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Review Article

Mesenchymal Stem Cell Treatment Does Not Result in Tumor Formation: A Systematic Review

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Abstract

Mesenchymal stem cells (MSCs) have emerged as a promising therapeutic avenue for various conditions due to their regenerative properties and immunomodulatory effects. Embryonic stem cells divide more freely than MSCs, and embryonic stem cells can cause teratomas. Perhaps for this reason, and although mesenchymal stem cells have not been generally associated with tumors, there has been concern about potential tumorigenicity of MSCs. This paper presents a comprehensive review aimed at investigating the potential tumorigenicity of MSC therapy. A systematic search of PubMed-indexed literature was conducted, focusing on clinical trials involving intravenous, intra-articular, intramuscular, and intrathecal delivery routes of MSCs. Additionally, studies examining the occurrence of tumor formation post-MSC treatment in humans were reviewed. Among 217 identified studies, no tumors arising from injected MSCs, and no difference in the incidence of tumorigenesis from host tissues was found. While acknowledging that the duration of some studies may be shorter than the latency period of tumor formation, this review provides robust evidence supporting the safety of MSC therapy with regard to tumorigenicity. It is concluded that properly conducted MSC treatment is not tumorigenic.

Keywords: Mesenchymal Stem Cells; Safety; Oncogenesis; Tumor; Tumorigenesis

Introduction

Mesenchymal stem cells (MSCs) are multipotent cells used for the treatment of various conditions due to their immunomodulatory, healing, and anti-inflammatory properties [1-4]. Numerous clinical trials using both allogeneic and autologous mesenchymal stem cells have shown efficacy for the treatment of various conditions including osteoarthritis, inflammatory arthritis, back pain, inflammatory bowel disease, polycystic ovary syndrome, asthma multiple sclerosis, rheumatoid arthritis, and autism [5-14].

All stem cells fall into a specific category of potency, which defines the types of cells into which they can differentiate and how freely they divide. MSCs are considered multipotent, limiting their differentiation to remain within a single germ layer while embryonic stem cells are characterized by their pluripotency [15]. Pluripotency is also demonstrated by the ability to form teratomas, also known as teratogenicity, in which a tumor consisting of all 3 germ layers is formed [16]. While embryonic cells are no longer widely used clinically or in research studies, this has led to some confusion as to whether the more differentiated MSCs also have tumorigenic properties [17]. However, a comprehensive 2024 systematic review of embryonic stem cells found no incidence of serious adverse events including tumorigenicity related to the use of embryonic stem cells or their derivatives for age-related macular degeneration, spinal cord injury, Stargardt's macular dystrophy, Type 1 Diabetes, as well as heart failure [18]. Notably, one study from September 2021 in which seven patients had transplantation of human embryonic stem cell-derived retinal pigment epithelium found no tumorigenesis or abnormal cell proliferation during the 5 year follow-up period [19]. The lack of tumorigenicity in the more freely dividing embryonic stem cells supported our hypothesis about MSCs. Specifically, we hypothesized that MSCs are not tumorigenic and conducted a formal systematic literature review to test this hypothesis.

Methods

To determine if MSCs are tumorigenic we conducted "PubMed" indexed literature searches as follows:

1. Search by site of delivery: We searched the literature for clinical trials that used intravenous, intra-articular, intramuscular, and intrathecal routes of MSC delivery.

2. MSC tumorigenicity: Using the PubMed search engine, we reviewed the scientific literature to evaluate the incidence of tumor formation after MSC treatment in humans. Using the clinical trial filter, the term "Mesenchymal stem cell" was cross-referenced with the following terms: "malignancy", "tumor", "cancer", or "neoplasm". Patients with pre-cancerous lesions or conditions or a current diagnosis of cancer were excluded. Articles that tested combination treatments as part of the trial and articles not available in English were removed from the selection of literature.

Following the collection of data, a two-sided paired t-test was performed to determine the statistical significance of the differences between control group malignancies and MSC treatment malignancies.

Results

The process of literature selection and the application of exclusionary criteria is portrayed in Figure 1. The site-specific search

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resulted in 300 clinical trials performing intravenous, intra-articular, intrathecal, or intramuscular administration of MSCs. Through the MSC and tumorigenicity cross-referenced search a total of 187 clinical trials were found. Across both criteria, a total of 487 articles were collected. Using EndNote as a citation manager, 41 duplicate articles were removed.

The exclusion criteria were then applied to the 487 articles. Subsequently, a total of 229 articles were removed. Studies were excluded if patients received a combined therapy of MSCs and any additional treatment. Additional exclusionary criteria included studies in which patients were previously diagnosed with cancer or precancerous conditions/lesions. A total of 217 articles remained and were analyzed for this review [20-236].

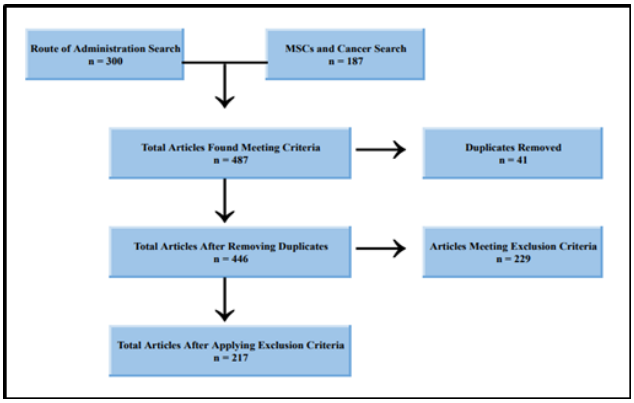

Figure 1: Flowchart of Literature Selection Process.

In Table 1, an analysis of the studies reviewed showed no difference in tumorigenicity between treatment and control groups. Of 4796 patients who received MSC treatment across controlled and non-controlled studies, only 12 malignancies were reported. Of the 2359 participants in control groups, 6 of them were reported to have developed a malignancy within the follow-up period. Performing a 2-sided paired T-test for the controlled clinical trials, a p-value of 0.82 was calculated, demonstrating no statistically significant difference between control groups and MSC groups for tumor formation.

Study Design	Controlled Studies	Non-Controlled Studies	Totals
	n = 110 Articles n = 5223 Patients	n = 107 Articles n = 1932 patients	n = 217 Articles n = 7155 Patients
# of MSC Treatment Malignancies n = 4796 Patients	6 (0.21%) p = 0.819744	6 (0.31%) p = 0.057	12 (0.25%) p = 0.697
# of Control Treatment Malignancies n = 2359 Patients	6 (0.25%)	N/A	6 (0.25%)
Total # of Malignancies	12 (0.23%)	6 (0.31%)	18 (0.25%)

Table 1: Malignancy Incidence in Controlled and Non-Controlled Studies of Mesenchymal Stem Cell Treatment.

The follow-up periods of the individual clinical trials vary from 0 months to 120 months, with longer follow-up periods providing better data for the tumorigenic potential of MSC treatment. In Table 2 a summary of the follow-up periods is shown, with 76.96% of studies providing follow-up data for at least 6 months. These articles account for 79.39% of all patients within this review. The mean duration of patient follow-up was found to be 13.92 months.

Follow-up Period	Less than 6 months	6+ Months
Number of Studies n = 217	48	167
Percentage of Studies	22.12%	76.96%
Number of Patients n = 7155	1526	5680
Percentage of Patients	21.33%	79.39%

Table 2: Follow-up Periods for all Patients.

Discussion

Despite questions raised due to the pluripotent characteristics of embryonic cells, we looked for any incidence of tumorigenesis following the use of pluripotent-derived stem cells and found none. We further conducted a formal literature review based on MSCs specifically, which are a part of the mesoderm germ layer. There was no evidence of an increase in tumor incidence due to MSC treatment, suggesting that MSCs did not undergo malignant transformation or promote any malignant transformation of tissue.

A strength of our study is the comprehensive nature of our literature search, encompassing over 4,500 patients receiving the treatment across 217 studies. The selected studies also included MSCs derived from various tissues, both autologous and allogeneic, including the umbilical cord, bone marrow, and adipose tissue, demonstrating the consistency of safety across many sources of MSCs. Further, we compared the tumor formation within MSC treatment groups to that of control groups where patients with similar characteristics did not receive the treatment. This provided an accurate representation of the tumorigenicity solely due to MSCs by demonstrating the incidence of malignancy from the control group for direct comparison to that of the treatment group. A notable constraint in this review pertains to the latency period of tumorigenesis. In 48 of the 217 studies, the duration of follow-up was less than 6 months. While the majority of patients within this review were followed up with for at least 6 months, it is conceivable that the manifestation of tumorous growth occurred subsequent to the cessation of data collection.

Conclusion

Properly performed MSC injections in humans do not appear to lead to an increased incidence of tumor formation. Across all studies in this review, we saw no significant difference between the control groups and MSC groups with malignancies. The results of this review reinforce the safety of MSC treatments for their wide variety of uses.

Statements and Declarations

Competing Interests and Funding

The funding for this publication was provided by the Foundation for Orthopaedics and Regenerative Medicine. No third-party funding was provided. The authors have no relevant financial or non-financial interests to disclose.

Declarations

Ethics approval and Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of supporting data

All data is available upon request from the authors.

Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

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Author's contribution

LP and KN performed data acquisition, data analysis, literature search, and literature analysis, and created the prose for this paper. CP conceptualized the study, conducted the study design, and created the prose for this paper.

