and GE software (Advantage Windows 4.4.; General Electric, Milwaukee, WI), CT volumetry was performed on the preprocedural and postprocedural CT/MRI liver on all patients. A 3D MIP application was used to outline the liver contours (total and FLR) and the summation volume was

Table 1
Patient demographics

Age, y	60 (32–81)
Sex	
Male	52/77
Female	25/77
Primary pathology	
Colorectal	95%
Other	5%
Carcinoid	1
Cholangiosarcoma	3
Cirrhosis	
Yes	2/77
No	34/77
Chemotherapy	
Yes	65/77
No	12/77

Values are mean (range) or n/N, unless otherwise indicated.

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