World Journal of Stem Cells

Submit a Manuscript: https://www.f6publishing.com

World J Stem Cells 2025 July 26; 17(7): 106856

DOI: 10.4252/wjsc.v17.i7.106856

ISSN 1948-0210 (online)

LETTER TO THE EDITOR

First-ever stem cell therapy restores insulin independence in type 1 diabetes: A medical milestone

Dinesh Kumar, Rajni Tanwar, Vrinda Gupta

Specialty type: Cell and tissue engineering

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification
Scientific Quality: Grade B
Novelty: Grade A
Creativity or Innovation: Grade A
Scientific Significance: Grade B

P-Reviewer: Wang AYL

Received: March 11, 2025
Revised: May 14, 2025
Accepted: June 23, 2025
Published online: July 26, 2025
Processing time: 135 Days and 17.5 Hours

Dinesh Kumar, Rajni Tanwar, Vrinda Gupta, School of Pharmacy, Desh Bhagat University, Mandi Gobindgarh 147301, Punjab, India

Corresponding author: Dinesh Kumar, Associate Professor, School of Pharmacy, Desh Bhagat University, Amloh Road, Mandi Gobindgarh 147301, Punjab, India.
dineshpotlia123@gmail.com

Abstract

Stem cell therapy has emerged as a groundbreaking treatment approach, particularly for type 1 diabetes, where the autoimmune destruction of beta cells necessitates regenerative strategies to restore insulin production. This article focuses on the recent medical milestone in which autologous stem cell therapy led to insulin independence in a type 1 diabetes patient. This article explores the role of stem cell therapy in reversing diabetes, focusing on the recent medical milestone in which stem cell therapy successfully reversed diabetes in a patient. Stem cells, particularly induced pluripotent stem cells, are used to regenerate pancreatic cells that produce insulin, thereby potentially eliminating the need for insulin injections. The study highlights both the promises and challenges of using stem cell therapy for diabetes including concerns about durability of the response, safety and long-term functionality of generated beta cells. Clinical trials and the ethical considerations of using stem cells are also discussed, along with future directions for stem cell-based diabetes therapies.

Key Words: Stem cell therapy; Diabetes; Type 1 diabetes; Type 2 diabetes; Insulin production; Regenerative medicine; Induced pluripotent stem cells; Clinical trials; Pancreatic regeneration; Autoimmune disease

©The Author(s) 2025. Published by Baishideng Publishing Group Inc. All rights reserved.

Core Tip: Stem cell therapy is emerging as a promising approach for type 1 diabetes by regenerating insulin-producing beta cells. This article highlights the first reported case of insulin independence using autologous induced pluripotent stem cell-derived islet-like cells and critically discusses clinical trial trends, ethical concerns, and safety considerations. While not yet a cure, these developments offer a glimpse into the future of regenerative diabetes therapy.

Citation: Kumar D, Tanwar R, Gupta V. First-ever stem cell therapy restores insulin independence in type 1 diabetes: A medical milestone. *World J Stem Cells* 2025; 17(7): 106856
URL: https://www.wjgnet.com/1948-0210/full/v17/i7/106856.htm
DOI: https://dx.doi.org/10.4252/wjsc.v17.i7.106856

TO THE EDITOR

Diabetes, particularly type 1, results from the autoimmune destruction of insulin-producing beta cells. Diabetes is currently the sixth most common cause of mortality in the United States. 23.6 million people and children in the nation, or 7.8% of the total population, have diabetes, according to the American Diabetes Association. Although it is estimated that 17.9 million individuals have been diagnosed with diabetes, 5.7 million people, or more than 25% of the population, remain unaware that they have the condition[1]. Diabetes is becoming more common worldwide, particularly in emerging countries like China, India, and some portions of Africa. Suffering and higher healthcare expenses result from this. While current management relies on insulin replacement, it fails to restore endogenous insulin production. Stem cell-based regenerative therapy offers a transformative alternative by aiming to replace lost beta-cell function. This article offers a perspective on the landmark study by Wang *et al*[2], which demonstrated insulin independence in a patient with type 1 diabetes (T1D) following autologous induced pluripotent stem cell (iPSC)-derived islet-like cell transplantation. While the findings are groundbreaking, critical discussion is warranted regarding long-term efficacy, scalability, and immune modulation[2].