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References

1. Ullah I, Subbarao RB, Rho GJ (2015) Human mesenchymal stem cells - current trends and future prospective. Biosci Rep 35: e00191.
2. Lopes-Pacheco M, Robba C, Rocco PRM, Pelosi P (2020) Current understanding of the therapeutic benefits of mesenchymal stem cells in acute respiratory distress syndrome. Cell Biol Toxicol 36: 83-102.
3. Wang L, Li Y, Xu M, Zhao Y, Yang M, et al. (2021) Regulation of Inflammatory Cytokine Storms by Mesenchymal Stem Cells. Front Immunol 12:726909.
4. Xu R, Feng Z, Wang FS (2022) Mesenchymal stem cell treatment for COVID-19. EBioMedicine 77:103920.
5. Wang LT, Ting CH, Yen ML, Liu KJ, Sytwu HK, et al. (2016) Human mesenchymal stem cells (MSCs) for treatment towards immune- and inflammation-mediated diseases: review of current clinical trials. J Biomed Sci 23: 76.
6. Lv YT, Zhang Y, Liu M, Huan Y, Chen XW, et al. (2013) Transplantation of human cord blood mononuclear cells and umbilical cord-derived mesenchymal stem cells in autism. J Transl Med Aug 11: 196.
7. Vega A, Martín-Ferrero MA, Del Canto F, Alberca M, García V, et al. (2015) Treatment of Knee Osteoarthritis With Allogeneic Bone Marrow Mesenchymal Stem Cells: A Randomized Controlled Trial. Transplantation 99: 1681-90.
8. Zhang J, Lv S, Liu X, Song B, Shi L (2018) Umbilical Cord Mesenchymal Stem Cell Treatment for Crohn's Disease: A Randomized Controlled Clinical Trial. Gut Liver 12:73-78.
9. Li JF, Zhang DJ, Geng T, Huang H, Wang YL, et al. (2014) The potential of human umbilical cord-derived mesenchymal stem cells as a novel cellular therapy for multiple sclerosis. Cell Transplant 1: S113-22.
10. Hu J, Zhao G, Zhang L, Qiao C, Di A, et al. (2016) Safety and therapeutic effect of mesenchymal stem cell infusion on moderate to severe ulcerative colitis. Exp Ther Med 12: 2983-2989.
11. Oh KW, Noh MY, Kwon MS, Kim HY, Oh SI, et al. (2018) Repeated Intrathecal Mesenchymal Stem Cells for Amyotrophic Lateral Sclerosis. Ann Neurol 84: 361-373.
12. Prodromos C, Jabbarzadeh K, Hirmiz M (2024) Complete lasting reversal of polycystic ovary syndrome from intravenous umbilical cord derived mesenchymal stem cell infusion. Am J Stem Cells 13: 222-224.
13. Sarsenova M, Issabekova A, Abisheva S, Rutskaya-Moroshan K, Ogay V, et al. (2021) Mesenchymal Stem Cell-Based Therapy for Rheumatoid Arthritis. Int J Mol Sci 22: 11592.
14. Sharan J, Barmada A, Band N, Liebman E, Prodromos C (2023) First Report in a Human of Successful Treatment of Asthma with Mesenchymal Stem Cells: A Case Report with Review of Literature. Curr Stem Cell Res Ther 18: 1026-1029.
15. Wuputra K, Ku CC, Wu DC, Lin YC, Saito S, et al. (2020) Prevention of tumor risk associated with the reprogramming of human pluripotent stem cells. J Exp Clin Cancer Res 39: 100.
16. Zhang WY, de Almeida PE, Wu JC (2012) Teratoma formation: A tool for monitoring pluripotency in stem cell research. 2012 Jun 10. In: StemBook [Internet]. Cambridge (MA): Harvard Stem Cell Institute; 2008. PMID: 23658974.
17. Christiansen JR, Kirkeby A (2024) Clinical translation of pluripotent stem cell-based therapies: successes and challenges. Development 151: dev202067.
18. Eguizabal C, Aran B, Chuva de Sousa Lopes SM, Geens M, Heindryckx B, et al. (2019) Two decades of embryonic stem cells: a historical overview. Hum Reprod 9: hoy024.
19. Li SY, Liu Y, Wang L, Wang F, Zhao TT, et al. (2021) A phase I clinical trial of human embryonic stem cell-derived retinal pigment epithelial cells for early-stage Stargardt macular degeneration: 5-years' follow-up. Cell Prolif 54: e13100.
20. Adas G, Cukurova Z, Yasar KK, Isiksacan N, Yesilbag Z, et al. (2021) The Systematic Effect of Mesenchymal Stem Cell Therapy in Critical COVID-19 Patients: A Prospective Double Controlled Trial. Cell Transplant 30: 9636897211024942.
21. Aghayan HR, Salimian F, Abedini A, Majidzadeh-AK, Hatamkhani A, et al. (2022) Human placenta-derived mesenchymal stem cells transplantation in patients with acute respiratory distress syndrome (ARDS) caused by COVID-19 (phase I clinical trial): safety profile assessment. Stem Cell Res Ther 13: 365.
22. Ahn SY, Chang YS, Sung SI, Park WS (2018) Mesenchymal Stem Cells for Severe Intraventricular Hemorrhage in Preterm Infants: Phase I Dose-Escalation Clinical Trial. Stem Cells Transl Med 7: 847-56.
23. Albu S, Kumru H, Coll R, Vallés M, Benito-Penalva J, et al. Clinical effects of intrathecal administration of expanded Wharton jelly mesenchymal stromal cells in patients with chronic complete spinal cord injury: a randomized controlled study. Cytotherapy 23: 146-56.
24. Al-Najar M, Khalil H, Al-Ajlouni J, Hamdan M, Rahmeh R, et al. (2017) Intra-articular injection of expanded autologous bone marrow mesenchymal cells in moderate and severe knee osteoarthritis is safe: a phase I/II study. J Orthop Surg Res 12: 190.
25. Álvaro-Gracia JM, Jover JA, García-Vicuña R, Taylor P, Tagarro I, et al. (2017) Intravenous administration of expanded allogeneic adipose-derived mesenchymal stem cells in refractory rheumatoid arthritis (Cx611): results of a multicentre, dose escalation, randomised, single-blind, placebo-controlled phase Ib/IIa clinical trial. Ann Rheum Dis 76: 196-202.

26. Amanat M, Majmaa A, Zarrabi M, Moaiedi AR, Salehi M, et al. (2021) Clinical and imaging outcomes after intrathecal injection of umbilical cord tissue mesenchymal stem cells in cerebral palsy: a randomized double-blind sham-controlled clinical trial. Stem Cell Res Ther 12: 439.

27. Ascheim DD, Gelijns AC, Goldstein D, Moye LA, Smedira N, et al. (2014) Mesenchymal precursor cells as adjunctive therapy in recipients of contemporary left ventricular assist devices. Circulation 129: 2287-96.

28. Ashoobi MT, Hemmati H, Aghayan HR, Zarei-Behjani Z, Keshavarz S, et al. (2024) Wharton's jelly mesenchymal stem cells transplantation for critical limb ischemia in patients with type 2 diabetes mellitus: a preliminary report of phase I clinical trial. Cell Tissue Res 395: 211-20.

29. Averyanov A, Koroleva I, Konoplyannikov M, Lesnyak V, Nikitin A, et al. (2020) First-in-human high-cumulative-dose stem cell therapy in idiopathic pulmonary fibrosis with rapid lung function decline. Stem Cells Transl Med 9: 6-16.

30. Baak LM, Wagenaar N, van der Aa NE, Mahamuud U, Smit LS, et al. (2022) Feasibility and safety of intranasally administered mesenchymal stromal cells after perinatal arterial ischaemic stroke in the Netherlands (PASSIoN): a first-in-human, open-label intervention study. Lancet Neurol 21: 528-36.

31. Bang OY, Kim EH, Cho YH, Oh MJ, Kim YH, et al. (2022) Circulating Extracellular Vesicles in Stroke Patients Treated With Mesenchymal Stem Cells: A Biomarker Analysis of a Randomized Trial. Stroke. 53: 2276-86.

32. Bang OY, Lee JS, Lee PH, Lee G (2005) Autologous mesenchymal stem cell transplantation in stroke patients. Ann Neurol 57: 874-82.

33. Barczewska M, Maksymowicz S, Zdolińska-Malinowska I, Siwek T, Grudniak M (2020) Umbilical Cord Mesenchymal Stem Cells in Amyotrophic Lateral Sclerosis: an Original Study. Stem Cell Rev Rep 16: 922-32.

34. Barnhoorn MC, Wasser M, Roelofs H, Maljaars PWJ, Hommes DW, et al. (2020) Long-term Evaluation of Allogeneic Bone Marrow-derived Mesenchymal Stromal Cell Therapy for Crohn's Disease Perianal Fistulas. J Crohns Colitis 14: 64-70.

35. Bartolucci J, Verdugo FJ, González PL, Goset C, Lamich R, et al. (2017) Safety and Efficacy of the Intravenous Infusion of Umbilical Cord Mesenchymal Stem Cells in Patients With Heart Failure: A Phase 1/2 Randomized Controlled Trial (RIMECARD Trial [Randomized Clinical Trial of Intravenous Infusion Umbilical Cord Mesenchymal Stem Cells on Cardiopathy]). Circ Res 121: 1192-204.

36. Bastos R, Mathias M, Andrade R, Amaral RJFC, Reis RL, et al. (2020) Intra-articular injection of culture-expanded mesenchymal stem cells with or without addition of platelet-rich plasma is effective in decreasing pain and symptoms in knee osteoarthritis: a controlled, double-blind clinical trial. Knee Surg Sports Traumatol Arthrosc 28: 1989-99.

