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Breakthrough in scarless wound recovery achieved with autologous blood

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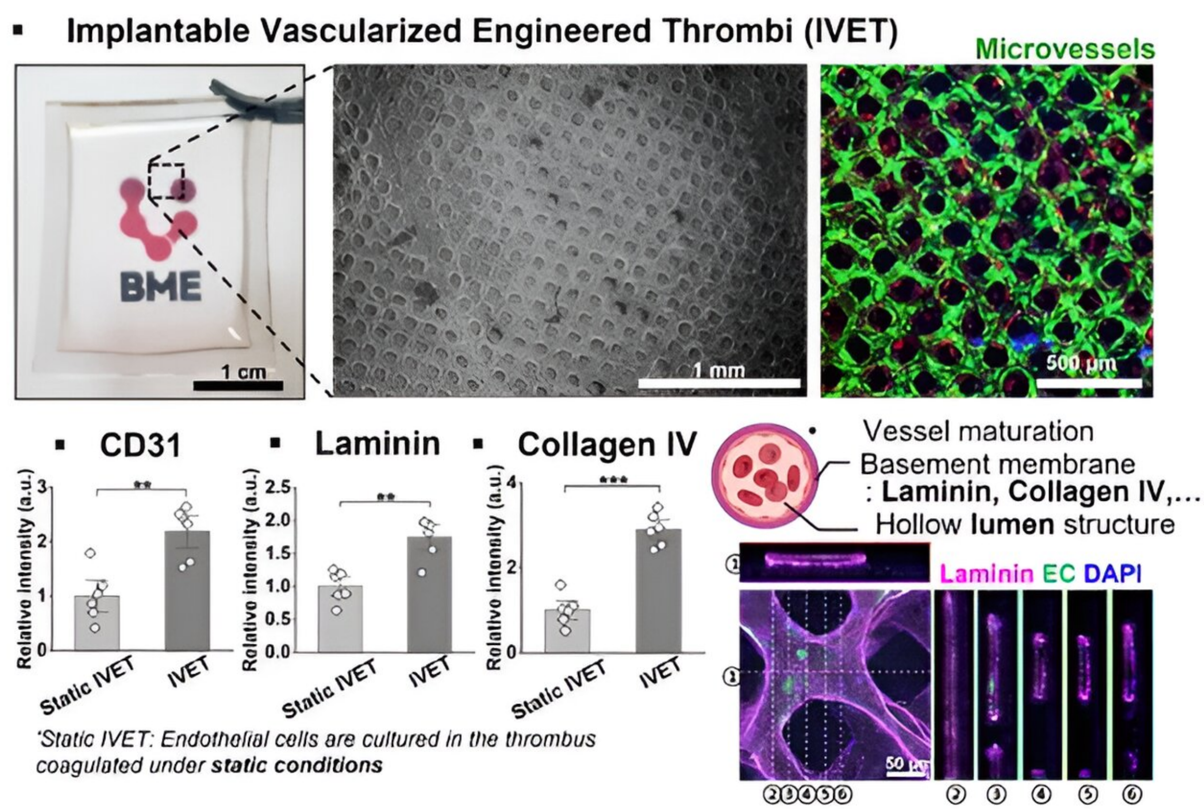

Implantable Vascularized Engineered Thrombi (IVET). Credit: UNIST

A research team, affiliated with UNIST has achieved a milestone in tissue regeneration by developing a technology that utilizes autologous blood to produce three-dimensional microvascular implants. These implants hold immense potential for various applications requiring vascular regeneration, including the treatment of chronic wounds.

Led by Professor Joo H. Kang from the Department of Biomedical Engineering at UNIST, the team successfully developed a microfluidic system capable of processing blood into an artificial tissue scaffold. Their research findings are published in *Advanced Materials*.

Unlike previous methods that relied on cell-laden hydrogel patches using fat tissues or platelet-rich plasma, this innovative approach enables the creation of robust microcapillary vessel networks within skin wounds. The utilization of autologous whole blood ensures compatibility and promotes effective wound healing.

The technology leverages microfluidic shear stresses to align bundled fibrin fibers along the direction of blood flow streamlines while activating platelets. This alignment and activation process results in moderate stiffness within the microenvironment—optimal conditions for facilitating endothelial cell maturation and vascularization.

When applied as patches to rodent dorsal skin wounds, these implantable vascularized engineered thrombi (IVETs) demonstrated superior wound closure rates (96.08 ± 1.58%), increased epidermis thickness, enhanced collagen deposition, hair follicle regeneration, reduced neutrophil infiltration, and accelerated wound healing through improved microvascular circulation.

Chronic wounds pose significant challenges as they often fail to heal properly over time and can lead to complications associated with diabetes and vascular diseases. In severe cases, they may result in sepsis—a life-threatening condition with high mortality rates—due to insufficient oxygen supply and nutrients caused by loss of blood vessels.

By harnessing the power of microfluidic technology, Professor Kang's team transformed autologous blood into IVETs suitable for transplantation. These IVETs were implanted into full-thickness skin wounds in experimental mice, resulting in rapid and scarless recovery of the entire damaged area. The study demonstrated successful regeneration of blood vessels within the wound site, facilitated movement of immune cells crucial for wound healing, and accelerated overall recovery.

Furthermore, the team evaluated the efficacy of IVET transplantation by infecting methicillin-resistant Staphylococcus aureus (MRSA)—an antibiotic-resistant bacterium—into the skin damage area. When artificial blood clots made from autologous blood were implanted into infected mice, quick vascular recovery was observed alongside enhanced migration of proteins and immune cells to combat bacterial infection. Additionally, collagen formation and hair follicle regeneration occurred without scarring.

These findings pave the way for advanced techniques in tissue engineering and wound healing using autologous blood-based implants. With further development and refinement, this technology holds tremendous potential to revolutionize treatment strategies for chronic wounds while contributing to advancements in regenerative medicine.

More information: Su Hyun Jung et al, Nematic Fibrin Fibers Enabling Vascularized Thrombus Implants Facilitate Scarless Cutaneous Wound Healing, *Advanced Materials* (2023). DOI: 10.1002/adma.202211149

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