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Research article

Hypothesis for the Prospective Use of Endoscopic Lasers for Grade 4 Esophageal Varices Ablation in Patients With Grade III-IV Liver Cirrhosis - Part-I

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Abstract

Liver cirrhosis is a chronic liver disease that can lead to the formation of esophageal varices, which are dilated veins in the lower part of the esophagus. These varices are prone to rupture, resulting in severe bleeding and high mortality rates. The current standard treatment for esophageal varices involves endoscopic band ligation, but this procedure has limitations in patients with advanced liver cirrhosis. This research publication presents a hypothesis for the prospective use of modified laser endoscopic probes for esophageal varices ablation in patients with grade II-IV liver cirrhosis. The physics and technicality of tissue ablation using lasers are discussed, along with the potential benefits and challenges of this novel approach.

Introduction

Esophageal varices are a common complication of liver cirrhosis, and their management poses significant challenges due to the increased risk of bleeding and re-bleeding.

Endoscopic band ligation is currently the standard treatment for esophageal varices, but it may not be suitable for patients with advanced liver cirrhosis. In recent years, the use of lasers for tissue ablation has shown promise in various medical applications. This research aims to explore the potential of modified laser endoscopic probes for esophageal varices ablation in patients with grade II-IV liver cirrhosis.

Grade 4 Esophageal Varices

> 4 mm, circular extension around the esophageal wall; varices almost meet in the middle of the lumen; with or without "good mucosal coverage"

Ref - Image-01, Image -02 , Image -03

Traditional Esophageal Varices Banding Ligation and Sclerotherapy Technique

The traditional techniques (Ref -Image-04) used for the treatment of esophageal varices are banding ligation and sclerotherapy. Esophageal varices are dilated veins in the lower part of the esophagus that can be prone to rupture, causing life-threatening bleeding.

In banding ligation, an endoscope is inserted into the esophagus to visualize the varices. Using a special device attached to the endoscope, small rubber bands are placed around the varices. These bands induce thrombosis, leading to the obliteration of the varices over time. The procedure is typically performed in multiple sessions, with the goal of ligating as many varices as possible to reduce the risk of bleeding. Banding ligation is a widely used and effective technique for controlling bleeding and preventing re-bleeding from esophageal varices.

Sclerotherapy is another technique used for the treatment of esophageal varices. During sclerotherapy, a sclerosing agent (such as ethanolamine or sodium morulae) is injected directly into the varices using an endoscope. The sclerosing agent causes irritation and inflammation of the varix, leading to the formation of scar tissue and subsequent obliteration. Sclerotherapy is generally performed in combination with endoscopic banding ligation or as an alternative treatment option in certain cases.

Both banding ligation and sclerotherapy aim to reduce the risk of bleeding from esophageal varices by inducing varix thrombo-

sis or obliteration. The choice of technique depends on various factors, including the severity of varices, patient's medical condition, and the expertise of the endoscopist. Close monitoring and follow-up are crucial after these procedures to assess the effectiveness of treatment and to detect any potential complications.

Physics and Technicality of Tissue Ablation using Lasers

Lasers have unique properties that make them an ideal tool for precise tissue ablation. Laser ablation is based on the principle of selective photo thermolysis, where a specific wavelength of laser light is absorbed by a target tissue, leading to localized heating and subsequent tissue destruction. The selection of laser parameters, such as wavelength, pulse duration, energy fluence, and spot size, is crucial for achieving optimal tissue ablation while minimizing collateral damage.

In the context of esophageal varices ablation, lasers can be used to selectively target the dilated veins while sparing the surrounding healthy tissues. Various laser systems have been developed for this purpose, including diode lasers, neodymium-doped yttrium-aluminum-garnet (Nd:YAG) lasers, and thulium lasers. These lasers offer different wavelengths and characteristics that can be tailored to the specific requirements of esophageal varices ablation.

Modified laser endoscopic probes

The modified laser endoscopic probes proposed in this research have a similar design to the probes used for varices banding. These probes consist of a flexible and slender shaft that can be easily maneuvered during the endoscopic procedure. However, instead of the traditional banding attachments, the distal ends of the probes are equipped with specialized rounded laser tips

The laser tips of the modified probes emit laser energy, which can be precisely directed at the endpoints of the varices. This allows for targeted laser ablation of the varix endpoints without the need for banding. The laser energy, delivered through a fiber optic system, is absorbed by the varix tissue, resulting in localized heating and subsequent destruction of the varices(Ref- Image -07, 08, 09). The surrounding healthy tissue remains relatively unaffected due to the selective photo thermolysis principle of lasers.

Parts - The endoscopic probe incorporates a modified design consisting of two distinct components. The probe tip comprises an outer elongated glass section measuring 10 centimeters (Ref image-05), specifically designed to provide clear visualization of the varices stem. Additionally, an inner shorter movable section is integrated, allowing it to move towards the end of the outer glass part. This inner section features a rounded laser tip(Ref Image -06), emitting focused laser energy that can be precisely directed at the varices stem.

Advantages of Modified Laser Endoscopic Probes

The use of modified laser endoscopic probes for laser ablation of varices offers several advantages. Firstly, it provides a more precise and targeted approach, allowing for specific ablation of the varix endpoints (Ref- Image -07, 08,09). This can potentially reduce the risk of re-bleeding and improve treatment outcomes. Additionally, laser ablation may be better suited for patients with advanced liver cirrhosis who may not be suitable candidates for banding due to the fragility of varices. The modified probes also maintain the flexibility and maneuverability required for effective endoscopic procedures.

Challenges and Considerations

The use of modified laser endoscopic probes for varices ablation presents certain challenges and considerations. The selection of appropriate laser parameters, such as wavelength and energy fluence, is crucial to ensure optimal tissue ablation while minimizing collateral damage. Safety measures, such as cooling mechanisms integrated into the probes, should be implemented to prevent excessive heating and protect the surrounding tissues. Proper training and expertise are also essential for endoscopists performing laser ablation procedures to ensure safe and effective treatment. Optimization of laser parameters, such as wavelength and energy fluence, is crucial to achieve effective and efficient tissue ablation. Standardization of laser ablation protocols, training of endoscopists, and long-term outcome studies are necessary to establish the safety and efficacy of this novel approach.

Conclusion

This research publication proposes the hypothesis for the prospective use of modified laser endoscopic probes for esophageal varices ablation in patients with grade II-IV liver cirrhosis. The physics and technicality of tissue ablation using lasers were discussed, highlighting the advantages and challenges associated with this innovative approach. Further studies are warranted to validate the hypothesis and optimize laser ablation protocols to enhance patient outcomes in the management of esophageal varices in liver cirrhosis.

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