37. Bastos R, Mathias M, Andrade R, Bastos R, Balduino A, et al. (2018) Intra-articular injections of expanded mesenchymal stem cells with and without addition of platelet-rich plasma are safe and effective for knee osteoarthritis. Knee Surg Sports Traumatol Arthrosc 26: 3342-50.

38. Baughman RP, Culver DA, Jankovi V, Fischkoff S, Brockway G, et al. (2015) Placenta-derived mesenchymal-like cells (PDA-001) as therapy for chronic pulmonary sarcoidosis: a phase 1 study. Sarcoidosis Vasc Diffuse Lung Dis 32: 106-14.

39. Berry JD, Cudkowicz ME, Windebank AJ, Nicholson K, McKenna-Yasek D, et al. (2019) NurOwn, phase 2, randomized, clinical trial in patients with ALS: Safety, clinical, and biomarker results. Neurology 93: e2294-e305.

40. Bhasin A, Srivastava MV, Mohanty S, Bhatia R, Kumaran SS, et al. (2013) Stem cell therapy: a clinical trial of stroke. Clin Neurol Neurosurg 115: 1003-8.

41. Bonab MM, Sahraian MA, Aghsaie A, Nikbin B, Harirchian MH, et al. (2012) Autologous mesenchymal stem cell therapy in progressive multiple sclerosis: an open label study. Curr Stem Cell Res Ther 7: 407-14.

42. Bowdish ME, Barkauskas CE, Overbey JR, Chang HL, Chang HL, et al. (2023) A Randomized Trial of Mesenchymal Stromal Cells for Moderate to Severe Acute Respiratory Distress Syndrome from COVID-19. Am J Respir Crit Care Med 207: 261-70.

43. Boyalı O, Kabatas S, Civelek E, Bahar-Ozdemir Y, Kaplan N, et al. (2024) Allogeneic mesenchymal stem cells may be a viable treatment modality in cerebral palsy. World J Clin Cases 12: 1585-96.

44. Bura A, Planat-Benard V, Bourin P, Saint-Lebese B, Grolleau JL, et al. (2014) Phase I trial: the use of autologous cultured adipose-derived stroma/stem cells to treat patients with non-revascularizable critical limb ischemia. Cytotherapy 16: 245-57.

45. Butler J, Epstein SE, Greene SJ, Kim RJ, Tankovich NI, et al. (2017) Intravenous Allogeneic Mesenchymal Stem Cells for Nonischemic Cardiomyopathy: Safety and Efficacy Results of a Phase II-A Randomized Trial. Circ Res 120: 332-40.

46. Bydon M, Qu W, Moinuddin FM, Hunt CL, Garlanger KL, et al. (2024) Intrathecal delivery of adipose-derived mesenchymal stem cells in traumatic spinal cord injury: Phase I trial. Nat Commun 15: 2201.

47. Carlsson PO, Espes D, Sisay S, Davies LC, Smith CIE, et al. (2023) Umbilical cord-derived mesenchymal stromal cells preserve endogenous insulin production in type 1 diabetes: a Phase I/II randomised double-blind placebo-controlled trial. Diabetologia 66: 1431-41.

48. Carstens MH, García N, Mandayam S, Workeneh B, Pastora I, et al. (2023) Safety of Stromal Vascular Fraction Cell Therapy for Chronic Kidney Disease of Unknown Cause (Mesoamerican Nephropathy). Stem Cells Transl Med 12: 7-16.

49. Casiraghi F, Perico N, Podestà MA, Zambelli M, Colledan M, et al. (2021) Third-party bone marrow-derived mesenchymal stromal cell infusion before liver transplantation: A randomized controlled trial. Am J Transplant 21: 2795-809.

50. Chahal J, Gómez-Aristizábal A, Shestopaloff K, Chaboureau A, Chiovitti J, et al. (2019) Bone Marrow Mesenchymal Stromal Cell Treatment in Patients with Osteoarthritis Results in Overall Improvement in Pain and Symptoms and Reduces Synovial Inflammation. Stem Cells Transl Med 8: 746-57.

51. Chambers DC, Enever D, Ilic N, Sparks L, Whitelaw K, et al. (2014) A phase 1b study of placenta-derived mesenchymal stromal cells in patients with idiopathic pulmonary fibrosis. Respirology 19: 1013-1018.

52. Chambers DC, Enever D, Lawrence S, Sturm MJ, Herrmann R, et al. (2017) Mesenchymal stromal cell therapy for chronic lung allograft dysfunction: Results of a first-in-man study. Stem Cells Transl Med 6: 1152-1157.

53. Chang YS, Ahn SY, Yoo HS, Sung SI, Choi SJ, et al. (2014) Mesenchymal stem cells for bronchopulmonary dysplasia: Phase 1 dose-escalation clinical trial. J Pediatr 164: 966-972.

54. Chen CF, Chen YC, Fu YS, Tsai SW, Wu PK, et al. (2024) Safety and tolerability of intra-articular injection of adipose-derived mesenchymal stem cells GXCPC1 in 11 subjects with knee osteoarthritis: A nonrandomized pilot study without a control arm. Cell Transplant 33: 9636897231221882.

55. Chen SL, Fang WW, Qian J, Ye F, Liu YH, et al. (2004) Improvement of cardiac function after transplantation of autologous bone marrow mesenchymal stem cells in patients with acute myocardial infarction. Chin Med J (Engl) 117: 1443-1448.

56. Cheng L, Wang S, Peng C, Zou X, Yang C, et al. (2022) Human umbilical cord mesenchymal stem cells for psoriasis: a phase 1/2a, single-arm study. Signal Transduct Target Ther 7: 263.

57. Chullikana A, Majumdar AS, Gottipamula S, Krishnamurthy S, Kumar AS, et al. (2015) Randomized, double-blind, phase I/II study of intravenous allogeneic mesenchymal stromal cells in acute myocardial infarction. Cytotherapy 17: 250-261.

58. Chun S, Choi CB, Kim MS, Nam JY, Lee TY, et al. (2022) Safety and tolerability of bone marrow-derived mesenchymal stem cells in lupus animal models and a phase I clinical trial in humans. Lupus 31: 1245-1253.

59. Chung JW, Chang WH, Bang OY, Moon GJ, Kim SJ, et al. (2021) Efficacy and Safety of Intravenous Mesenchymal Stem Cells for Ischemic Stroke. Neurology 96: 1012-1023.

60. Clé DV, Santana-Lemos B, Tellechea MF, Prata KL, Orellana MD, et al. (2015) Intravenous infusion of allogeneic mesenchymal stromal cells in refractory or relapsed aplastic anemia. Cytotherapy 17: 1696-1705.

61. Cotten CM, Fisher K, Malcolm W, Gustafson KE, Cheatham L, et al. (2023) A pilot phase I trial of allogeneic umbilical cord tissue-derived mesenchymal stromal cells in neonates with hypoxic-ischemic encephalopathy. Stem Cells Transl Med 12: 355-364.

62. Cudkowicz ME, Lindborg SR, Goyal NA, Miller RG, Burford MJ, et al. (2022) A randomized placebo-controlled phase 3 study of mesenchymal stem cells induced to secrete high levels of neurotrophic factors in amyotrophic lateral sclerosis. Muscle Nerve 65: 291-302.

63. Dai G, Liu X, Zhang Z, Yang Z, Dai Y, et al. (2013) Transplantation of autologous bone marrow mesenchymal stem cells in the treatment of complete and chronic cervical spinal cord injury. Brain Res 1533: 73-79.

64. Daumas A, Magalon J, Jouve E, Casanova D, Philandrianos C, et al. (2022) Adipose tissue-derived stromal vascular fraction for treating hands of patients with systemic sclerosis: A multicentre randomized trial Autologous AD-SVF versus placebo in systemic sclerosis. Rheumatology (Oxford) 61: 1936-1947.

65. Davatchi F, Abdollahi BS, Mohyeddin M, Nikbin B (2016) Mesenchymal stem cell therapy for knee osteoarthritis: 5 years follow-up of three patients. Int J Rheum Dis 19: 219-225.

66. Celis-Ruiz ED, Fuentes B, Leciñana MAD, Gutiérrez-Fernández M, Borobia AM, et al. (2022) Final Results of Allogeneic Adipose Tissue-Derived Mesenchymal Stem Cells in Acute Ischemic Stroke (AMASCIS): A Phase II, Randomized, Double-Blind, Placebo-Controlled, Single-Center, Pilot Clinical Trial. Cell Transplant 31: 9636897221083863.

67. Dhere T, Copland I, Garcia M, Chiang KY, Chinnadurai R, et al. (2016) The safety of autologous and metabolically fit bone marrow mesenchymal stromal cells in medically refractory Crohn's disease - a phase 1 trial with three doses. Aliment Pharmacol Ther 44: 471-481.

68. Dilogo IH, Aditianingsih D, Sugiarto A, Burhan E, Damayanti T, et al. (2021) Umbilical cord mesenchymal stromal cells as critical COVID-19 adjuvant therapy: A randomized controlled trial. Stem Cells Transl Med 10: 1279-1287.

69. Duijvestein M, Vos AC, Roelofs H, Wildenberg ME, Wendrich BB, et al. (2010) Autologous bone marrow-derived mesenchymal stromal cell treatment for refractory luminal Crohn's disease: Results of a phase I study. Gut 59: 1662-1669.

70. El-Ansary M, Abdel-Aziz I, Mogawer S, Abdel-Hamid S, Hammam O, et al. (2012) Phase II trial: Undifferentiated versus differentiated autologous mesenchymal stem cells transplantation in Egyptian patients with HCV induced liver cirrhosis. Stem Cell Rev Rep 8: 972-981.