Conventional therapy primarily involves external insulin supplementation. However, it does not address the underlying beta-cell destruction in T1D. This requires the patient to carefully control blood insulin levels and check blood glucose levels many times throughout the day. Even though this is now considered the best course of action, scientists are still looking for ways to improve the body's ability to produce insulin or control its levels of the hormone.

In a landmark case reported by Wang *et al*[2], a 25-year-old woman with T1D achieved insulin independence within three months after receiving autologous iPSC-derived islet-like cells. The study marks a significant advancement in diabetes treatment. However, it reflects a preliminary success, and long-term studies are required to determine whether insulin independence can be maintained permanently[2].

Follow-up on the same 25-year-old woman with T1D showed that, within two-and-a-half months of receiving a transplant of reprogrammed autologous stem cells, she began producing enough insulin to live without additional insulin. Her blood glucose levels stabilized within a target range for over 98% of the day, and she has maintained this for more than a year. Researchers are optimistic but emphasize the need for further trials to confirm these results. While Wang *et al*'s study[2] used autologous iPSCs, separate preliminary trials are also exploring the use of donor-derived stem cells for islet transplantation. These trials have shown early signs of insulin production and glycemic control in T1D patients, although long-term outcomes remain to be seen[3]. While this case marks a breakthrough in the field, concerns remain regarding the durability of insulin independence and the long-term functionality of the transplanted beta-like cells. Notably, the Wang *et al*'s study[2] did not employ immune suppression, which raises questions about how the newly derived cells avoided immune attack - a central issue in T1D. Moreover, given the short follow-up period and the single-patient nature of the trial, further studies involving diverse populations are essential to confirm replicability and generalizability[4]. While both type 1 and type 2 diabetes involve dysregulation of blood glucose, they differ significantly in etiology and treatment goals. T1D is characterized by autoimmune destruction of beta cells, making it an ideal target for regenerative approaches such as stem cell therapy. In contrast, type 2 diabetes primarily involves insulin resistance and is managed through lifestyle modification and pharmacotherapy; stem cell therapy for type 2 remains largely experimental and less well-established. Therefore, this manuscript focuses primarily on the therapeutic potential of stem cells in T1D[5].

Pros of stem cell therapy in diabetes

Stem cell therapy aims to regenerate functional pancreatic beta cells, enabling the body to restore its own insulin production. If given early on, it is possible to stop being dependent on medicine and insulin. Diabetes patients who get stem cell treatment need less insulin and medicine because their bodies start making insulin on their own. If given early on, it is possible to stop being dependent on medicine and insulin. Stem cell experts will choose the amount of stem cells, where they come from, and how many rounds of stem cell treatment you need based on your present level of diseases and other conditions that make you sick[6]. While autologous stem cells (such as iPSCs) reduce the risk of immune rejection, they are not entirely free of side effects. Risks include genetic mutations acquired during reprogramming, incomplete differentiation, or formation of abnormal cell types such as teratomas. Ongoing clinical trials continue to monitor these outcomes carefully to ensure safety. Stem cell treatment can only be done by stem cell experts, who need a special lab to work on the stem cells and a medical setting to take them out and inject them. The treatments will be given through injections and must be done in a hospital[7]. Stem cell therapy has the potential to reduce or eliminate insulin dependency, particularly when initiated early in the disease course. In advanced stages, it may still lead to reduced medication needs. However, repeat dosing may be necessary, and results can vary based on patient-specific factors. Stem cells are the building blocks of all living things. Stem cells' main job is to fix broken cells by making copies of themselves and new cells[8].

