SUPPLEMENTAL MATERIAL

Online Table I. Study characteristics for animal models

Author	Animal model	Type of animal model	n	Sex	Age (wks)	Weight	Type of MI	Type of injury	Route of delivery	Time of cell administration	Area of cell administration	Cell type	Dose	Passage	BM-MSC Donor Species	Autologous/ Syngeneic/ Allogeneic/ Xenogeneic	Control
Nakamura *et al.* 2007[1]	Mouse	NOD/SCID mice	10	N/A	16	29-31g	Acute	Permanent LAD ligation	DI	15 mins after MI	Border zone	BM-MSC	$1.00x10^6$	80	6w Yorkshire swine	Xenogeneic	PBS
Grauss *et al.* 2008[2]	Mouse	NOD/SCID mice	22	M	8-10	N/A	Acute	Permanent LAD ligation	DI	10-20 mins after MI	Border/Infarct zone	BM-MSC	$2.00x10^5$	3-8	Human	Xenogeneic	PBS
Shyu *et al.* 2006[3]	Mouse	SCID mice	14	M	6-8	N/A	Acute	Permanent LAD ligation	DI	Immediately after MI	Border zone	BM-MSC	$1.00x10^6$	19	Human	Xenogeneic	PBS
Buccini *et al.* 2012[4]	Mouse	C57BL/6 mice	11	F	8-12	N/A	Acute	Permanent LAD ligation	DI	N/A	IM	BM-MSC	$2.00x10^5$	3	4–6w M Oct4-GFP mice	Syngeneic	DMEM
Li *et al.* 2012[5]	Mouse	SCID mice	28	M	10-12	N/A	Acute	Permanent LAD ligation	DI	Immediately after MI	Infarct zone	BM-MSC	$1.00x10^5$	N/A	Human	Xenogeneic	PBS
Lian *et al.* 2011[6]	Mouse	C57BL/6 mice	36	M	8-10	N/A	Acute	Permanent LAD ligation	DI	Immediately after MI	Border zone	BM-MSC	$5.00x10^4$	2-4	8-10w M C57BL/6 mice	Syngeneic	PBS
Yao *et al.* 2015[7]	Mouse	NOD/SCID mice	16	F	8-10	25-30g	Acute	Permanent LAD ligation	DI	Immediately after MI	Infarct zone	BM-MSC	$1.00x10^6$	3	6-8w M (20-25g) transgenic mice	Allogeneic	PBS
Nagaya *et al.* 2004[8]	Rat	Lewis rats	24	M	N/A	220-250g	Acute	Permanent LCA ligation	IV	3 hours after MI	Left jugular vein	BM-MSC	$5.00x10^6$	4-5	M Lewis rats	Syngeneic	PBS
Dai *et al.* 2005[9]	Rat	Fischer CDF rats	24	F	8-12	N/A	Acute	Permanent LCA ligation	DI	1 week after MI	Infarct zone	BM-MSC	$2.00x10^6$	3	M ACI (250-300g) rats	Allogeneic	PBS
Li *et al.* 2009[10]	Rat	Sprague-Dawley rats	16	M	N/A	200-250g	Acute	Permanent LAD ligation	DI	1 hour after MI	Border zone	BM-MSC	$1.00x10^7$	N/A	M Sprague-Dawley (200-250g) rats	Syngeneic	DMEM
*Li *et al.* 2011[11]	Rat	Sprague-Dawley rats	18	F	N/A	80-100g	Acute	Permanent LAD ligation	IV/DI	1 day after MI	IV/IM	BM-MSC	$1.00x10^6$	3	M Sprague-Dawley rats	Syngeneic	DMEM
Khan *et al.* 2009[12]	Rat	Fisher-344 rats	12	N/A	N/A	150-200g	Acute	Permanent LAD ligation	DI	30 mins after MI	Border/Infarct zone	BM-MSC	$5.00x10^5$	2	Fisher 344 rats	Syngeneic	DMEM
