Editorial

Open Access CrossMark

Forthcoming perspective could revolutionize healthcare worldwide for patients with extensive burns

Abstract

Burns impact millions of individuals, both adults and children, across the globe, leading to significant morbidity and mortality rates. The primary factor influencing survival in burn cases is the speed of wound healing. Extensive wounds surpass the body's natural healing abilities, and existing coverage materials often fall short due to limitations in cellular content, availability, or the risk of immunological rejection. Severe burns, particularly those that cover a substantial area of the body, continue to pose a significant challenge for contemporary medical practice. Current therapeutic approaches primarily involve skin grafting, which utilizes the patient's own healthy tissue to facilitate wound coverage. In situations where the area affected by burns is extensive, it becomes nearly unfeasible to locate sufficient healthy skin for grafting. This challenge is further exacerbated by the presence of scarring, persistent pain, and various other complications that considerably diminish the quality of life for those who survive. Within this framework, a groundbreaking approach utilizing 3D bioprinting (3DBP) and stem cell cultivation may offer a viable solution for addressing severe burn injuries.

Keywords: burns, 3D bio printing, minimally invasive surgery, skin grafting, stem cell

Volume 10 Issue 1 - 2025

Prof. Laila Mahmoud Montaser
Prof. of Clinical Pathology, Chair, Stem Cell, Regenerative Medicine, Nanotechnology and Tissue Engineering (SRNT) Research Group, Faculty of Medicine, Menoufia University, Egypt

Correspondence: Prof. Laila Mahmoud Montaser, Prof. of Clinical Pathology, Chair, Stem Cell, Regenerative Medicine, Nanotechnology and Tissue Engineering (SRNT) Research Group, Faculty of Medicine, Menoufia University, Egypt, Email lailamontaser@gmail.co

Received: January 30, 2025 | **Published:** January 31, 2025

Research shows that appealing images are the most effective means of retaining information. Therefore, Laila M. Montser is always eager to present a schematic to clarify and simplify the concept of the study by a graphical abstract (Figure 1). This paper's concept is that *in situ* 3DBP combined with freshly obtained patient stem cells could create tailored grafts that closely mimic target tissue and accurately fill in target deficiencies. The goal is to intensify work by combining 3DBP with stem cells.

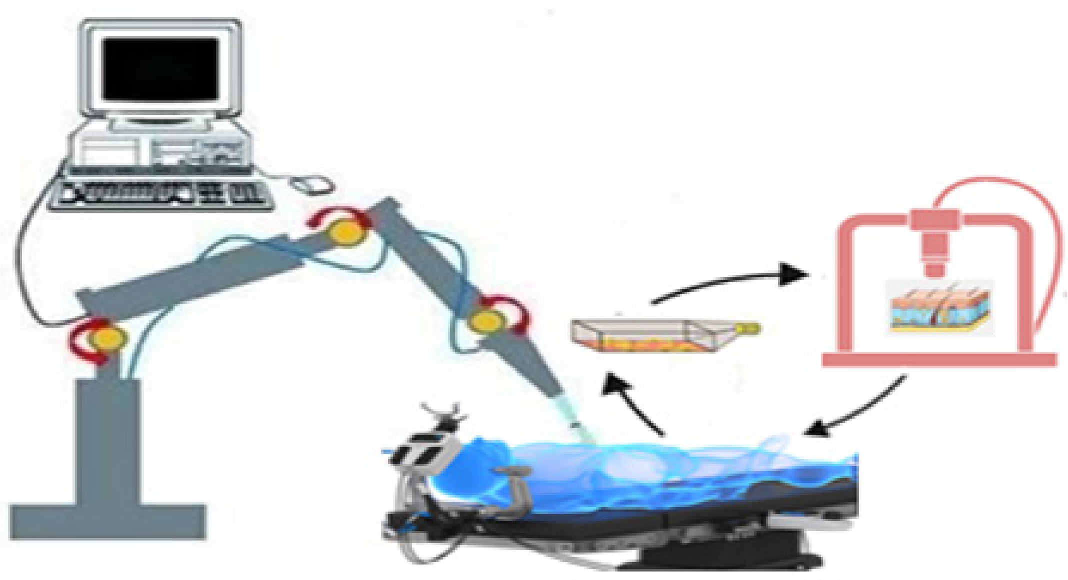

Figure 1 Robot-aided 3D bioprinting. Diagram explains the notion of robot-aided *in vivo* 3D bioprinting in the cadre of minimally invasive surgery.