71. Emadedin M, Labibzadeh N, Liastani MG, Karimi A, Jaroughi N, et al. (2018) Intra-articular implantation of autologous bone marrow-derived mesenchymal stromal cells to treat knee osteoarthritis: A randomized, triple-blind, placebo-controlled phase 1/2 clinical trial. Cytotherapy 20: 1238-1246.

72. Erpicum P, Weekers L, Detry O, Bonvoisin C, Delbouille MH, et al. (2019) Infusion of third-party mesenchymal stromal cells after kidney transplantation: A phase I-II, open-label, clinical study. Kidney Int 95: 693-707.

73. Fathi-Kazerooni M, Fattah-Ghazi S, Darzi M, Makarem J, Nasiri R, et al. (2022) Safety and efficacy study of allogeneic human menstrual blood stromal cells secretome to treat severe COVID-19 patients: Clinical trial phase I & II. Stem Cell Res Ther 13: 96.

74. Florea V, Rieger AC, Natsumeda M, Tompkins BT, Banerjee MN, et al. (2020) The impact of patient sex on the response to intramyocardial mesenchymal stem cell administration in patients with non-ischaemic dilated cardiomyopathy. Cardiovasc Res 116: 2131-2141.

75. Forbes GM, Sturm MJ, Leong RW, Sparrow MP, Segarajasingam D, et al. (2014) A phase 2 study of allogeneic mesenchymal stromal cells for luminal Crohn's disease refractory to biologic therapy. Clin Gastroenterol Hepatol 12: 64-71.

76. Freitag J, Bates D, Wickham J, Shah K, Huguenin L, et al. (2019) Adipose-derived mesenchymal stem cell therapy in the treatment of knee osteoarthritis: a randomized controlled trial. Regen Med 14: 213-230.

77. Friis T, Haack-Sørensen M, Mathiasen AB, Ripa RS, Kristoffersen US, et al. (2011) Mesenchymal stromal cell derived endothelial progenitor treatment in patients with refractory angina. Scand Cardiovasc J 45: 161-168.

78. Fujita M, Matsumoto T, Sobajima S, Tsubosaka M, Matsushita T, et al. (2023) Clinical and Radiological Comparison of Single and Double Intra-articular Injection of Adipose-Derived Stromal Vascular Fraction for Knee Osteoarthritis. Cell Transplant 32: 9636897231190175.

79. Gao LR, Chen Y, Zhang NK, Yang XL, Liu HL, et al. (2015) Intracoronary infusion of Wharton's jelly-derived mesenchymal stem cells in acute myocardial infarction: Double-blind, randomized controlled trial. BMC Med 13: 162.

80. Garza JR, Campbell RE, Tjoumakaris FP, Freedman KB, Miller LS, et al. (2020) Clinical Efficacy of Intra-articular Mesenchymal Stromal Cells for the Treatment of Knee Osteoarthritis: A Double-Blinded Prospective Randomized Controlled Clinical Trial. Am J Sports Med 48: 588-598.

81. Ghoryani M, Shariati-Sarabi Z, Tavakkol-Afshari J, Ghasemi A, Poursamimi J, et al. (2019) Amelioration of clinical symptoms of patients with refractory rheumatoid arthritis following treatment with autologous bone marrow-derived mesenchymal stem cells: A successful clinical trial in Iran. Biomed Pharmacother 109: 1834-1840.

82. Ghoryani M, Shariati-Sarabi Z, Tavakkol-Afshari J, Mohammadi M (2020) The Sufficient Immunoregulatory Effect of Autologous Bone Marrow-Derived Mesenchymal Stem Cell Transplantation on Regulatory T Cells in Patients with Refractory Rheumatoid Arthritis. J Immunol Res 2020: 3562753.

83. Giannotti S, Trombi L, Bottai V, Ghilardi M, D'Alessandro D, et al. (2013) Use of autologous human mesenchymal stromal cell/fibrin clot constructs in upper limb non-unions: long-term assessment. PLoS One 8: 73893.

84. Glassberg MK, Minkiewicz J, Toonkel RL, Simonet ES, Rubio GA, et al. (2017) Allogeneic Human Mesenchymal Stem Cells in Patients With Idiopathic Pulmonary Fibrosis via Intravenous Delivery (AETHER): A Phase I Safety Clinical Trial. Chest 151: 971-981.

85. Golpanian S, DiFede DL, Khan A, Schulman IH, Landin AM, et al. (2017) Allogeneic Human Mesenchymal Stem Cell Infusions for Aging Frailty. J Gerontol A Biol Sci Med Sci 72: 1505-1512.

86. Gomez-Ruiz V, Blanco JF, Villarón EM, Fidalgo H, López-Parra M, et al. (2023) Autologous mesenchymal stem cell transplantation for spinal fusion: 10 years follow-up of a phase I/II clinical trial. Stem Cell Res Ther 14: 78.

87. Götherström C, Westgren M, Shaw SWS, Aström E, Biswas A, et al. (2014) Pre- and postnatal transplantation of fetal mesenchymal stem cells in osteogenesis imperfecta: A two-center experience. Stem Cells Transl Med 3: 255-264.

88. Grégoire C, Layios N, Lambermont B, Lechanteur C, Briquet A, et al. (2022) Bone Marrow-Derived Mesenchymal Stromal Cell Therapy in Severe COVID-19: Preliminary Results of a Phase I/II Clinical Trial. Front Immunol 13: 932360.

89. Gu F, Wang D, Zhang H, Feng X, Gilkeson GS, et al. (2014) Allogeneic mesenchymal stem cell transplantation for lupus nephritis patients refractory to conventional therapy. Clin Rheumatol 33: 1611-1619.

90. Gu J, Huang L, Zhang C, Wang Y, Zhang R, et al. (2020) Therapeutic evidence of umbilical cord-derived mesenchymal stem cell transplantation for cerebral palsy: A randomized, controlled trial. Stem Cell Res Ther 11: 43.

91. Gupta PK, Chullikana A, Rengasamy M, Shetty N, Pandey V, et al. (2016) Efficacy and safety of adult human bone marrow-derived, cultured, pooled, allogeneic mesenchymal stromal cells (Stempeucel®): preclinical and clinical trial in osteoarthritis of the knee joint. Arthritis Res Ther 18: 301.

92. Gupta PK, Dutta S, Kala S, Nekkanti M, Desai SC, et al. (2021) Phase IV postmarketing surveillance study shows continued efficacy and safety of Stempeucel in patients with critical limb ischemia due to Buerger's disease. Stem Cells Transl Med 10: 1602-1613.

93. Gupta PK, Krishna M, Chullikana A, Desai S, Murugesan R, et al. (2017) Administration of Adult Human Bone Marrow-Derived, Cultured, Pooled, Allogeneic Mesenchymal Stromal Cells in Critical Limb Ischemia Due to Buerger's Disease: Phase II Study Report Suggests Clinical Efficacy. Stem Cells Transl Med 6: 689-699.

94. Hare JM, DiFede DL, Rieger AC, Florea V, Landin AM, et al. (2016) Randomized Comparison of Allogeneic Versus Autologous Mesenchymal Stem Cells for Nonischemic Dilated Cardiomyopathy: POSEIDON-DCM Trial. J Am Coll Cardiol 69: 526-537.

95. Hare JM, Traverse JH, Henry TD, Dib N, Strumpf RK, et al. (2009) A randomized, double-blind, placebo-controlled, dose-escalation study of intravenous adult human mesenchymal stem cells (prochymal) after acute myocardial infarction. J Am Coll Cardiol 54: 2277-2286.

96. Hashemian SR, Aliannejad R, Zarrabi M, Zarrabi M, Soleimani M, et al. (2021) Mesenchymal stem cells derived from perinatal tissues for treatment of critically ill COVID-19-induced ARDS patients: A case series. Stem Cell Res Ther 12: 91.

97. He X, Ai S, Guo W, Yang Y, Wang Z, et al. (2018) Umbilical cord-derived mesenchymal stem (stromal) cells for treatment of severe sepsis: A phase 1 clinical trial. Transl Res 199: 52-61.

98. Heldman AW, DiFede DL, Fishman JE, Zambrano JP, Trachtenberg BH, et al. (2014) Transendocardial mesenchymal stem cells and mononuclear bone marrow cells for ischemic cardiomyopathy: The TAC-HFT randomized trial. JAMA 311: 62-73.

99. Hernández-Monjaraz B, Santiago-Osorio E, Ledesma-Martínez E, Alcauter-Zavala A, Mendoza-Núñez VM (2018) Retrieval of a periodontally compromised tooth by allogeneic grafting of mesenchymal stem cells from dental pulp: A case report. J Int Med Res 46: 2983-2993.

100. Hernigou P, Bouthors C, Bastard C, Lachaniette CHF, Rouard H, et al. (2021) Subchondral bone or intra-articular injection of bone marrow concentrate mesenchymal stem cells in bilateral knee osteoarthritis: What better postpone knee arthroplasty at fifteen years? A randomized study. Int Orthop 45: 391-399.

101. Hlebokazov F, Dakukina T, Ihnatsenko S, Kosmacheva S, Potapnev M, et al. (2017) Treatment of refractory epilepsy patients with autologous mesenchymal stem cells reduces seizure frequency: An open label study. Adv Med Sci 62: 273-279.

102. Hlebokazov F, Dakukina T, Potapnev M, Kosmacheva S, Moroz L, et al. (2021) Clinical benefits of single vs repeated courses of mesenchymal stem cell therapy in epilepsy patients. Clin Neurol Neurosurg 207: 106736.