Cons of stem cell therapy in diabetes

Inconvenience: If you have to take insulin to manage your diabetes, this is done daily. You can inject yourself wherever you are, and it becomes part of your routine[9]. Specialists, such as our team at the Stemwell Clinic, carry out stem cell therapy, and you will need to travel to a dedicated unit for treatment. Using stem cells to treat diabetes, especially type 1, seems promising. Researchers think stem cell treatments must meet many criteria to be safe and successful. This includes: (1) Source of stem cells: It is crucial to identify the most suitable type of stem cells for therapy. Embryonic stem cells (ESCs), iPSCs, and adult stem cells (like mesenchymal stem cells) are candidates. iPSCs are particularly appealing as they can be derived from the patient's cells, minimizing the risk of immune rejection; (2) Differentiation into beta cells: The ability to reliably differentiate stem cells into functional insulin-producing beta cells is a primary goal. These beta cells must be capable of responding to blood glucose levels and secreting insulin as healthy pancreatic cells would[10]; (3) Immune system modulation: In T1D, the immune system attacks the body's beta cells. Any stem cell-based therapy would need to address this autoimmune aspect, either by altering the immune response or by protecting the newly created beta cells from immune attack, such as through encapsulation techniques; (4) Long-term functionality and stability: The newly generated beta cells must remain functional and stable over time. They need to produce insulin effectively and not degrade or lose functionality after transplantation[11]; (5) Safety concerns: Ensuring that the stem cells do not form tumors or differentiate into unwanted cell types is essential for patient safety. Controlling their growth and ensuring they behave predictably after transplantation is critical; (6) Delivery method: Another important requirement is developing an effective and minimally invasive delivery method. Whether through direct injection or encapsulation, the transplanted cells must integrate with the patient's body and start functioning[12]; (7) Regulatory and ethical considerations: Stem cell therapies need to undergo rigorous clinical trials to ensure they are safe and effective. The use of ESCs continues to raise significant ethical concerns, primarily due to the destruction of human embryos required for their derivation. These concerns are particularly pronounced in certain religious and cultural contexts, where embryos are regarded as potential life[13]. Legal restrictions on ESC research vary significantly across countries, complicating global clinical translation. Moreover, ESC-based therapies often face delays in approval due to ethical review bottlenecks. In contrast, iPSCs, which are reprogrammed from adult somatic cells, offer an ethically acceptable alternative that bypasses the embryo debate. However, they are not without risks - such as genetic instability or incomplete differentiation - highlighting the need for continued ethical oversight regardless of cell type[14]; and (8) Cost and accessibility: Finally, developing cost-effective production and delivery methods for stem cell-based therapies is necessary to make them widely available to patients[9]. In Table 1 clinical trials are discussed for type-1 diabetics.

Table 1 Clinical trials for stem cell-based therapies of type 1 diabetes

Trial ID	Cell type	Phase/status	Key feature
ChiCTR2300072200	iPSC (autologous)	Approved	Personalized therapy in T1D
NCT04061746	MSC (umbilical cord)	Recruiting	Immune modulation
NCT03163511	ESC-derived beta cells	Active	Subcutaneous VC-02 implant
NCT03920397	MSC + Vit D	Recruiting	Combination strategy
NCT04817774	CAR-T Reg	Not completed	Regulatory cell targeting
NCT02239354	hESCs (VC-01)	Suspended	Safety issues noted

iPSC: Induced pluripotent stem cell; T1D: Type 1 diabetes; MSC: Mesenchymal stem cell; ESC: Embryonic stem cell; Vit D: Vitamin D; CAR-T: Chimeric antigen receptor-modified T cell; Reg: Regulatory; hESCs: Human embryonic stem cell.

Clinical safety outcomes: A review of representative clinical trials reveals that mesenchymal stem cells are the most commonly used cell type, with trials like NCT04061746 and NCT03920397 currently recruiting and showing promising safety profiles[15]. ESC-based therapies (*e.g.*, NCT03163511, VC-02) are under development but face ethical and regulatory hurdles. iPSC therapies, such as the one described in ChiCTR2300072200, represent a personalized approach with reduced immunogenicity[16]. However, scalability and tumorigenic risks remain concerns. Notably, most trials are in early phases, highlighting the need for longer follow-ups and large-scale multicentre validation[17]. It is important to note that while the term 'reversal' has been used in media reports, the observed outcomes so far reflect temporary insulin independence rather than a definitive cure. Long-term monitoring is necessary to confirm sustained beta-cell function and safety[18].