Introduction

As we approach the year 2025 and prepare to enter the New Year, I came across information about the incredible enormous stem cell, often referred to as the sacred cup of regenerative medicine and a groundbreaking innovation of the 21st Century. I found out that a mistake made in the lab resulted in a significant discovery when a team member confused a sample of charred skin with healthy skin and attempted to extract stem cells from it. To everyone's surprise, the extraction was successful. This oversight motivated me to explore and document a groundbreaking approach to treating patients by utilizing stem cells derived from their own burned skin to promote healing. As someone who judges numerous articles, serves on the Editorial Board of various global journals, and is widely recognized as an expert and leading author in stem cell and regenerative medicine, I suddenly received a prestigious invitation to contribute an article to a respected international journal.

A laboratory mistake resulted in a significant discovery

Not long ago, charred skin tissue was regarded as medical waste. According to RAS International Corp[1] during a surgical procedure performed by Dr. Marc Jeschke at a Toronto hospital, an unforeseen discovery occurred due to a mistake made by a laboratory technician. The technician incorrectly identified a sample of burned skin as healthy skin and attempted to extract stem cells from it. To the astonishment of all involved, the extraction was successful.

Outcomes of this discovery

A pioneering study, conducted by Dr. Marc Jeschke and published in 2018,[2] was initiated as a result of this discovery. The research revealed that burned skin tissue harbored viable, intact stem cells that could be harvested and utilized in the wound healing process for mice and pigs, demonstrating no negative side effects. Given the similarity between pig skin and human skin, this finding has provided renewed optimism for individuals suffering from severe burn injuries. This discovery challenged existing paradigms, as burned tissue had previously been regarded as "disposable" material. This groundbreaking study led to a number of reviews and preclinical studies, which recently came to an end with Dr. Marc Jeschke's announcement[1] that their lab will be the first in the world to treat patients with stem cells taken from their own burned skin to promote healing after the Phase 1 clinical trial begins. Varkey and team in 2019[3] developed a bioprinting system using a cartridge-based delivery system to deposition cells at wound sites. They validated this in a pig wound model, showing potential for wound healing and skin regeneration through growth factor-mediated stem cell re-epithelialization. Shpichka and colleagues[4] in their review study explored skin replacement using cells, growth factors, *scaffolds*, or cell-seeded *scaffolds*, comparing their efficacy and cost-effectiveness in reducing scar formation and improving burn injury treatment. Albouy and colleagues[5] conducted a preliminary study involving swine to investigate a deep third-degree severe burn model. The researchers found that the application of cell-laden bioink significantly enhances skin regeneration by promoting the production of fibroblast growth factor and vascular endothelial growth factor, both of which are essential for tissue regeneration and the re-epidermalization process of the wound. The authors detailed an animal study that utilized intraoperative 3DBP of living tissue. This cutting-edge technology provides the first evidence of the feasibility of *in vivo* skin printing, employing a robotic arm-based bioprinter designed for surgical applications. The favorable results in skin regeneration, combined with the practicality of this procedure, lead them to anticipate the potential for implementing this innovative method in human clinical trials in the near future. Lukomskyj and his team[6] searched databases to find original research on stem cell-based tissue engineering treatments for burn wounds. They found promising results in animal models, indicating potential for improved therapy. Tabriz and colleagues' study[7] highlighted the potential of using biomaterials and cell-laden bioinks for wound treatment, skin regeneration, and personalized dressings. 3D printing (3DP) technologies offer advantages like unlimited bioactive molecules, polymers, and accelerated healing times. Chogan and group[8] reported that autologous skin transplantation remains the benchmark for effective wound healing. Nevertheless, the use of autologous skin grafts may not be feasible in certain circumstances, particularly in instances of severe burns and insufficient donor sites. In such cases, allografts derived from human cadaver skin and xenografts sourced from porcine skin can serve as temporary solutions for wound coverage. Additionally, dermal analogs may be employed until a permanent solution is established through autologous skin grafts or synthetic skin, necessitating a series of procedures that can extend healing durations and increase the risk of both local and systemic infections. Successful burn patient care requires interdisciplinary cooperation and personalization. Radzikowska-Büchner and colleagues[9] have compiled and examined the available treatment options in their thorough review, with particular attention to recent developments in topical treatments, wound cleaning, dressings, skin grafting, nutrition, pain management, and scar tissue management. Susla and the team[10] conducted a systematic review of the literature that investigates advancements in isolating and cultivating autologous skin cells, particularly keratinocytes and fibroblasts, from children for bioprinting purposes. Significant research has shown the successful culture of these essential cells, which play a vital role in creating functional skin grafts. Preclinical research has been assessed to determine the integration, performance, and aesthetic results of bioprinted skin grafts in animal studies, emphasizing their potential to enhance healing and minimize scarring. Yassaghi and colleagues[11] conducted a thorough investigation through the PubMed, Medline, Embase, and Cochrane Library databases, utilizing a mix of keywords such as "Cell transplantation," "Fibroblast," "Keratinocyte," "Melanocyte," or "Stem Cell" in conjunction with "Burn," "Burn wound," or "Burn injury." Their research indicated that the use of cell-based therapies for addressing burn wounds yields significant outcomes in clinical trials and represents promising alternatives for treatment in various scenarios. Nevertheless, it is crucial to select the appropriate cell-based therapy for each burn wound, as this choice relies heavily on the specific circumstances of each patient. In tissue engineering and regenerative medicine, 3DBP techniques have become a versatile tool for creating or patterning functional 3D bio-structures with precise geometric designs, bridging the gap between natural and engineered tissue constructs, according to Mirshafiei and colleagues.[12] The production of models and *in vitro* implants that can at least partially succeed in preclinical testing has been made possible by the continuous development of innovative biomaterial inks. Achieving the most recent milestone with designed tissue- or organ-like structures having defined levels of functionality has been made possible by remarkable advancements in cell biology and biology-inspired computational design. But there is still a long way to go before bio-fabricated structures are used in clinics.