Jiang *et al.* 2006[13]	Rat	Fisher-344 rats	40	F	N/A	180-200g	Acute	Permanent LCA ligation	DI	3 hours after MI	Free wall of left ventricle	BM-MSC	$3.00x10^6$	2-3	M Fischer-344 rats	Syngeneic	DMEM
Tsubokawa *et al.* 2010[14]	Rat	Lewis rats	48	M	N/A	250-300g	Acute	Permanent LAD ligation	DI	1 hour after MI	Border/Infarct zone	BM-MSC	$5.00x10^6$	4-5	M Lewis (200-300g) rats	Syngeneic	PBS
*Jiang *et al.* 2008[15]	Rat	Fisher-344 rats	38	F	N/A	180-200g	Acute	Permanent LAD ligation	DI	Immediately after MI	Border/Infarct zone	BM-MSC	$2.00x10^6$	4-5	YoungMSCs (8–12w) & oldMSCs (24–26 weeks) M Fischer-344 rats	Syngeneic	DMEM

Furlani *et al.* 2009[16]	Rat	Lewis rats	17	M	8-12	280g	Acute	Permanent LAD ligation	DI	Immediately after MI	Border zone	BM-MSC	$6.00x10^6$	3, 6, 9	Lewis rats	Syngeneic	PBS
Afzal *et al.* 2010[17]	Rat	Fisher-344 rats	12	F	8-12	N/A	Acute	Permanent LAD ligation	DI	Immediately after MI	Border/Infarct zone	BM-MSC	$1.00x10^6$	3-5	8-12w M Fisher-344 rats	Syngeneic	DMEM
Zeng *et al.* 2008[18]	Rat	Sprague-Dawley rats	24	M	N/A	250g	Acute	Permanent LCA ligation	DI	1 hour after MI	Border zone	BM-MSC	$1.00x10^6$	3	M Sprague-Dawley (250g) rats	Syngeneic	PBS
Gao *et al.* 2010[19]	Rat	Sprague-Dawley rats	16	F	6	N/A	Acute	Permanent LAD ligation	DI	1 hour after MI	Border/Infarct zone	BM-MSC	$8.00x10^6$	3	Sprague-Dawley rats	Syngeneic	PBS
Flynn *et al.* 2012[20]	Rat	Sprague-Dawley rats	12	F	N/A	200g	Acute	Permanent LCA ligation	DI	24 hours after MI	Border zone	BM-MSC	$5.00x10^6$	4	Sprague-Dawley rats	Syngeneic	F12 medium
Wang *et al.* 2012[21]	Rat	Sprague-Dawley rats	21	M	N/A	350-450g	Acute	Permanent LAD ligation	DI	10 mins after MI	Border/Infarct zone	BM-MSC	$5.00x10^6$	3	N/A	N/A	PBS
Wang *et al.* 2009[22]	Rat	Sprague-Dawley rats	25	M	N/A	275-300g	Acute	Permanent LAD ligation	DI	1 week after MI	Infarct zone	BM-MSC	$1.00x10^7$	3	16w±2 F Mice	Xenogeneic	PBS
Herrmann *et al.* 2011[23]	Rat	Sprague-Dawley rats	20	M	8-9	250-275g	Acute	Permanent LCA ligation	DI	30 mins after MI	Border zone	BM-MSC	$1.00x10^6$	3	M C57BL/6J mice	Xenogeneic	PBS
Rasmussen *et al.* 2014[24]	Rat	Sprague-Dawley rats	16	M	20	450-550g	Acute	Permanent LAD ligation	DI	1 week after MI	Border zone	BM-MSC	$1.00x10^6$	2	84y M Human	Xenogeneic	PBS
*Hu *et al.* 2007[25]	Rat	Sprague-Dawley rats	30	M	8	N/A	Acute	Permanent LAD ligation	DI	1 week after MI	Border/Infarct zone	BM-MSC	$2.00x10^6$	N/A	M Sprague-Dawley rats	Syngeneic	PBS
Dai *et al.* 2007[26]	Rat	Fischer CDF rats	21	F	N/A	N/A	Acute	Permanent LAD ligation	DI	1 week after MI	Infarct zone	BM-MSC	$2.00x10^6$	N/A	ACI rats	Allogeneic	PBS