103. Hong Z, Chen J, Zhang S, Zhao C, Bi M, et al. (2019) Intra-articular injection of autologous adipose-derived stromal vascular fractions for knee osteoarthritis: a double-blind randomized self-controlled trial. Int Orthop 43: 1123-1134.

104. Honmou O, Houkin K, Matsunaga T, Niitsu Y, Ishiai S, et al. (2011) Intravenous administration of auto serum-expanded autologous mesenchymal stem cells in stroke. Brain 134: 1790-1807.

105. Honmou O, Yamashita T, Morita T, Oshigiri T, Hirota R, et al. (2021) Intravenous infusion of auto serum-expanded autologous mesenchymal stem cells in spinal cord injury patients: 13 case series. Clin Neurol Neurosurg 203: 106565.

106. Huang J, Li Q, Yuan X, Liu Q, Zhang W, et al. (2022) Intrauterine infusion of clinically graded human umbilical cord-derived mesenchymal stem cells for the treatment of poor healing after uterine injury: a phase I clinical trial. Stem Cell Res Ther 13: 85.

107. Huang L, Zhang C, Gu J, Wu W, Shen Z, et al. (2018) A Randomized, Placebo-Controlled Trial of Human Umbilical Cord Blood Mesenchymal Stem Cell Infusion for Children With Cerebral Palsy. Cell Transplant 27: 325-334.

108. Hur JW, Cho TH, Park DH, Lee JB, Park JY, et al. (2016) Intrathecal transplantation of autologous adipose-derived mesenchymal stem cells for treating spinal cord injury: A human trial. J Spinal Cord Med 39: 655-664.

109. Ichikado K, Kotani T, Kondoh Y, Imanaka H, Johkoh T, et al. (2023) Clinical efficacy and safety of multipotent adult progenitor cells (invimestrocel) for acute respiratory distress syndrome (ARDS) caused by pneumonia: a randomized, open-label, standard therapy-controlled, phase 2 multicenter study (ONE-BRIDGE). Stem Cell Res Ther 14: 217.

110. Izadi M, Nejad ASH, Moazenchi M, Masoumi S, Rabbani A, et al. (2022) Mesenchymal stem cell transplantation in newly diagnosed type-1 diabetes patients: a phase I/II randomized placebo-controlled clinical trial. Stem Cell Res Ther 13: 264.

111. Jaillard A, Hommel M, Moisan A, Zeffiro TA, Favre-Wiki IM, et al. (2020) Autologous Mesenchymal Stem Cells Improve Motor Recovery in Subacute Ischemic Stroke: a Randomized Clinical Trial. Transl Stroke Res 11: 910-923.

112. Jamali F, Aldughmi M, Atiani S, Al-Radaideh A, Dahbour S, et al. (2024) Human Umbilical Cord-Derived Mesenchymal Stem Cells in the Treatment of Multiple Sclerosis Patients: Phase I/II Dose-Finding Clinical Study. Cell Transplant 33: 9636897241233045.

113. Jiang R, Han Z, Zhuo G, Qu X, Li X, et al. (2011) Transplantation of placenta-derived mesenchymal stem cells in type 2 diabetes: a pilot study. Front Med 5: 94-100.

114. Jiang Y, Zhu W, Zhu J, Wu L, Xu G, et al. (2013) Feasibility of delivering mesenchymal stem cells via catheter to the proximal end of the lesion artery in patients with stroke in the territory of the middle cerebral artery. Cell Transplant 22: 2291-2298.

115. Jo CH, Lee YG, Shin WH, Kim H, Chai JW, et al. (2014) Intra-articular injection of mesenchymal stem cells for the treatment of osteoarthritis of the knee: a proof-of-concept clinical trial. Stem Cells 32: 1254-1266.

116. Farkhad NK, Sedaghat A, Reihani H, Moghadam AA, Moghadam AB, et al. (2022) Mesenchymal stromal cell therapy for COVID-19-induced ARDS patients: a successful phase 1, control-placebo group, clinical trial. Stem Cell Res Ther 13: 283.

117. Kamen DL, Wallace C, Li Z, Wyatt M, Paulos C, et al. (2022) Safety, immunological effects and clinical response in a phase I trial of umbilical cord mesenchymal stromal cells in patients with treatment refractory SLE. Lupus Sci Med 9: 000704.

118. Karantalis V, DiFede DL, Gerstenblith G, Pham S, Symes J, et al. (2014) Autologous mesenchymal stem cells produce concordant improvements in regional function, tissue perfusion, and fibrotic burden when administered to patients undergoing coronary artery bypass grafting: The Prospective Randomized Study of Mesenchymal Stem Cell Therapy in Patients Undergoing Cardiac Surgery (PROMETHEUS) trial. Circ Res 114: 1302-1310.

119. Karussis D, Karageorgiou C, Vaknin-Dembinsky A, Gowda-Kurkalli B, Gomori JM, et al. (2010) Safety and immunological effects of mesenchymal stem cell transplantation in patients with multiple sclerosis and amyotrophic lateral sclerosis. Arch Neurol 67: 1187-1194.

120. Karyana M, Djaharuddin I, Rif'ati L, Arif M, Choi MK, et al. (2022) Safety of DW-MSC infusion in patients with low clinical risk COVID-19 infection: a randomized, double-blind, placebo-controlled trial. Stem Cell Res Ther 13: 134.

121. Keller CA, Gonwa TA, Hodge DO, Hei DJ, Centanni JM, et al. (2018) Feasibility, Safety, and Tolerance of Mesenchymal Stem Cell Therapy for Obstructive Chronic Lung Allograft Dysfunction. Stem Cells Transl Med 7: 161-167.

122. Soltani SK, Forogh B, Ahmadbeigi N, Kharazi HH, Fallahzadeh K, et al. (2019) Safety and efficacy of allogenic placental mesenchymal stem cells for treating knee osteoarthritis: a pilot study. Cytotherapy 21: 54-63.

123. Kim HY, Kim H, Oh KW, Oh SI, Koh SH, et al. (2014) Biological markers of mesenchymal stromal cells as predictors of response to autologous stem cell transplantation in patients with amyotrophic lateral sclerosis: an investigator-initiated trial and in vivo study. Stem Cells 32: 2724-2731.

124. Kim JH, Kim KI, Yoon WK, Song SJ, Jin W (2022) Intra-articular Injection of Mesenchymal Stem Cells After High Tibial Osteotomy in Osteoarthritic Knee: Two-Year Follow-up of Randomized Control Trial. Stem Cells Transl Med 11: 572-585.

125. Kim KI, Lee MC, Lee JH, Moon YW, Lee WS, et al. (2023) Clinical Efficacy and Safety of the Intra-articular Injection of Autologous Adipose-Derived Mesenchymal Stem Cells for Knee Osteoarthritis: A Phase III, Randomized, Double-Blind, Placebo-Controlled Trial. Am J Sports Med 51: 2243-2253.

126. Koh YG, Choi YJ (2012) Infrapatellar fat pad-derived mesenchymal stem cell therapy for knee osteoarthritis. Knee 19: 902-907.

127. Kong D, Zhuang X, Wang D, Qu H, Jiang Y, et al. (2014) Umbilical cord mesenchymal stem cell transfusion ameliorated hyperglycemia in patients with type 2 diabetes mellitus. Clin Lab 60: 1969-1976.

128. Lamo-Espinosa JM, Blanco JF, Sánchez M, Moreno V, Granero-Moltó F, et al. (2020) Phase II multicenter randomized controlled clinical trial on the efficacy of intra-articular injection of autologous bone marrow mesenchymal stem cells with platelet rich plasma for the treatment of knee osteoarthritis. J Transl Med 18: 356.

129. Lamo-Espinosa JM, Mora G, Blanco JF, Granero-Moltó F, Núñez-Córdoba JM, et al. (2018) Intra-articular injection of two different doses of autologous bone marrow mesenchymal stem cells versus hyaluronic acid in the treatment of knee osteoarthritis: long-term follow up of a multicenter randomized controlled clinical trial (phase I/II). J Transl Med 16: 213.

130. Lamo-Espinosa JM, Mora G, Blanco JF, Granero-Moltó F, Nuñez-Córdoba JM, et al. (2016) Intra-articular injection of two different doses of autologous bone marrow mesenchymal stem cells versus hyaluronic acid in the treatment of knee osteoarthritis: multicenter randomized controlled clinical trial (phase I/II). J Transl Med 14: 246.

131. Lan Y, Liu F, Chang L, Liu L, Zhang Y, et al. (2021) Combination of umbilical cord mesenchymal stem cells and standard immunosuppressive regimen for pediatric patients with severe aplastic anemia. BMC Pediatr 21: 102.

132. Lanzoni G, Linetsky E, Correa D, Messinger Cayetano S, Alvarez RA, et al. (2021) Umbilical cord mesenchymal stem cells for COVID-19 acute respiratory distress syndrome: A double-blind, phase 1/2a, randomized controlled trial. Stem Cells Transl Med 10: 660-673.

133. Laterre PF, Sánchez García M, van der Poll T, Wittebole X, Martínez-Sagasti F, et al. (2024) The safety and efficacy of stem cells for the treatment of severe community-acquired bacterial pneumonia: A randomized clinical trial. J Crit Care 79: 154446.

134. Law ZK, Tan HJ, Chin SP, Wong CY, Wan Yahya WNN, et al. (2021) The effects of intravenous infusion of autologous mesenchymal stromal cells in patients with subacute middle cerebral artery infarct: a phase 2 randomized controlled trial on safety, tolerability and efficacy. Cytotherapy 23: 833-480.

