

The Engineering of Vascular Grafts, Can We Improve Vascular Disease Treatments?

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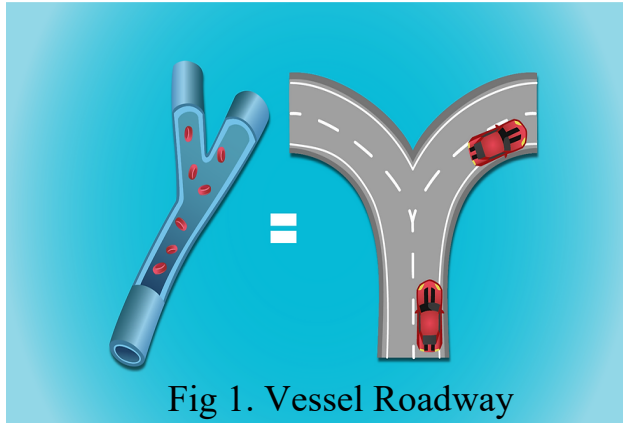


Fig 1. Vessel Roadway

Ever wonder why your fingertips turn purple in the cold? That's because blood flow is lacking in that area! Blood is important for delivering oxygen and nutrients to all the body's organs and tissues (Muniswami et al., 2020). The

complex network of blood vessels that comprise the circulatory system can be compared to a highway (Fig 1). Veins, arteries, and capillaries are the roads of this system. Blood and nutrients are delivered to cells like cars dropping off a package. Thanks to your circulatory system, blood circulates throughout the body. Maintaining healthy blood flow ensures that tissues and organs receive the necessary supplies to function (Rudnicka-Drożak et al., 2022).

But what happens when one of the roads becomes blocked? Having a blocked or damaged blood vessel prevents the proper delivery of nutrients. As a result of vascular disease, blood vessels are damaged or blocked, resulting in improper blood flow (Fig 2.). Several factors can lead to this, including high blood pressure, diabetes, and high cholesterol (Fuchs & Whelton, 2020). People

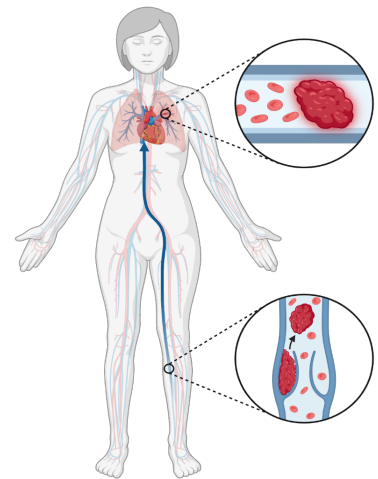


Fig 2. Vascular Disease

suffering from vascular diseases can experience symptoms such as limb loss, organ failure, strokes, heart attacks, and more. Vascular disease is on the rise, but treatment options are few and far from effective. For example, cardiovascular disease contributes to 32% of deaths worldwide (Wang et al., 2022). This condition causes blood vessels in the heart to become blocked or damaged. Conditions like this can be detrimental. If your heart fails to get oxygen and nutrients it will be too tired to function properly (Wang et al., 2022). Without proper blood flow, the heart will become fatigued and eventually cease functioning. Being able to fix these roadblocks within our circulatory system is one of the challenges scientists and doctors are faced with today.

Luckily, there are ways we can intervene to help those who have damaged blood vessels. An implantable device known as vascular grafts can aid in redirecting blood flow! The grafts are tubes constructed from plastic-like material but mimic the look and function of your blood vessels (Ratner, n.d.). Patients who suffer from vascular disease often need to reroute blood around the blocked area, and these grafts provide a solution. This allows your organs to maintain proper blood flow by using the grafts as a new roadway.

However, as great as this may sound, grafts come with many complications. Over time vascular grafts can become blocked or narrow, causing blood flow to stop once again (Ratner, n.d.). What exactly causes these grafts to fail even though they look and act like blood vessels? Vascular grafts do not contain any special chemicals or materials to enhance the healing process, they are simply plastic tubes inserted into blood vessels (Hao et al., 2023). Oftentimes the body becomes irritated, and the vascular device is

seen as foreign to the body. The body responds by causing blood clots or narrowing of the graft until blood flow is stopped (Hao et al., 2023) Using vascular grafts can help to restore blood flow, yet sometimes they can do just the opposite!

Clearly, there is a need to enhance the current graft implants to reduce their failure rates and improve patient outcomes. The current research goal is to add substances to these grafts so that they have blood vessel-like properties and can be regenerative to help facilitate the formation of new vessel tissue and healing. You may be wondering, what substances can we add to improve these grafts? Stem cells! Humans have special cells in their bodies that can help heal and regenerate some of our tissues (Rudnicka-Drożak et al., 2022). For example, when you get a cut, eventually you stop bleeding and the torn blood vessel heals. This is, in part, thanks to these stem cells in your body that go in and repair the damaged area. Therefore, stem cells can be thought of as construction workers fixing or building roads.

We can use the stem cells that are specific to our blood vessels and attach them to vascular grafts (Fig 3). By coating grafts with the human stem cells within our blood, they can repair the damaged blood vessels and help create new vessels along the graft (Hao et al., 2023). This will help the graft become more like a natural human blood vessel. If successfully done, it can reduce blood clots from forming

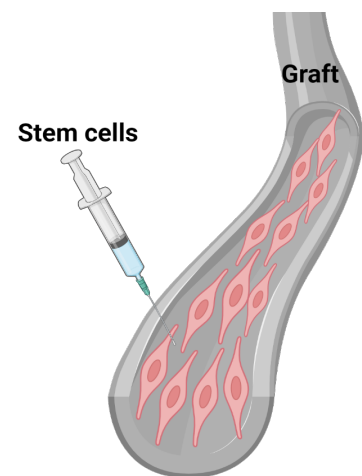


Fig 3. Modified Graft

inside the graft and facilitate healing at the site where the graft has been implemented (Hao et al., 2023).

Modifying vascular grafts to be coated in stem cells found in our blood can be a potential solution to reduce their failure rates following implantation. Vascular disease causes a significant economic burden to the healthcare system, patients, and their families due to the lack of effective treatment options. Developing a novel modified graft for improved vascular access can significantly reduce their failure rates and improve patient quality of life. This shows great promise in allowing them to mimic natural blood vessels and repair some damage done to the blood vessels. Using stem cells to act as building blocks for the formation of blood vessel tissue in these grafts can keep vessels from being blocked. Improved vascular grafts can reduce the risk of complications, reduce hospital stays, and prevent patients from repeatedly going under the knife.

References

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