Canonical Particle Swarm Optimization Bionanocomposites-Bot: Potential Non-Invasive Definitive Treatment for Aortic Aneurysm

Tungki Pratama Umar

1Medical Profession Program, Faculty of Medicine, Sriwijaya University, Palembang, Indonesia

Corresponding Author: Tungki Pratama Umar, Sriwijaya University Faculty of Medicine, Dr. Mohammad Ali Street, RSMH Complex, Km 3.5, Palembang, Indonesia, 30126. Email: tungkipratamaumar@student.unsri.ac.id

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Abstract
Aortic aneurysm is a cardiovascular disease that has a great deal of notoriety all over the world. If the diagnosis is postponed, there is a strong risk for rupture, leading to 90% mortality even before the patient arrives to the hospital. Treatment of aortic aneurysm is usually surgery in the form of open surgery or endovascular grafting. However, this type of surgery still has some disadvantages, including the safety profile and the risk of failure. Nanorobot surgery is a potential approach as a standard treatment for aortic aneurysm. The existence as a precision surgery will provide a better method of delivery. A combination with canonical Particle Swarm Optimization (PSO) and bionanocomposite could improve its effectiveness, operation and stability, creating a better nanorobot for aortic aneurysm therapy.

Keywords: Aortic Aneurysm, Nanorobot, Nanosurgery, Bionanocomposite

Introduction
Aortic aneurysm is a cardiovascular illness which is attracting a great deal of popularity all over the world. This case refers to the dilation of the arteries beyond normal conditions, both in the thoracic and abdominal aorta (especially in the same level with the renal artery). The incidence in abdominal aorta is more frequent due to a lack of flexibility in the arteries (low elastin: collagen ratio), atherosclerotic media, and increased plaque deposition. Normally, this narrowing of the arteries does not cause serious effects for the sufferers. Nevertheless, this disorder presents a high risk to the patient, as the blood vessels are more fragile and may burst at any moment, causing sudden death. This is reflected in relatively high mortality statistics, expected to reach 168,200 deaths by 2015. Aortic aneurysm is a debilitating condition that affects people aged 65 years and over and is preceded by a variety of risk factors. These risk factors include genetic predisposition, male, smoking behavior, hypertension, coronary heart disease, history of myocardial infarction, dyslipidemia, and peripheral arterial disease. Aortic aneurysms are generally difficult to detect since they do not show symptoms and also have no specific signs until aneurysms rupture. Delay in detection is very dangerous because more than 90 percent of patients will die before they reach hospital in case of aneurysm rupture.

Aortic aneurysm treatment is normally performed in the form of aneurysm surgery. The risk of surgery is significant, including the rare possibility of failure due to a surgical operation (iatrogenic). Alternative aortic aneurysm therapy is therefore needed, one of which involves the implementation of nanosurgery using nanorobots based on bionanocomposite canonical PSO. The application of this system may reduce invasive procedures, reduce complications and increase the success rate due to its use in the field of precision surgery. On this occasion, a literature review on the efficacy of this system as a definitive treatment for aortic aneurysms will be discussed.

Available Modalities for Aortic Aneurysm Treatment
Aortic aneurysm treatment can usually be divided into two types. The two methods are risk factors management (including pharmacological approach) and surgical therapy. Risk factor monitoring is a strategy that attempts to prevent the development of aortic aneurysms. In general, this method is still very controversial and has little proof. Some risk factors are antihypertensive drugs (beta-blockers and angiotensin-converting enzyme inhibitors) and statin drugs. The effectiveness of antihypertensive drugs in the prevention of worsening aneurysms is doubtful while the use of statins is promising to minimize cardiovascular risk factors. However there is not enough evidence to support its efficacy in aortic aneurysm. The lack of available evidence on risk factor control therapy indicates that surgery remains an option for aortic aneurysm management.

Surgery is the primary method of treatment for aortic aneurysms. The surgical methods required for the management of this case are categorized into two procedures, open and endovascular interventions. Both forms of surgery have their advantages and disadvantages, which need
to be adapted to the individual who is undergoing surgery.15

Open surgery is a gold standard therapy that is often used in patients at risk of aortic aneurysm rupture.10 This is a major bypass surgery that utilizes certain materials (e.g. Dacron) in certain areas that have been dilated due to aneurysm.17 Multiple morbidity and mortality are associated with this procedure as a result of visceral organ exposure to the external environment, in addition to bleeding and aortic clamping associated due to ischemia-reperfusion injury in the lower torso.18 Besides, various other complications, such as visceral ischemia, persistent chronic aortitis, ischaemic colitis, aorto-enteral fistula, sexual dysfunction, trash foot, and acute renal failure can occur. Mortality due to this treatment is about 25 percent in 30 days.19 This has led to efforts to develop a more non-invasive form of surgery, endovascular grafting.15

Non-invasive surgical procedures, endovascular grafting is an alternative attempt to repair aortic aneurysms. Although this procedure offers advantages because it does not require exposure to the dissected part of the outside world, this option can only be applied in 70% of cases (capacity is limited compared to open surgery). Also, this technique is associated with a lower blood loss and a reduced need for transfusion.20-22 While this procedure has several benefits, it also has several complications, both systemic (myocardial infarction, multi-organ failure, kidney injury or abdominal compartment syndrome) and local (infection and hematoma).23 The occurrence of abdominal compartment syndrome has risen dramatically with this treatment.24-26 Besides, this operation poses a high risk of failure, secondary rupture after the repair, which has a detrimental effect on the economy and health of patients.27,28

Currently, offered surgical procedures for managing aortic aneurysm are still not satisfactory because they pose a high risk.15 This is the basis for the need of additional alternatives in the treatment of this condition, one alternative that has the potential to replace the currently available approach is through the use of nanorobots.