Mykhaylichenko *et al.* 2016[27]	Rat	Wistar rats	60	F	N/A	280±20g	Acute	Permanent LAD ligation	IV	1 day after MI	Femoral vein	BM-MSC	$5.00x10^6$	3-5	6-8w M Wistar Rats	Syngeneic	N/A
Armiñán *et al.* 2010[28]	Rat	Nude rats	29	N/A	N/A	200-250g	Acute	Permanent LCA ligation	DI	7 days after MI	Border zone	BM-MSC	$1.20x10^6$	N/A	Human	Xenogeneic	Saline
Shujia *et al.* 2007[29]	Rat	Fischer-344 rats	20	F	N/A	180-200g	Acute	Permanent LAD ligation	DI	Immediately after MI	Free wall of left ventricle	BM-MSC	$3.00x10^6$	3-4	12-16w M Fischer Rats	Syngeneic	DMEM
^Jiang *et al.* 2006[30]	Rat	Sprague-Dawley rats	24	F	N/A	200-250g	Acute	Permanent LCA ligation	IV	3 hours after MI	Tail vein	BM-MSC	$1.00x10^7$	N/A	4w M Sprague-Dawley rats	Syngeneic	DMEM-LG
Guarita-Souza *et al.* 2006[31]	Rat	Wistar rats	34	M	N/A	N/A	Acute	Permanent LCA ligation	DI	1 week after MI	Random area of ventricular wall	BM-MSC	$2.50x10^6$	N/A	Wistar rats	Syngeneic	Medium
**Amado *et al.* 2005[32]	Swine	Yorkshire swine	12	F	N/A	N/A	Acute	60 min LAD balloon occlusion followed by reperfusion	TESI	3 days after MI	Damaged myocardium	BM-MSC	$2.00x10^8$	3	M Durok-Landrace swine	Allogeneic	Plasmalyte

Price *et al.* 2006[33]	Swine	Farm swine	15	N/A	N/A	20±9.5 kg	Acute	60 min LAD balloon occlusion followed by reperfusion	IV	30 mins after MI	Internal jugular vein	BM-MSC	$3.20x10^8$	N/A	Swine	Allogeneic	N/A
Schuleri *et al.* 2008[34]	Swine	Yorkshire swine	16	F	N/A	N/A	Acute	60 min LAD balloon occlusion followed by reperfusion	TESI	2 days after MI	Border/Infarct zone	BM-MSC	$2.00x10^8$	3	M Durok-Landrace swine	Allogeneic	Plasma lyte
Hatzistergos *et al.* 2010[35]	Swine	Yorkshire swine	6	F	N/A	25-35kg	Acute	60 min LAD balloon occlusion followed by reperfusion	TESI	3 days after MI	Border/Infarct zone	BM-MSC	$1.00x10^8$	5	M swine	Allogeneic	Plasma lyte
Zhao *et al.* 2014[36]	Swine	Mini-swine	20	N/A	N/A	25-30kg	Acute	LAD ligation following 3 intermittent 5 min occlusions	DI	Immediately after MI	Infarct zone	BM-MSC	$1.00x10^7$	3-5	Mini-swine	Autologous	N/A
Fan *et al.* 2014[37]	Swine	Mini-swine	12	M	8	16-18kg	Acute	LAD double ligation	DI	30 mins after MI	Infarct zone	BM-MSC	$3.00x10^7$	N/A	Mini-swine	Autologous	DMEM/ Culture medium
*Halkos *et al.* 2008[38]	Swine	Yorkshire swine	33	M/F	N/A	25-35kg	Acute	75 min LAD balloon occlusion followed by reperfusion	IV	15 mins after reperfusion	IV	BM-MSC	$1.00x10^7$	N/A	Yorkshire swine	Syngeneic	Plasma lyte
Yang *et al.* 2008[39]	Swine	Chinese Mini-swine	25	N/A	40	30±5kg	Acute	90 min LAD occlusion followed by reperfusion	DI	30 mins after reperfusion	Border/Infarct zone	BM-MSC	$3.00x10^7$	N/A	Chinese Mini-swine	Autologous	DMEM
