Study on the application of embolization materials of polyvinyl alcohol particles

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Study on the application of embolization materials of polyvinyl alcohol particles

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Abstract. The application, advantages and disadvantages of PVA particle embolization materials were analyzed retrospectively, and the correlation between the application field and the choice of embolization materials was discussed, which provided a reference for clinical treatment. Relevant literatures in PubMed and Web of Science databases were searched, and the literature on clinical application and experimental research of embolic materials was systematically evaluated. The embolization mechanism, advantages and disadvantages, and clinical application of PVA particle embolization materials were discussed. Polyvinyl alcohol particles are such kind of polymer material that insoluble in water, high expansion coefficient, mechanical embolization of blood vessels, no sensitization reaction, no systemic acute toxicity, no intradermal stimulation reaction, safe and effective use. The adhesive liquid embolism material has no vascular toxicity and has been widely used. The application and upgrading of thrombolytic surface materials can significantly improve the blood compatibility of the materials. All kinds of embolic materials have their own advantages and disadvantages, and none of them can be suitable for all diseases. Therefore, it is very important to choose suitable embolic materials for safe and effective treatment.

1. Introduction

Excellent embolic materials should be non-toxic, non-antigenicity, biocompatible, easy to obtain and disinfect, not through X-ray and easy to be injected through catheter. In the process of targeted interventional therapy, the target blood vessels can be completely blocked, the abnormal blood flow channels in the body can be stopped quickly, and the tissue blood flow can be redistributed to ensure the efficacy [1]. It can control the time of occlusion of blood vessels. Once required, percutaneous recovery or recanalization of blood vessels are higher requirements for bioembolic materials [2]. Embolic material of a lot of kinds, according to the nature can be divided into solid and liquid, according to the body can be absorbed in the body can be divided into two types of absorption and non-absorption. At present, gelfoam, polyvinyl alcohol, anhydrous ethanol, isobutyl-2-cyanoacrylate, n-butyl-2-cyanoacrylate are widely used. Gelfoam can be disinfected without antigenicity and can be made into granules or strips of different sizes according to the needs. It is convenient to prepare and can occlude blood vessels from several weeks to several months. Polyvinyl alcohol is a synthetic

material with the characteristics of long occlusion time, non-absorption, hygroscopic expansion and so on.

Isobutyl -2- cyanacrylate is a liquid tissue adhesive, in the case of ionic substances, such as blood and ion type contrast agent soon after polymerization curing, can long-term occlusion of blood vessels, often used in arteriovenous malformations, esophageal varices bleeding. The polymerization time was delayed by adding appropriate amount of iodized oil and iodized benzyl ester, and made it opaque to X-ray. The similar preparation is n-butyl-2-cyanoacrylate, which has a long polymerization time and is beneficial to technical operation. Recently, it has gradually replaced isobutyl-2-cyanoacrylate for clinical use [3]. Autologous blood clot is the only short-term embolism at present. The embolization time is 24-48 h. The advantages of autologous blood clot are convenient sampling and no antigenicity. Spring coil for mechanical emboli can be used for large and small arteries, permanent occlusion of blood vessels, no active role in the body [4].

2. Advantages and disadvantages of polyvinyl alcohol particles

2.1. Advantages

Polyvinyl alcohol particles are permanent embolizers, a kind of polymer material, white or yellowish-light and soft porous sponge particles and porous irregular particles. The raw material is polyvinyl alcohol, which must be mixed with the contrast agent before development [5]. When used, polyvinyl alcohol needs to be cut into pieces to soak with contrast agent, which is suitable for embolization of large and medium-sized blood vessels. Powder is used for embolization of peripheral blood vessels, non-toxic, insoluble in water, with good histopcompatibility and high expansion coefficient. Fibrous tissue can grow into it quickly and mechanically block the blood vessels after being injected into the blood vessel system. Polyvinyl alcohol particles foam embolization particles of different specifications were designed for embolization of vascular-rich tumors and intravascular embolization of arteriovenous malformations according to particle diameter and size [6].

