Effect of Material Properties on the Mechanical Performance of Nitinol Esophageal stent: Finite Element Analysis

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Stent placement has been a main approach to solve gastrointestinal diseases during past decade. Nitinol superelastic stents has been considered a solution to such difficulties as restenosis after implantation, low twisting ability, inadequate radial mechanical strength and inappropriate dynamic behaviors associated with the ducts. In this paper, effects of Ar temperatures on mechanical performance of z-shaped Nitinol wire stent under crimping test for clinical applications are investigated by finite element simulation. With 60 % crimping, high radial resistive strength, favorable superelastic behaviors are attained at Ar temperature of 22°C. Performance of the stent is seen to drastically different with a merely change of 1° in the segments angle.

Keywords: Finite Element Analysis, Material Properties, Mechanical Performance, Nitinol Stent, Esophageal

1. INTRODUCTION

Gastrointestinal disease is a main cause of death these days [1]. Esophageal cancer is a worldwide source of gastrointestinal malignancies [1-2]. Stent placement has been a major approach to solve gastrointestinal diseases like esophageal malignancy during past decade. Application of stent has two main objectives: (1) short-term effect by avoiding intimal dissection and the elastic recoil and (2) long-term effect by avoiding restenosis owing to the neointimal hyperplasia [3-4]. Nitinol stent placements have been developed as a behavioral modality for palliation of malignant dysphagia. Nitinol stents for esophageal duct are easily implanted with low risk of severe complication. Nitinol superelastic stents has been considered a solution to such problems as restenosis after implantation, low twisting ability, unsatisfactory radial mechanical strength and improper dynamic behaviors associated with the ducts. Because of good retrievability and flexibility, z-shaped wire stents are most widely used in stent designs [3-4]. They can be used to fabricate custom stents of preselected values exerting radial forces of clinical need. Z-shape models are also advantageous due to their easy manufacturing even in laboratory by hand. They permit various designs with different amounts of radial forces [5]. Important parameters like length, wire diameter, stent inner diameter, number of bends, segments angle and radial con-