*Hashemi *et al.* 2008[40]	Swine	Yorkshire swine	31	F	8	27-32kg	Acute	60 min LAD balloon occlusion followed by reperfusion	TESI	3 days after MI	Border/Infarct zone	BM-MSC	$2.40x10^7$, $2.40x10^8$, $4.40x10^8$	3	Swine	Allogeneic	Plasma lyte
Dubois *et al.* 2010[41]	Swine	Swine	14	N/A	N/A	20-30kg	Acute	90 min LCX occlusion followed by reperfusion	IC	1 week after MI	LCX	BM-MSC	$1.10x10^6$	N/A	Swine	Allogeneic	Medium
Song *et al.* 2013[42]	Swine	Chinese Mini-swine	14	N/A	40	25±5kg	Acute	90 min LAD occlusion followed by reperfusion	DI	30 mins after reperfusion	Border/Infarct zone	BM-MSC	$3.00x10^7$	4-5	Chinese Mini-swine	Autologous	DMEM -LG
Lim *et al.* 2006[43]	Swine	Swine	24	F	N/A	25-35kg	Acute	60 min LAD balloon occlusion followed by reperfusion	IC	3 days after MI	LAD	BM-MSC	$5.00x10^7$	N/A	Swine	Allogeneic	N/A

Feygin *et al.* 2007[44]	Swine	Yorkshire swine	12	F	6	10kg	Acute	Permanent ligation of LAD 1st and 2nd diagonals	DI	1 hour after MI	Border zone	BM-MSC	$5.00x10^6$	N/A	Swine	Autologous	PBS
Krause *et al.* 2007[45]	Swine	Farm swine	16	N/A	N/A	20kg	Acute	Permanent LAD ligation	IV	2 days after MI	Ear vein	BM-MSC	$2.00x10^7$	N/A	Farm swine	Autologous	PBS
Qi *et al.* 2008[46]	Swine	Swine	13	M	N/A	30-35kg	Acute	60 min LAD occlusion following 3 intermittent 5 min occlusions	IC	3-7 days after MI	LAD	BM-MSC	$1.00x10^7$	2-3	Swine	N/A	PBS
Lu *et al.* 2012[47]	Swine	Chinese Mini-swine	11	N/A	40	27±3kg	Acute	90 min LAD occlusion followed by reperfusion	IC	1 week after MI	LAD	BM-MSC	$3.00x10^7$	4-5	Swine	Autologous	PBS
Zhang et al. 2007[48]	Swine	Chinese Mini-swine	12	F	12	25-35kg	Acute	90 min LAD occlusion followed by reperfusion	DI	1 week after MI	Border zone	BM-MSC	$1.00x10^8$	4-5	M Chinese Mini-swine	Syngeneic	PBS
Chen *et al.* 2014[49]	Swine	Taihu Meishan swine	15	N/A	12	24.5±2.9kg	Acute & Chronic	LAD second diagonal embolus	IC	3 hours after MI/4 weeks after MI	LCA	BM-MSC	$1.00x10^7$	N/A	Taihu Meishan swine	Autologous	DMEM
Quevedo *et al.* 2009[50]	Swine	Gottingen Mini-swine	10	F	N/A	20-27kg	Chronic	150 min LAD occlusion followed by reperfusion	TESI	12 wks	Border/Infarct zone	BM-MSC	$2.00x10^8$	3	M Landrace swine	Allogeneic	N/A
Williams *et al.* 2013[51]	Swine	Gottingen Mini-swine	12	F	N/A	23-28kg	Chronic	150 min LAD occlusion followed by reperfusion	TESI	12 wks	Border zone	BM-MSC	$2.00x10^8$	N/A	M swine	Allogeneic	N/A