135. Lee J, Chang WH, Chung JW, Kim SJ, Kim SK, et al. (2022) Efficacy of Intravenous Mesenchymal Stem Cells for Motor Recovery After Ischemic Stroke: A Neuroimaging Study. Stroke 53: 20-28.

136. Lee JS, Hong JM, Moon GJ, Lee PH, Ahn YH, et al. (2010) A long-term follow-up study of intravenous autologous mesenchymal stem cell transplantation in patients with ischemic stroke. Stem Cells 28: 1099-1106.

137. Lee PH, Kim JW, Bang OY, Ahn YH, Joo IS, et al. (2008) Autologous mesenchymal stem cell therapy delays the progression of neurological deficits in patients with multiple system atrophy. Clin Pharmacol Ther 83: 723-730.

138. Lee PH, Lee JE, Kim HS, Song SK, Lee HS, et al. (2012) A randomized trial of mesenchymal stem cells in multiple system atrophy. Ann Neurol 72: 32-40.

139. Lee SE, Lee SJ, Kim SE, Kim K, Cho B, et al. (2021) Intravenous allogeneic umbilical cord blood-derived mesenchymal stem cell therapy in recessive dystrophic epidermolysis bullosa patients. JCI Insight 6.

140. Lee WS, Kim HJ, Kim KI, Kim GB, Jin W, et al. (2019) Intra-Articular Injection of Autologous Adipose Tissue-Derived Mesenchymal Stem Cells for the Treatment of Knee Osteoarthritis: A Phase IIb, Randomized, Placebo-Controlled Clinical Trial. Stem Cells Transl Med 8: 504-511.

141. Levy ML, Crawford JR, Dib N, Verkh L, Tankovich N, et al. (2019) Cramer SC. Phase I/II Study of Safety and Preliminary Efficacy of Intravenous Allogeneic Mesenchymal Stem Cells in Chronic Stroke. Stroke 50: 2835-2841.

142. Li TT, Zhang B, Fang H, Shi M, Yao WQ, et al. (2023) Human mesenchymal stem cell therapy in severe COVID-19 patients: 2-year follow-up results of a randomized, double-blind, placebo-controlled trial. EbioMedicine 92: 104600.

143. Lian XF, Lu DH, Liu HL, Liu YJ, Han XQ, et al. (2022) Effectiveness and safety of human umbilical cord-mesenchymal stem cells for treating type 2 diabetes mellitus. World J Diabetes 13: 877-887.

144. Lian XF, Lu DH, Liu HL, Liu YJ, Yang Y, et al. (2023) Safety evaluation of human umbilical cord-mesenchymal stem cells in type 2 diabetes mellitus treatment: A phase 2 clinical trial. World J Clin Cases 11: 5083-5096.

145. Lightner AL, Dadgar N, Matyas C, Elliott K, Fulmer C, et al. (2022) A phase IB/IIA study of remestemcel-L, an allogeneic bone marrow-derived mesenchymal stem cell product, for the treatment of medically refractory ulcerative colitis: an interim analysis. Colorectal Dis 24: 1358-1370.

146. Liu X, Fu X, Dai G, Wang X, Zhang Z, et al. (2017) Comparative analysis of curative effect of bone marrow mesenchymal stem cell and bone marrow mononuclear cell transplantation for spastic cerebral palsy. J Transl Med 15: 48.

147. Lu J, Shen SM, Ling Q, Wang B, Li LR, et al. (2021) One repeated transplantation of allogeneic umbilical cord mesenchymal stromal cells in type 1 diabetes: an open parallel controlled clinical study. Stem Cell Res Ther 12: 340.

148. Lu L, Dai C, Du H, Li S, Ye P, et al. (2020) Intra-articular injections of allogeneic human adipose-derived mesenchymal progenitor cells in patients with symptomatic bilateral knee osteoarthritis: a Phase I pilot study. Regen Med 15: 1625-1636.

149. Lv YT, Zhang Y, Liu M, Qiuwaxi JN, Ashwood P, et al. (2013) Transplantation of human cord blood mononuclear cells and umbilical cord-derived mesenchymal stem cells in autism. J Transl Med 11: 196.

150. Makhlough A, Shekarchian S, Moghadasali R, Einollahi B, Dastgheib M, et al. (2018) Bone marrow-mesenchymal stromal cell infusion in patients with chronic kidney disease: A safety study with 18 months of follow-up. Cytotherapy 20: 660-669.

151. Makhlough A, Shekarchian S, Moghadasali R, Einollahi B, Hosseini SE, et al. (2017) Safety and tolerability of autologous bone marrow mesenchymal stromal cells in ADPKD patients. Stem Cell Res Ther 8: 116.

152. Matas J, Orrego M, Amenabar D, Infante C, Tapia-Limonchi R, et al. (2019) Umbilical Cord-Derived Mesenchymal Stromal Cells (MSCs) for Knee Osteoarthritis: Repeated MSC Dosing Is Superior to a Single MSC Dose and to Hyaluronic Acid in a Controlled Randomized Phase I/II Trial. Stem Cells Transl Med 8: 215-224.

153. Matthay MA, Calfee CS, Zhuo H, Thompson BT, Wilson JG, et al. (2019) Treatment with allogeneic mesenchymal stromal cells for moderate to severe acute respiratory distress syndrome (START study): a randomised phase 2a safety trial. Lancet Respir Med 7: 154-162.

154. Mazzini L, Ferrero I, Luparello V, Rustichelli D, Gunetti M, et al. (2010) Mesenchymal stem cell transplantation in amyotrophic lateral sclerosis: A Phase I clinical trial. Exp Neurol 223: 229-237.

155. Mazzini L, Mareschi K, Ferrero I, Miglioretti M, Stecco A, et al. (2012) Mesenchymal stromal cell transplantation in amyotrophic lateral sclerosis: a long-term safety study. Cytotherapy 1: 56-60.

156. McIntyre LA, Stewart DJ, Mei SHJ, Courtman D, Watpool I, et al. (2018) Cellular Immunotherapy for Septic Shock. A Phase I Clinical Trial. Am J Respir Crit Care Med 197: 337-347.

157. Meng F, Xu R, Wang S, Xu Z, Zhang C, et al. (2020) Human umbilical cord-derived mesenchymal stem cell therapy in patients with COVID-19: a phase 1 clinical trial. Signal Transduct Target Ther 172.

158. Mohajeri M, Farazmand A, Mohyeddin Bonab M, Nikbin B, Minagar A. (2011) FOXP3 gene expression in multiple sclerosis patients pre- and post mesenchymal stem cell therapy. Iran J Allergy Asthma Immunol 155-161.

159. Mohamed SA, Howard L, McInerney V, Hayat A, Krawczyk J, et al. (2020) Autologous bone marrow mesenchymal stromal cell therapy for "no-option" critical limb ischemia is limited by karyotype abnormalities. Cytotherapy 22: 313-321.

160. Mohseni R, Hamidieh AA, Shoae-Hassani A, Ghahvechi-Akbari M, Majma A, et al. (2022) An open-label phase 1 clinical trial of the allogeneic side population adipose-derived mesenchymal stem cells in SMA type 1 patients. Neurol Sci 43 : 399-410.

161. Mohyeddin Bonab M, Yazdanbakhsh S, Lotfi J, Alimoghaddom K, Talebian F, et al. (2007) Does mesenchymal stem cell therapy help multiple sclerosis patients? Report of a pilot study. Iran J Immunol 4 :50-57.

162. Monsel A, Hauw-Berlemont C, Mebarki M, Heming N, Mayaux J, et al.(2022) Treatment of COVID-19-associated ARDS with mesenchymal stromal cells: a multicenter randomized double-blind trial. Crit Care 26: 48

163. Nejad-Moghaddam A, Ajdary S, Tahmasbpour E, Rad FR, Panahi Y, Ghanei M (2016) Immunomodulatory Properties of Mesenchymal Stem Cells Can Mitigate Oxidative Stress and Inflammation Process in Human Mustard Lung. Biochem Genet 54 :769-783.

164. Nguyen LT, Hoang DM, Nguyen KT, Bui DM, Nguyen HT, et al. (2021) Type 2 diabetes mellitus duration and obesity alter the efficacy of autologously transplanted bone marrow-derived mesenchymal stem/stromal cells. Stem Cells Transl Med 10: 1266-1278.

165. Oh KW, Moon C, Kim HY, Oh SI, Park J, et al. (2015) Phase I trial of repeated intrathecal autologous bone marrow-derived mesenchymal stromal cells in amyotrophic lateral sclerosis. Stem Cells Transl Med 4: 590-597.

166. Olufade O, Negron G, Berrigan W, Sirutis B, Whitley J, et al. (2022) Amniotic dehydrated cell and protein concentrate versus corticosteroid in knee osteoarthritis: preliminary findings. Regen Med 17: 431-443.

167. Orozco L, Munar A, Soler R, Alberca M, Soler F, et al. (2013)Treatment of knee osteoarthritis with autologous mesenchymal stem cells: a pilot study. Transplantation 95: 1535-1541.

168. Park EH, Lim HS, Lee S, Roh K, Seo KW, et al. (2018) Intravenous Infusion of Umbilical Cord Blood-Derived Mesenchymal Stem Cells in Rheumatoid Arthritis: A Phase Ia Clinical Trial. Stem Cells Transl Med 7: 636-642.

169. Perico N, Remuzzi G, Griffin MD, Cockwell P, Maxwell AP, et al. (2023) Safety and Preliminary Efficacy of Mesenchymal Stromal Cell (ORBCEL-M) Therapy in Diabetic Kidney Disease: A Randomized Clinical Trial (NEPHSTROM). J Am Soc Nephrol 34: 1733-1751.