CONCLUSION

Stem cell therapy offers a transformative approach to treating T1D, with the potential to regenerate insulin-producing beta cells and eliminate the need for lifelong insulin therapy. The recent case demonstrating insulin independence using autologous iPSC-derived islet-like cells marks a critical milestone in the field. However, several challenges must still be

addressed before widespread clinical translation is feasible. These include ensuring long-term functionality and safety of transplanted cells, managing immune responses without long-term immunosuppression, developing scalable manufacturing processes, and maintaining ethical oversight. While not yet a cure, these advances signal the beginning of a new era in T1D management. Continued research and larger clinical trials are essential to validate these early successes and bring stem cell therapies into mainstream practice.

FOOTNOTES

Author contributions: Kumar D, Tanwar R, and Gupta V contributed equally to the drafting and writing of the manuscript. Kumar D conceptualized the study and prepared the main draft; Tanwar R handled literature referencing and data analysis; Gupta V contributed to writing and revisions.

Conflict-of-interest statement: All the authors report no relevant conflicts of interest for this article.

Open Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: https://creativecommons.org/Licenses/by-nc/4.0/

Country of origin: India

ORCID number: Dinesh Kumar 0000-0002-6598-4675; Rajni Tanwar 0009-0003-3391-2153.

S-Editor: Wang JJ
L-Editor: A
P-Editor: Zhang XD

REFERENCES

1 **Popoviciu MS**, Kaka N, Sethi Y, Patel N, Chopra H, Cavalu S. Type 1 Diabetes Mellitus and Autoimmune Diseases: A Critical Review of the Association and the Application of Personalized Medicine. *J Pers Med* 2023; **13**: 422 [*RCA*] [PMID: 36983604 DOI: 10.3390/jpm13030422] [FullText]
2 **Wang S**, Du Y, Zhang B, Meng G, Liu Z, Liew SY, Liang R, Zhang Z, Cai X, Wu S, Gao W, Zhuang D, Zou J, Huang H, Wang M, Wang X, Wang X, Liang T, Liu T, Gu J, Liu N, Wei Y, Ding X, Pu Y, Zhan Y, Luo Y, Sun P, Xie S, Yang J, Weng Y, Zhou C, Wang Z, Wang S, Deng H, Shen Z. Transplantation of chemically induced pluripotent stem-cell-derived islets under abdominal anterior rectus sheath in a type 1 diabetes patient. *Cell* 2024; **187**: 6152-6164.e18 [*RCA*] [PMID: 39326417 DOI: 10.1016/j.cell.2024.09.004] [FullText]
3 **Arte PA**, Tungare K, Bhori M, Jobby R, Aich J. Treatment of type 2 diabetes mellitus with stem cells and antidiabetic drugs: a dualistic and future-focused approach. *Hum Cell* 2024; **37**: 54-84 [*RCA*] [PMID: 38038863 DOI: 10.1007/s13577-023-01007-0] [FullText]
4 **Czarnecka Z**, Dadheech N, Razavy H, Pawlick R, Shapiro AMJ. The Current Status of Allogenic Islet Cell Transplantation. *Cells* 2023; **12**: 2423 [*RCA*] [PMID: 37887267 DOI: 10.3390/cells12202423] [FullText]
5 **Antar SA**, Ashour NA, Sharaky M, Khattab M, Ashour NA, Zaid RT, Roh EJ, Elkamhawy A, Al-Karmalawy AA. Diabetes mellitus: Classification, mediators, and complications; A gate to identify potential targets for the development of new effective treatments. *Biomed Pharmacother* 2023; **168**: 115734 [*RCA*] [PMID: 37857245 DOI: 10.1016/j.biopha.2023.115734] [FullText]