Schuleri *et al.* 2011[52]	Swine	Gottingen Mini-swine	22	F	N/A	N/A	Chronic	120-150 min LAD occlusion followed by reperfusion	DI	12 wks	Border/Infarct zone	BM-MSC	$2.00x10^8$	N/A	Gottingen Mini-swine	Autologous	PBS
Karantalis *et al.* 2015[53]	Swine	Gottingen Mini-swine	12	F	40-56	N/A	Chronic	150 min LAD occlusion followed by reperfusion	TESI	12 wks	Border/Infarct zone	BM-MSC	$2.00x10^8$	N/A	Gottingen Mini-swine	Autologous	Plasma lyte
van der Spoel *et al.* 2015[54]	Swine	Dutch Landrace swine	11	F	N/A	N/A	Chronic	75 min LCX occlusion followed by reperfusion	TESI	4 wks	Border/Infarct zone	BM-MSC	$1.00x10^7$	5-7	Dutch Landrace swine	Autologous	PBS

Huang *et al.* 2006[55]	Swine	Yorkshire swine	20	N/A	N/A	20-25kg	Chronic	Permanent LCX occlusion	DI	4 wks	Infarct zone	BM-MSC	$1.00x10^6$	N/A	Yorkshire swine	Autologous	N/A
*Schuleri *et al.* 2009[56]	Swine	Gottingen Mini-swine	15	F	52-61	31.6±1.4kg	Chronic	120 min LAD occlusion followed by reperfusion	DI	16 wks	Border/Infarct zone	BM-MSC	$2.00x10^7$, $2.00x10^8$	4-7	Gottingen Mini-swine	Autologous	PBS
Yu *et al.* 2010[57]	Swine	Meishan swine	12	N/A	N/A	N/A	Chronic	LAD second diagonal embolus	IC	4 wks	LCA	BM-MSC	$1.00x10^7$	N/A	Meishan swine	Autologous	DMEM
Yang *et al.* 2006[58]	Swine	Swine	12	M	12	30±5kg	Chronic	Permanent LAD ligation	IC	4 wks	Non-infarct relative artery	BM-MSC	$5.00x10^6$	N/A	12w M Swine	Autologous	IMDM

*Denotes study with multiple treatment groups, means were averaged. **Denotes study that included a baseline value with no significant change. ^Denotes studies that share the same first author and year.
Abbreviations: DI – intramyocardial injection, TESI – transendocardial stem cell injection, IV – intravenous infusion, IC – intracoronary infusion, LAD – left anterior descending artery, LCA – left coronary artery, LCX – left circumflex artery, NOD/SCID – non-obese diabetic/severe combined immunodeficiency, BM-MSC – bone marrow-derived mesenchymal stem cells, PBS – phosphate-buffered saline, DMEM-LG – Dulbecco's Modified Eagle Medium-low glucose, IMDM – Iscove's Modified Dulbecco's Medium, N/A – not available.

Online Table II. Study characteristics for AMI clinical trials

	Rodrigo et al. 2013[59]		Chen et al. 2004[60]		Gao et al. 2013[61]		Lee et al. 2014[62]		Wang et al. 2014[63]		Hare et al. 2009[64]	
	Control	MSC	Control	MSC	Control	MSC	Control	MSC	Control	MSC	Control	MSC
Number of patients (n)	45	9	35	34	22	21	28	30	30	28	19	34
Age (years)	61±11	56±8	57±5	58±7	58.6±2.5	55.0±1.6	54.2±7.7	52.9±10.5	56.1±9.8	58.0±10.2	55.1±10.2	59.0±12.3
