

Endovascular Stent Grafts to Treat Abdominal Aortic Aneurysms: Investigation of Stent Materials

Nicole Rivera

*Department of Aerospace and Mechanical Engineering
University of Notre Dame, Notre Dame, IN 46556*

Abstract

Abdominal aortic aneurysms result in 15,000 deaths a year in the United States, primarily affecting older patients, due to an increasing percentage of the population being over 50 years old, this condition is becoming more prevalent in today's society. Abdominal aortic aneurysms (AAA) are the result of many processes leading to the destruction of the aortic wall and atherosclerotic plaque formation resulting in aneurysmal enlargement. AAAs can be treated with an open surgical approach or less invasively with endovascular repair. Endovascular repair of AAAs involves the use of an endovascular stent graft. The focus of this investigation is the use of 316L stainless steel (SS) and nitinol as stent materials. The effectiveness of each stent is primarily influenced by the mechanical properties of the material and the surface oxide formed as a result of surface. While neither SS nor nitinol is the perfect stent material, each has been proven to be an effective stent material. The tensile and fatigue strengths of SS and nitinol are sufficient for most implant applications, indicating that most stent failures are due to alterations in the material properties due to corrosion and external biomechanical effects. The amorphous oxide layer formed by each material is critical to optimal corrosion resistance, preventing mechanical failure, biocompatibility and is significantly influenced by the final surface treatment performed on each stent.

1. Background

1.1. Clinical Significance

An abdominal aortic aneurysm (AAA) is defined as a focal dilation of the abdominal aorta where the diameter is at least 50% larger than the expected normal diameter. AAA is an increasingly prevalent condition in today's society because of its primary incidence in older patients and an increasing percentage of the population begin over 50 years old. At least 15,000 deaths per year in the United States are attributed to AAAs [1]. In 2000, AAAs were the 10th leading cause of death in white men ages 65 to 74 in the United States. Of people who experience a ruptured aneurysm, the survival rate is 15% and the survivors' risk of mortality increases after rupture because only 50% survive surgical repair of the rupture [2].

1.2. Anatomy of Abdominal Aorta

The abdominal aorta is the portion of the descending aorta that extends from the aortic hiatus of the diaphragm into the abdomen and ends at the 4th lumbar vertebra where it divides into the two common iliac arteries (Fig. 1(a)). The abdominal aorta is vital in supplying blood to the abdominal structures. The artery wall is made of 3 layers: tunica adventitia, tunica media, and tunical intima (Fig. 1(b)) [3]. The tunica adventitia is a fibrous outer layer made of connective tissues, collagen,