In 2022, Dr. Marc Jeschke transitioned to Hamilton Health Sciences (HHS) hospital in Canada with the intention of initiating at this location a clinical trial aimed at assessing the safety and efficacy of utilizing stem cells derived from patients' burned skin. This

Citation: Montaser LM. Forthcoming perspective could revolutionize healthcare worldwide for patients with extensive burns. *J Stem Cell Res Ther.* 2025;10(1):17–20. DOI: 10.15406/jsrt.2025.10.00177

endeavor has now been facilitated by nearly $1 million in funding from the Stem Cell Network, along with contributions from the HHS Foundation. Recently, RAS International Corp[1] announced that in early 2025, the Center for Burn Research within the HHS hospital network in Canada will initiate the clinical trial. This innovative approach holds the potential to regenerate tissue without solely depending on healthy skin, which they anticipate will significantly transform the treatment paradigm for severe burns. The stem cells extracted from the damaged tissue will be utilized to create a biological ink for the development of new skin. According to RAS International Corp[1] the Phase 1 clinical trial, which has been approved by Health Canada, will assess the viability and safety of using stem cells taken from the patient's own burned skin tissue to treat wounds. Dr. Marc Jeschke from HHS announced that their laboratory will be the first globally to treat patients using stem cells harvested from their own burned skin to aid in healing, following the initiation of the Phase 1 clinical trial.

3D bioprinting

The study of Ashammakhi and team[13] reported that 3DBP represents a cutting-edge biofabrication technology that is fostering numerous innovations and creating new possibilities in the field of regenerative medicine. The primary objective of 3DBP is to produce grafts *in vitro* for subsequent implantation *in vivo*. Nevertheless, the process of *ex vivo* tissue culture poses safety concerns, necessitating sophisticated manufacturing equipment and practices to ensure the safe implantation of tissues in humans. Additionally, the implantation of printed tissues introduces further complexities, particularly in preserving the structural integrity of the fabricated constructs. To address this issue, the approach of *in situ* 3DBP has been proposed, allowing for the direct printing of tissues at the location of injury or defect.

Wang and colleagues[14] stated that the ideal solution for producing and implanting 3D printed customized implants in the same setting would use 3DP in the operating room and *in situ*, using robotic arms controlled by computers and scanners (Figure 1).

Surowiecka et al., 'study[15] aimed to compile the body of knowledge regarding the application of stem cells to burn wound care. The analysis comprised eighty-one studies. The designs, burn wound models, stem cell sources, and cellular therapy application techniques varied amongst the studies. Cellular therapy sped up the burn wound's healing process, and no serious side effects were noted. Serious adverse events were not reported in many case reports on human models. Cellular therapy is still an experimental approach for treating burn wounds, though, because of the inconsistent evidence._

Prof. Laila M. Montaser has three consecutive studies on 3BP: i) the first in 2022[16] highlighted 3DBP as a promising new technique for tissue engineering and regenerative medicine. This technology allowed stem cells to split and differentiate into different tissue types, potentially aiding in COVID-19 recovery and generating human organ and tissue specimens for research purposes, ii) while the second in 2023[17] focused on the advantages of 3DP in *in vitro* bioprinting, which allows for direct transplantation of stem cells into the body, and the potential for on-site bioprinting for surgical procedures. Mobile emergency printers are expected to be utilized in developing countries and remote areas, and iii) the third in 2024[18] spotlighted the potential of 3DP in the medical field for improving patient life, including surgical elaboration, prostheses, dental, and tissue and organ 3DP. She gave prominence to the potential for *in situ* 3DBP, focusing on the importance of stem cell literacy and the potential for customization, prototyping, and industrialization. 3DBP of stem cells and 3D *scaffolds* using electro-spinning and 3DP offers pre-planned, accurate flaw-measured structures, which are simulated outside the body and instilled *in vivo*.