Nanorobot in Surgery and Application Potential in Aortic Aneurysm (Bionanocomposites Bot)

Nanorobot is a technology that strives to create nanometer-scale machines or robots. The creation of this tool is related to the manipulation of objects that were previously in the form of micro or macro devices so that they are better able to locate the target organs in order to run the therapy more efficiently. Nanorobots can transfer energy from blood glucose and body oxygen and are very harmless as they do not activate immune system activation (not recognized as a foreign body).29

The use of nanorobots in the field of medicine is closely linked to the advancement of nanotechnology. Nanorobots have the medicinal function as agents for the identification and treatment of diseases associated with cellular tissue repair. In addition, nanorobots also play a part in disease detection and diagnosis process.30 The creation of nanorobots has currently been proposed for the treatment of different medical conditions, such as cancer diagnosis, gene therapy, brain aneurysms, and dentistry.31 This indicates a strong promise for the use of nanorobots in patients with aortic aneurysms.

Nanorobot would have a nanotechnology-based surgical tool in aneurysm surgery. This technology enables the nano-manipulation procedure to repair lesions in blood vessels.30

Surgery using nanorobots can provide a more specific therapeutic effect on abnormality without inducing too much (non-invasive) disruption to the body’s condition. The use of nanorobots is regulated by a variety of sensors, including long-distance (radioactive coloring), short distance (flow meter), and control equipment managed by the operating officer (computer).32

At the beginning of therapy, a remote sensor (radioactive dye) is inserted to detect abnormalities in the blood vessels. Radioactive compounds are then monitored using fluoroscopic imaging techniques or other radiation-sensitive techniques, one of which is a high-resolution, real-life CT scan of the chest. Once the imagery is collected, the reconstruction of the blood vessels is carried out using data obtained from CT scans, both video and photo images.33 It can be also accompanied with X-Ray, endoscopic or fluorescence imaging.34,35 The findings of the mapping process are then integrated into the nanorobot to form the basis of artificial intelligence, which is inserted into the application as a nanochip embedded in the nanorobot processor. Embedding information into the nanorobot allows the ability to track paths in CT video that can be maintained by computer applications to ensure the accuracy of the path chosen. A signal is used to detect the accuracy of the operational path in the nanorobot tracking process. Short-range sensors are provided by the detection of blood flow abnormalities using flow meters. In the meantime, the operator will sense interference through a computer screen attached to a device held by a nanorobot. This allows the operator to control the movement of the nanorobot in the event of an error in movement.32

Precision surgery with nanorobots is a solution to the difficulties faced in traditional surgery, particularly in the case of aortic aneurysms. Conventional surgery (generally open surgery) involves an injury that can affect the tissue around the wound, increased discomfort (associated with a higher dose of anesthesia), a performance ratio that is not so good (associated with the capacity of the operator’s hand). In the meantime, precision surgery with nanorobots will provide minimal injuries (shorter recovery), continuous
monitoring of the condition of the patient's body and enable automated rapid intervention via a nanorobot-implanted system.26 The study demonstrated significant potential of micro/nanorobots to conduct precision surgery at the cellular and even subcellular level. The efficiency of surgical nanorobots will be significantly enhanced by their ability to penetrate and resettle tissues as well as to identify specific targets through the selection of propulsion methods and the use of real-time visualization and mapping with a robust monitoring system.27

The nanorobot used in aortic aneurysm therapy will have a bionanocomposite-based material combined with technology that adapts to Newtonian and non-Newtonian situations in the blood vessels (Canonical PSO Bionanocomposites-Bot). Bionanocomposite material is a multifunctional device that incorporates inorganic and biological components, with a nanometer range (1-100 nm).28 Inorganic components used may be magnetic nanoparticles, glass nanoparticles, hydroxyapatite, carbon nanotubes, silver or gold nanoparticle component.29 The inorganic component is a structural reinforcement component (flexural strength, tensile strength, hardness, Young's modulus and material stiffness) as well as avoiding immunological reactions that might occur during surgical procedures.30,31 Such inorganic components may be combined with organic components, such as platelets, to improve the biocompatibility of materials, in addition to turning the framework of inorganic compounds into biologically active materials.32

The bionanocomposite material in the nanorobot will be paired with the canonical PSO method, which adapts to the state of the blood vessels, both large (Newtonian rules) and small (non-Newtonian rules) diameter. This device can be part of a nanorobot control mechanism that provides improved agility, biocompatibility, programmability, connection, communication, detection, and signal generation than a random system. Based on the evaluation, this device will enable the nanorobot to conduct an independent assembly to repair the blood vessels with the ability to measure the diameter of the blood vessels and the average speed of the blood cells in those vessels.33

Potential Adverse Event of PSO Bionanocomposites-Bot Application

Most of the results suggested that the use of robotic surgery or possible application of nanorobot is generally safer than the procedure currently available due to its lower invasive profile.34,35 However, there is still some possible false recognition by the immune system, caused elevated immune response,36 in addition to the potential for longer operation and long physician training to adapt.37,38 With the use of bionanocomposites, because of the nature of this biocompatible material, there are no recorded adverse effects in its use.39,40 In the meantime, the use of PSO is related to easy use and higher accuracy of device control and is not related to any side effects.32,41

Conclusion

Aortic aneurysm is one of the most debilitating disorders with a high mortality rate. Its main modality is surgery, but it is still unsatisfactory. Nanorobot is a kind of precision surgery which is able to target specific lesion in the blood vessel and offers many advantages including safety profile and better control. Combination with bionanocomposite and particle swarm optimization is an improvement to get better sustainability and activity as the potential non-invasive treatment of aortic aneurysm.

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Authors’ Contributions

None.

Conflicts of Interests

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