2.2. Disadvantages

Polyvinyl alcohol particles were used for embolization of tumor arteries or malformed vessels. Polyvinyl alcohol particles granules were injected into human body to mechanically embolize vessels at the lesion site. Thrombus materials and mechanism were formed in the gap between polyvinyl alcohol particles granules to permanently embolize vessels. Polyvinyl alcohol particles injected into the human body are treated by mechanical embolization of blood vessels, which has no pharmacological effect on its own. Insoluble in water and ethanol, soluble in formic acid, with good biological safety, mechanical embolization of blood vessels, no sensitization, no systemic acute toxicity, no intradermal stimulation, safe and effective use [7].

Angiography was performed before use to understand the blood supply artery and intubation pathway of the lesion and the related collateral circulation [8]. Superselective intubation was performed according to the standard technique, and the position of catheter insertion should be as close as possible to the treatment site to prevent embolization of normal vessels. Polyvinyl alcohol particles of appropriate size were selected according to the condition of the lesion, and improper selection of particle size may lead to particles entering the blood supply vein of normal tissue or entering the outflow vein of the lesion [9-12].

3. Compared with other materials

3.1. Spring coils

The spring coil which has good compliance and accurate embolization positioning can fully fill the gap beyond the reach of the balloon and smaller fistula, and can complete the embolization of larger diameter through a thinner catheter [13]. At the same time, the spring coil has a relatively high safety in the operation process, does not cause damage to the vascular intima, and has good controllability,

randomness and permanent embolization. It can be shaped according to the size of aneurysm and morphology, and different types of spring coil can be selected according to the size of the fistula [14]. During embolization, the coil was placed in the aneurysm to promote intra aneurysm thrombosis. Even if the coil was improperly placed, it was recovered and replaced, which could be observed by X-ray plain film long-term follow-up. In addition, the application of spring coil embolization of fistula can achieve dense embolization and reduce the recurrence rate [15]. Its disadvantages lie in its incomplete embolization, which is a proximal embolization material, easy to establish collateral circulation, high friction in microcatheter, poor biocompatibility, displacement of spring coil and embolization of normal blood vessels, so it is not an ideal embolization material [16].

3.2. Surface materials

The main anticoagulant heparin is usually fixed on the surface of the polymer, which can significantly improve the blood compatibility of the material [17]. Heparin is a natural anticoagulant with strong anticoagulant effect [18]. The strong anionic properties of heparin are combined with polymer materials with cationic surfaces to form heparinized hydrophilic polymer materials. If the material continues to release heparin in contact with blood, local thrombosis can be prevented [19]. The fixation of heparin on the material surface includes physical adsorption and chemical binding, and in the chemical binding, there are ionic bond binding and covalent bond binding. Heparin fixed by chemical bonds is more stable than that by physical adsorption, while that by covalent bonds is much more stable than that by ionic bonds in chemical fixation. On the other hand, the biological activity of heparin immobilized on the surface through covalent binding is low, so there is a problem that the size of improved anticoagulant is not very prominent [20].

In order to ensure the treatment effect and improve the safety of treatment, the scaffold materials used in clinical should have good biocompatibility. Specifically, it mainly involves blood compatibility and cell compatibility [21]. In the application process of various biological materials, good anticoagulant energy should be satisfied, so as to help reduce the tendency of thrombosis and avoid the occurrence of various risk events in clinical treatment. Platelet adhesion assay is the most direct and commonly used method to evaluate and judge the anticoagulant properties of blood contact materials [22]. By observing the adhesion of platelets on the surface of the material, we can intuitively understand the blood compatibility of the material. In the experiment of platelet adhesion, a small number of platelets could be observed on the surface of the material without aggregation by electron microscopy scanning and fluorescence staining [23].

4. Conclusions

At present, improving the blood compatibility of biomaterials is a crucial step in the research of biomaterials, and the surface modification of biomaterials is the key of this step. However, when grafting materials on the surface, the requirements of blood compatibility of grafted groups or substances should be considered, and the strength of the bond between grafted groups and matrix materials should also be considered. Usually, the ideal modification effect can be achieved by coupling the grafted materials with appropriate intermediate media. There are many methods for the preparation of blood compatible biomaterials. The optimization and modification of material surface interface characteristics have become an important way to improve its blood compatibility, but there are still some problems in the existing evaluation system, such as the selection of sensitive indicators and effective positive control materials and the quantification of evaluation results.

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