170. Perlee D, van Vught LA, Scicluna BP, Maag A, Lutter R, et al. (2018) Intravenous Infusion of Human Adipose Mesenchymal Stem Cells Modifies the Host Response to Lipopolysaccharide in Humans: A Randomized, Single-Blind, Parallel Group, Placebo Controlled Trial. Stem Cells 36: 1778-1788.

171. Pers YM, Rackwitz L, Ferreira R, Pullig O, Delfour C, et al. (2016) Adipose Mesenchymal Stromal Cell-Based Therapy for Severe Osteoarthritis of the Knee: A Phase I Dose-Escalation Trial. Stem Cells Transl Med 5: 847-856.

172. Petrou P, Gothelf Y, Argov Z, Gotkine M, Levy YS, et al. (2016) Safety and Clinical Effects of Mesenchymal Stem Cells Secreting Neurotrophic Factor Transplantation in Patients With Amyotrophic Lateral Sclerosis: Results of Phase 1/2 and 2a Clinical Trials. JAMA Neurol 73: 337-244.

173. Petrou P, Kassis I, Ginzberg A, Hallimi M, Karussis D (2022) Effects of Mesenchymal Stem Cell Transplantation on Cerebrospinal Fluid Biomarkers in Progressive Multiple Sclerosis. Stem Cells Transl Med 11: 55-58.

174. Petrou P, Kassis I, Levin N, Paul F, Backner Y, et al. (2020) Beneficial effects of autologous mesenchymal stem cell transplantation in active progressive multiple sclerosis. Brain 143: 3574-3588.

175. Petrou P, Kassis I, Yaghmour NE, Ginzberg A, Karussis D.(2021) A phase II clinical trial with repeated intrathecal injections of autologous mesenchymal stem cells in patients with amyotrophic lateral sclerosis. Front Biosci (Landmark Ed) 26: 693-706.

176. Pintore A, Notarfrancesco D, Zara A, Oliviero A, Migliorini F, et al. (2023) Intra-articular injection of bone marrow aspirate concentrate (BMAC) or adipose-derived stem cells (ADSCs) for knee osteoarthritis: a prospective comparative clinical trial. J Orthop Surg Res 18: 350.

177. Ra JC, Shin IS, Kim SH, Kang SK, Kang BC, et al. (2011) Safety of intravenous infusion of human adipose tissue-derived mesenchymal stem cells in animals and humans. Stem Cells Dev 20: 1297-1308.

178. Rashidghamat E, Kadiyirire T, Ayis S, Petrof G, Liu L, et al. (2020) Phase I/II open-label trial of intravenous allogeneic mesenchymal stromal cell therapy in adults with recessive dystrophic epidermolysis bullosa. J Am Acad Dermatol 83: 447-454

179. Rebelatto CLK, Senegaglia AC, Franck CL, Daga DR, Shigunov P, et al. (2022) Safety and long-term improvement of mesenchymal stromal cell infusion in critically COVID-19 patients: a randomized clinical trial. Stem Cell Res Ther 13:122.

180. Riordan NH, Morales I, Fernández G, Allen N, Fearnot NE, et al. (2018) Clinical feasibility of umbilical cord tissue-derived mesenchymal stem cells in the treatment of multiple sclerosis. J Transl Med 16: 57.

181. Roesch EA, Bonfield TL, Lazarus HM, Reese J, Hilliard K, et al. (2022) A phase I study assessing the safety and tolerability of allogeneic mesenchymal stem cell infusion in adults with cystic fibrosis. J Cyst Fibros 22: 407-413.

182. Rushkevich YN, Kosmacheva SM, Zabrodets GV, Ignatenko SI, Goncharova NV, et al. (2015) The Use of Autologous Mesenchymal Stem Cells for Cell Therapy of Patients with Amyotrophic Lateral Sclerosis in Belarus. Bull Exp Biol Med 159: 576-581.

183. Sadeghi B, Roshandel E, Pirsalehi A, Kazemi S, Sankanian G, et al. (2021) Conquering the cytokine storm in COVID-19-induced ARDS using placenta-derived decidua stromal cells. J Cell Mol Med 25: 10554-10564.

184. Sadri B, Hassanzadeh M, Bagherifard A, Mohammadi J, Alikhani M, et al. (2023) Cartilage regeneration and inflammation modulation in knee osteoarthritis following injection of allogeneic adipose-derived mesenchymal stromal cells: a phase II, triple-blinded, placebo controlled, randomized trial. Stem Cell Res Ther 14: 162.

185. Sadri B, Tamimi A, Nouraein S, Fard AB, Mohammadi J, et al. (2022) Clinical and laboratory findings following transplantation of allogeneic adipose-derived mesenchymal stromal cells in knee osteoarthritis, a brief report. Connect Tissue Res 63: 663-674.

186. Salama H, Zekri AR, Medhat E, Alim SAA, Ahmed OS, et al. (2014) Peripheral vein infusion of autologous mesenchymal stem cells in Egyptian HCV-positive patients with end-stage liver disease. Stem Cell Res Ther 5: 70.

187. Saleh M, Vaezi AA, Aliannejad R, Sohrabpour AA, Kiaei SZF, et al. (2021) Cell therapy in patients with COVID-19 using Wharton's jelly mesenchymal stem cells: a phase 1 clinical trial. Stem Cell Res Ther 12: 410.

188. Satti HS, Waheed A, Ahmed P, Ahmed K, Akram Z, et al. (2016) Autologous mesenchymal stromal cell transplantation for spinal cord injury: A Phase I pilot study. Cytotherapy 18: 518-522.

189. Sengupta V, Sengupta S, Lazo A, Woods P, Nolan A, et al. (2020) Exosomes Derived from Bone Marrow Mesenchymal Stem Cells as Treatment for Severe COVID-19. Stem Cells Dev 29: 747-754.

190. Shadmanfar S, Labibzadeh N, Emadedin M, Jaroughi N, Azimian V, et al. (2018) Intra-articular knee implantation of autologous bone marrow-derived mesenchymal stromal cells in rheumatoid arthritis patients with knee involvement: Results of a randomized, triple-blind, placebo-controlled phase 1/2 clinical trial. Cytotherapy 20: 499-506.

191. Shi L, Huang H, Lu X, Yan X, Jiang X, et al. (2021) Effect of human umbilical cord-derived mesenchymal stem cells on lung damage in severe COVID-19 patients: a randomized, double-blind, placebo-controlled phase 2 trial. Signal Transduct Target Ther 6: 58.

192. Shi L, Yuan X, Yao W, Wang S, Zhang C, et al. (2021) Human mesenchymal stem cells treatment for severe COVID-19: 1-year follow-up results of a randomized, double-blind, placebo-controlled trial. EbioMedicine 75: 103789.

193. Shi M, Zhang Z, Xu R, Lin H, Fu J, et al. (2012) Human mesenchymal stem cell transfusion is safe and improves liver function in acute-on-chronic liver failure patients. Stem Cells Transl Med 1: 725-731.

194. Shirbaghaee Z, Keshel SH, Rasouli M, Valizadeh M, Nazari SSH, et al. (2023) 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 14: 174.

195. Shu L, Niu C, Li R, Huang T, Wang Y, et al. (2020) Treatment of severe COVID-19 with human umbilical cord mesenchymal stem cells. Stem Cell Res Ther 11: 361.

196. Singer W, Dietz AB, Zeller AD, Gehrking TL, Schmelzer JD, et al. (2019) Intrathecal administration of autologous mesenchymal stem cells in multiple system atrophy. Neurology 93: 77-87.

197. Sitbon A, Hauw-Berlemont C, Mebarki M, Heming N, Mayaux J, et al. (2024) Treatment of COVID-19-associated ARDS with umbilical cord-derived mesenchymal stromal cells in the STROMA-CoV-2 multicenter randomized double-blind trial: long-term safety, respiratory function, and quality of life. Stem Cell Res Ther 15: 109.

198. Siwek T, Jezierska-Woźniak K, Maksymowicz S, Barczewska M, Sowa M, et al. (2020) Repeat Administration of Bone Marrow-Derived Mesenchymal Stem Cells for Treatment of Amyotrophic Lateral Sclerosis. Med Sci Monit 26: 927484.

199. Soler R, Orozco L, Munar A, Huguet M, López R, et al. (2016) Final results of a phase I-II trial using ex vivo expanded autologous Mesenchymal Stromal Cells for the treatment of osteoarthritis of the knee confirming safety and suggesting cartilage regeneration. Knee 23: 647-654.

200. Song Y, Du H, Dai C, Zhang L, Li S, et al. (2018) Human adipose-derived mesenchymal stem cells for osteoarthritis: a pilot study with long-term follow-up and repeated injections. Regen Med 13: 295-307.

201. Staff NP, Madigan NN, Morris J, Jentoft M, Sorenson EJ, et al. (2016) Safety of intrathecal autologous adipose-derived mesenchymal stromal cells in patients with ALS. Neurology 87: 2230-2234.

202. Stolk J, Broekman W, Mauad T, Zwaginga JJ, Roelofs H, et al. (2016) A phase I study for intravenous autologous mesenchymal stromal cell administration to patients with severe emphysema. Qjm 109: 331-336.

203. Swart JF, de Roock S, Nievelstein RAJ, Slaper-Cortenbach ICM, Boelens JJ, et al. (2019) Bone-marrow derived mesenchymal stromal cells infusion in therapy refractory juvenile idiopathic arthritis patients. Rheumatology (Oxford) 58: 1812-1817.