In conclusion, advancements in additive manufacturing have led to the development of 3DBP, a trans-formative technology that could significantly improve patient outcomes in wound reconstruction. Stem cells could become a key component in treating burns, changing healthcare strategies. The integration of stem cell technology and 3DBP in wound healing shows great promise, promoting quicker wound closure and reducing scarring. If successful, the trial of Dr. Marc Jeschke could revolutionize patients with deep, extensive burns, reducing the need for additional surgery and reducing side effects.

Acknowledgments

None.

Conflicts of interest

The author declares that there are no conflicts of interest.

References

1. 2024 RAS International Corp. Upcoming trial to use 3d bioprinting in improving the treatment of extensive burns. 2025.
2. Amini–Nik S, Dolp R, Eylert G, et al. Stem cells derived from burned skin – the future of burn care. *EBioMedicine*. 2018;37:509–520.
3. Varkey M, Visscher DO, van Zuijlen PPM, et al. Skin bioprinting: the future of burn wound reconstruction? *Burns Trauma*. 2019;7(4):1–12.
4. Shpichka A, Butnaru D, Bezrukov EA, et al. Skin tissue regeneration for burn injury. *Stem Cell Rese Ther*. 2019;10(94):1–16.
5. Albouy M, Desanlis A, Brosset S, et al. A preliminary study for an intraoperative 3D bioprinting treatment of severe burn injuries. *Plast Reconstr Surg Glob Open*. 2022;10(1):e4056.
6. Lukomskyj AO, Rao N, Yan L, et al. Stem cell–based tissue engineering for the treatment of burn wounds: a systematic review of preclinical studies. *Stem Cell Rev Rep*. 2022;18(6):1926–1955.
7. Tabriz AG, Douroumis D. Recent advances in 3D printing for wound healing: a systematic review. *J Drug Delivery Sci Technol*. 2022;74:103564.
8. Chogan F, Chen Y, Wood F, et al. Skin tissue engineering advances in burns: a brief introduction to the past, the present, and the future potential. *J Burn Care Res*. 2022;44(Suppl 1):S1–S4.
9. Büchner ER, Łopuszyńska I, Flieger W, et al. An overview of recent developments in the management of burn injuries. *Int J Mol Sci.* 2023;24(22):16357.
10. Susla LBS, Forsyth ABS, Rodriguez BSA, et al. Recent advancements in 3D bioprinting for pediatric burn treatment. *Proc 2nd Int Elect Conf Clin Med*. 2024.
11. Yassaghi Y, Nazerian Y, Niazi F, et al. Advancements in cell–based therapies for thermal burn wounds: a comprehensive systematic review of clinical trials outcomes. *Stem Cell Res Ther*. 2024;15:277.
12. Mirshafiei M, Rashedi H, Yazdian F, et al. Advancements in tissue and organ 3D bioprinting: current techniques, applications, and future perspectives. *Materials Design*. 2024;240:112853.
13. Ashammakhi N, Ahadian S, Pountos I, et al. *In situ* three–dimensional printing for reparative and regenerative therapy. *Biomed Microdevices.* 2019;21(2):42.
14. Wang M, He J, Liu Y, et al. The trend towards in vivo bioprinting. *Int J Bioprinting*. 2015;1(1):15–26.

15. Surowiecka A, Chrapusta A, Chrapusta MK, et al. Mesenchymal stem cells in burn wound management. *Int J Mol Sci*. 2022;23(23):15339.

16. Montaser LM. 3D Bioprinting for tissue engineering amidst the century cataclysm. *J Reg Med Bio Res*. 2022;3(2):1–12.

17. Montaser LM. A prospective perspective on the advances in robotic–assisted 3D bio–printing for tissue engineering. *Adv Tissue Eng Regen Med Open Access*. 2023;9(1):35–40.

18. Montaser LM. In situ 3D printing of stem cell in regenerative medicine takes future center stage. *Adv Tissue Eng Regen Med Open Access.* 2024;10(1):14–18.

Citation: Montaser LM. Forthcoming perspective could revolutionize healthcare worldwide for patients with extensive burns. *J Stem Cell Res Ther.* 2025;10(1):17–20. DOI: 10.15406/jsrt.2025.10.00177