6 **Ghoneim MA**, Gabr MM, El-Halawani SM, Refaie AF. Current status of stem cell therapy for type 1 diabetes: a critique and a prospective consideration. *Stem Cell Res Ther* 2024; **15**: 23 [*RCA*] [PMID: 38281991 DOI: 10.1186/s13287-024-03636-0] [FullText] [Full Text(PDF)]
7 **Hunault L**, Hesselson D. Finishing the odyssey to a stem cell cure for type 1 diabetes. *npj Metab Health Dis* 2024; **2**: 9 [*RCA*] [DOI: 10.1038/s44324-024-00014-5] [FullText] [Full Text(PDF)]
8 **Singh A**, Afshan N, Singh A, Singh SK, Yadav S, Kumar M, Sarma DK, Verma V. Recent trends and advances in type 1 diabetes therapeutics: A comprehensive review. *Eur J Cell Biol* 2023; **102**: 151329 [*RCA*] [PMID: 37295265 DOI: 10.1016/j.ejcb.2023.151329] [FullText]
9 **Mobarak H**, Rahbarghazi R, Mahdipour M. Stem Cell- and Stem Cell-Free-Based Therapies: Pros and Cons. *West Kaz Med J* 2023; **65**: 88-94 [DOI: 10.18502/wkmj.v65i4.14684] [FullText]
10 **Yang L**, Hu ZM, Jiang FX, Wang W. Stem cell therapy for insulin-dependent diabetes: Are we still on the road? *World J Stem Cells* 2022; **14**: 503-512 [*RCA*] [PMID: 36157527 DOI: 10.4252/wjsc.v14.i7.503] [FullText] [Full Text(PDF)]
11 **James EA**, Joglekar AV, Linnemann AK, Russ HA, Kent SC. The beta cell-immune cell interface in type 1 diabetes (T1D). *Mol Metab* 2023; **78**: 101809 [*RCA*] [PMID: 37734713 DOI: 10.1016/j.molmet.2023.101809] [FullText] [Full Text(PDF)]
12 **Rathod S**. Novel Insights into the Immunotherapy-Based Treatment Strategy for Autoimmune Type 1 Diabetes. *Diabetology* 2022; **3**: 79-96 [DOI: 10.3390/diabetology3010007] [FullText]
13 **Park SJ**, Kim YY, Han JY, Kim SW, Kim H, Ku SY. Advancements in Human Embryonic Stem Cell Research: Clinical Applications and Ethical Issues. *Tissue Eng Regen Med* 2024; **21**: 379-394 [*RCA*] [PMID: 38502279 DOI: 10.1007/s13770-024-00627-3] [FullText]
14 **Song SJ**, Nam Y, Rim YA, Ju JH, Sohn Y. Comparative analysis of regulations and studies on stem cell therapies: focusing on induced pluripotent stem cell (iPSC)-based treatments. *Stem Cell Res Ther* 2024; **15**: 447 [*RCA*] [PMID: 39574212 DOI: 10.1186/s13287-024-04065-9] [FullText]
15 **Shirbaghaee Z**, Heidari Keshel S, Rasouli M, Valizadeh M, Hashemi Nazari SS, Hassani M, Soleimani M. Report of a phase 1 clinical trial for safety assessment of human placental mesenchymal stem cells therapy in patients with critical limb ischemia (CLI). *Stem Cell Res Ther* 2023; **14**: 174 [*RCA*] [PMID: 37408043 DOI: 10.1186/s13287-023-03390-9] [FullText]

16 **Zhou T**, Yuan Z, Weng J, Pei D, Du X, He C, Lai P. Challenges and advances in clinical applications of mesenchymal stromal cells. *J Hematol Oncol* 2021; **14**: 24 [*RCA*] [PMID: 33579329 DOI: 10.1186/s13045-021-01037-x] [FullText] [Full Text(PDF)]

17 **Alanazi A**, Alassiri M, Jawdat D, Almalik Y. Mesenchymal stem cell therapy: A review of clinical trials for multiple sclerosis. *Regen Ther* 2022; **21**: 201-209 [*RCA*] [PMID: 36092509 DOI: 10.1016/j.reth.2022.07.003] [FullText] [Full Text(PDF)]

18 **Addissouky TA**, Ali MMA, El Sayed IET, Wang Y. Type 1 diabetes mellitus: retrospect and prospect. *Bull Natl Res Cent* 2024; **48**: 42 [DOI: 10.1186/s42269-024-01197-z] [FullText]

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: office@baishideng.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com

© 2025 Baishideng Publishing Group Inc. All rights reserved.