204. Syková E, Rychmach P, Drahorádová I, Konrádová Š, Růžičková K, et al. (2017) Transplantation of Mesenchymal Stromal Cells in Patients with Amyotrophic Lateral Sclerosis: Results of Phase I/IIa Clinical Trial. Cell Transplant 26: 647-658.

205. Tedesco M, Bellei B, Garelli V, Caputo S, Latini A, et al. (2020) Adipose tissue stromal vascular fraction and adipose tissue stromal vascular fraction plus platelet-rich plasma grafting: New regenerative perspectives in genital lichen sclerosus. Dermatol Ther 33: e14277.

206. Tedesco M, Bellei B, Garelli V, Caputo S, Latini A, et al. (2020) Allogeneic Mesenchymal Stem Cells Ameliorate Aging Frailty: A Phase II Randomized, Double-Blind, Placebo-Controlled Clinical Trial. J Gerontol A Biol Sci Med Sci 72: 1513-1522.

207. Tsai YA, Liu RS, Lirng JF, Yang BH, Chang CH, et al. Treatment of Spinocerebellar Ataxia With Mesenchymal Stem Cells: A Phase I/IIa Clinical Study. Cell Transplant 26: 503-512.

208. Vangsness CT Jr, Farr J 2nd, Boyd J, Dellaero DT, Mills CR, et al. (2014) Adult human mesenchymal stem cells delivered via intra-articular injection to the knee following partial medial meniscectomy: a randomized, double-blind, controlled study. J Bone Joint Surg Am 96: 90-98.

209. Vaquero J, Zurita M, Rico MA, Aguayo C, Bonilla C, et al. (2018) Intrathecal administration of autologous mesenchymal stromal cells for spinal cord injury: Safety and efficacy of the 100/3 guideline. Cytotherapy 20: 806-819.

210. Vega A, Martín-Ferrero MA, Del Canto F, Alberca M, García V, et al. (2015) Treatment of Knee Osteoarthritis With Allogeneic Bone Marrow Mesenchymal Stem Cells: A Randomized Controlled Trial. Transplantation 99: 1681-1690.

211. Vester-Glowinski PV, Herly M, Ørholt M, Rasmussen BS, Müller FC, et al. (2022) Fat Grafting With Expanded Adipose-Derived Stromal Cells for Breast Augmentation: A Randomized Controlled Trial. Aesthet Surg J 42: 1279-1289.

212. Viganò M, Ragni E, Di Matteo B, Gambaro FM, Perucca Orfei C, et al. (2022) A single step, centrifuge-free method to harvest bone marrow highly concentrated in mesenchymal stem cells: results of a pilot trial. Int Orthop 46: 391-400.

213. Vij R, Stebbings KA, Kim H, Park H, Chang D (2022) Safety and efficacy of autologous, adipose-derived mesenchymal stem cells in patients with rheumatoid arthritis: a phase I/IIa, open-label, non-randomized pilot trial. Stem Cell Res Ther 13: 88.

214. Wang D, Li J, Zhang Y, Zhang M, Chen J, et al. (2014) Umbilical cord mesenchymal stem cell transplantation in active and refractory systemic lupus erythematosus: a multicenter clinical study. Arthritis Res Ther 16: R79.

215. Wang D, Zhang H, Liang J, Li X, Feng X, et al. (2013) Allogeneic mesenchymal stem cell transplantation in severe and refractory systemic lupus erythematosus: 4 years of experience. Cell Transplant 22: 2267-2277.

216. Wang JA, Xie XJ, He H, Sun Y, Jiang J, et al. (2006) A prospective, randomized, controlled trial of autologous mesenchymal stem cells transplantation for dilated cardiomyopathy. Zhonghua Xin Xue Guan Bing Za Zhi 34: 107-110.

217. Wang L, Huang S, Li S, Li M, Shi J, et al. (2019) Efficacy and Safety of Umbilical Cord Mesenchymal Stem Cell Therapy for Rheumatoid Arthritis Patients: A Prospective Phase I/II Study. Drug Des Devel Ther 13: 4331-4340.

218. Wang P, Li Y, Huang L, Yang J, Yang R, et al. (2014) Effects and safety of allogenic mesenchymal stem cell intravenous infusion in active ankylosing spondylitis patients who failed NSAIDs: a 20-week clinical trial. Cell Transplant 23: 1293-1303.

219. Wei Y, Chen X, Zhang H, Su Q, Peng Y, et al. (2021) Efficacy and Safety of Bone Marrow-Derived Mesenchymal Stem Cells for Chronic Antibody-Mediated Rejection After Kidney Transplantation- A Single-Arm, Two-Dosing-Regimen, Phase I/II Study. Front Immunol 12: 662441.

220. Wilson JG, Liu KD, Zhuo H, Caballero L, McMillan M, et al. (2015) Mesenchymal stem (stromal) cells for treatment of ARDS: a phase 1 clinical trial. Lancet Respir Med 3: 24-32.

221. Wu Z, Xu X, Cai J, Chen J, Huang L, et al. (2022) Prevention of chronic diabetic complications in type 1 diabetes by co-transplantation of umbilical cord mesenchymal stromal cells and autologous bone marrow: a pilot randomized controlled open-label clinical study with 8-year follow-up. Cytotherapy 24: 421-427.

222. Xiao Y, Jiang ZJ, Pang Y, Li L, Gao Y, et al. (2013) Efficacy and safety of mesenchymal stromal cell treatment from related donors for patients with refractory aplastic anemia. Cytotherapy 15: 760-766.

223. Yagyu T, Yasuda S, Nagaya N, Doi K, Nakatani T, et al. (2019) Long-Term Results of Intracardiac Mesenchymal Stem Cell Transplantation in Patients With Cardiomyopathy. Circ J 83:1590-1599.

224. Yamout B, Hourani R, Salti H, Barada W, El-Hajj T, et al. (2010) Bone marrow mesenchymal stem cell transplantation in patients with multiple sclerosis: a pilot study. J Neuroimmunol 227: 185-189.

225. Yao K, Huang RC, Ge L, Qian JY, Li YL, et al. (2006) Observation on the safety: clinical trail on intracoronary autologous bone marrow mononuclear cells transplantation for acute myocardial infarction. Zhonghua Xin Xue Guan Bing Za Zhi 34: 577-581.

226. Yau TM, Pagani FD, Mancini DM, Chang HL, Lala A, et al. (2019) Intramyocardial Injection of Mesenchymal Precursor Cells and Successful Temporary Weaning From Left Ventricular Assist Device Support in Patients With Advanced Heart Failure: A Randomized Clinical Trial. Jama 321: 1176-1186.

227. Zang L, Li Y, Hao H, Liu J, Cheng Y, et al. (2022) Efficacy and safety of umbilical cord-derived mesenchymal stem cells in Chinese adults with type 2 diabetes: a single-center, double-blinded, randomized, placebo-controlled phase II trial. Stem Cell Res Ther 13: 180.

228. Zang L, Li Y, Hao H, Liu J, Zhang Q, et al. (2023) Efficacy of Umbilical Cord-Derived Mesenchymal Stem Cells in the Treatment of Type 2 Diabetes Assessed by Retrospective Continuous Glucose Monitoring. Stem Cells Transl Med 12: 775-782.

229. Zhang C, Huang L, Wang X, Zhou X, Zhang X, et al. (2022) Topical and intravenous administration of human umbilical cord mesenchymal stem cells in patients with diabetic foot ulcer and peripheral arterial disease: a phase I pilot study with a 3-year follow-up. Stem Cell Res Ther 13: 451.

230. Zhang J, Lv S, Liu X, Song B, Shi L (2018) Umbilical Cord Mesenchymal Stem Cell Treatment for Crohn's Disease: A Randomized Controlled Clinical Trial. Gut Liver 12: 73-78.

231. Zhang S, Xu H, He B, Fan M, Xiao M, et al. (2022) Mid-term prognosis of the stromal vascular fraction for knee osteoarthritis: a minimum 5-year follow-up study. Stem Cell Res Ther 13: 105.

232. Zhang Y, Bi Q, Luo J, Tong Y, Yu T, et al. (2022) The Effect of Autologous Adipose-Derived Stromal Vascular Fractions on Cartilage Regeneration Was Quantitatively Evaluated Based on the 3D-FS-SPGR Sequence: A Clinical Trial Study. Biomed Res Int 2022: 2777568.

233. Zhang YC, Liu W, Fu BS, Wang GY, Li HB, et al. (2017) Therapeutic potentials of umbilical cord-derived mesenchymal stromal cells for ischemic-type biliary lesions following liver transplantation. Cytotherapy 19: 194-199.

234. Zhao T, Liang Q, Meng X, Duan P, Wang F, et al. (2020) Intravenous Infusion of Umbilical Cord Mesenchymal Stem Cells Maintains and Partially Improves Visual Function in Patients with Advanced Retinitis Pigmentosa. Stem Cells Dev 29: 1029-1037.

235. Zheng G, Huang L, Tong H, Shu Q, Hu Y, et al. (2014) Treatment of acute respiratory distress syndrome with allogeneic adipose-derived mesenchymal stem cells: a randomized, placebo-controlled pilot study. Respir Res 15: 39.

236. Zhu Y, Huang C, Zheng L, Li Q, Ge J, et al. (2024) Safety and efficacy of umbilical cord tissue-derived mesenchymal stem cells in the treatment of patients with aging frailty: a phase I/II randomized, double-blind, placebo-controlled study. Stem Cell Res Ther 15: 122.

237. Prodromos CC, Nenchev K, Pfeffer L (2024) Mesenchymal Stem Cell Treatment Does Not Result in Tumor Formation: A Systematic Review. ResearchGate.

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