Male	35 (78%)	7 (78%)	34 (97%)	32 (94%)	19 (86%)	21 (100%)	25 (89%)	27 (90%)	16 (53%)	19 (68%)	15 (79%)	28 (82%)
Female	10 (22%)	2 (22%)	1 (3%)	2 (6%)	3 (14%)	0 (0%)	3 (11%)	3 (10%)	14 (47%)	9 (32%)	4 (21%)	6 (18%)
Cardiovascular risk factors												
Smoking	19 (42%)	6 (67%)	N/A	N/A	6 (27.3%)	8 (38.1%)	20 (71.4%)	19 (63.3%)	N/A	N/A	4 (21.1%)	4 (11.8%)
Hypertension	18 (40%)	4 (44%)	N/A	N/A	11 (50%)	13 (61.9%)	12 (42.9%)	14 (46.7%)	6 (20%)	8 (29%)	9 (47.4%)	16 (47.1%)
Diabetes Mellitus	5 (11%)	1 (11%)	N/A	N/A	5 (22.7%)	6 (28.6%)	8 (28.6%)	5 (16.7%)	N/A	N/A	1 (5.3%)	6 (17.6%)
Dyslipidemia	9 (20%)	2 (22%)	N/A	N/A	7 (31.8%)	6 (28.6%)	N/A	N/A	N/A	N/A	N/A	N/A
Family history of coronary artery disease	18 (40%)	4 (44%)	N/A	N/A	9 (40.9%)	9 (42.9%)	N/A	N/A	N/A	N/A	N/A	N/A
BMI (kg/m^2)	N/A	N/A	N/A	N/A	24.9±0.7	25.6±0.7	24.9±2.8	25.7±2.6	N/A	N/A	30.3±4.3	29.8±6.7
Laboratory findings												
Peak Troponin T level (μg/L)	10.1±5.6	9.1±6.2	N/A	N/A	10.8±2.4	13.2±2.9	N/A	N/A	N/A	N/A	N/A	N/A
Peak CK-MB level (μ/L)	4859±3677	3242±1277	92±49	98±54	1934±269	2201±324	N/A	N/A	N/A	N/A	457	429.1
Peak Creatine kinase level (U/L)	75±12	85±30	N/A	N/A	157±17	188±27	N/A	N/A	124±92	116±82	N/A	N/A
Coronary angiography findings												
Infarct-related coronary artery (LAD/LCX/RCA)	25 (56%) 5 (11%) 15 (33%)	5 (56%) 1 (11%) 3 (33%)	21 (60%) 7 (20%) 7 (20%)	20 (59%) 6 (18%) 8 (23%)	12 (54%) 2 (9%) 8 (36%)	14 (67%) 1 (5%) 6 (28%)	18 (64%) 2 (7%) 8 (29%)	22 (73%) 2 (7%) 6 (20%)	14 (46%) 8 (27%) 8 (27%)	15 (54%) 7 (25%) 6 (21%)	11 (58%) 1 (5%) 6 (32%)	15 (44%) 2 (6%) 13 (38%)
Number of diseased coronary arteries	N/A	N/A	1.7±0.4	1.6±0.5	N/A	N/A	N/A	N/A	1.67±0.79	1.71±0.81	N/A	N/A
Onset of infarction before PCI (hours)	N/A	N/A	8.5±3.9	8.3±3.8	7.2±0.8	7.0±0.9	4.36±2.22	4.66±4.23	12±10	10±9	11.7±14.2	9.8±10.4

Onset of infarction to injection (hours)	N/A	N/A	N/A	N/A	N/A	N/A	1.92± 0.59	5.65±5.42	N/A	N/A	N/A	N/A
Time interval between PCI to injection (days)	N/A	21±3	18.2±0.3	18.4±0.5	N/A	17.1±0.6	N/A	25.0±2.4	15±0.8	15±1	N/A	N/A
Stents deployed (n)	N/A	N/A	38	36	22	21	30	28	30	27	N/A	N/A
MSC characteristics												
BM-MSC source (autologous vs. allogeneic)	N/A	Autologous	N/A	Autologous	N/A	Autologous	N/A	Autologous	N/A	Autologous	N/A	Allogeneic
BM collected	N/A	7d after MI	N/A	8d after PCI	N/A	2-3d after PCI	N/A	3.8±1.5d after admission	N/A	8d after PCI	N/A	N/A
MSC cultured (days)	N/A	18.6±3.5	N/A	10 days	N/A	14.6±0.7	N/A	N/A	N/A	14	N/A	N/A
Passage	N/A	N/A	N/A	N/A	N/A	2	N/A	4.4±0.5	N/A	N/A	N/A	N/A
Viability of cells (%)	N/A	93±5	N/A	N/A	N/A	91.4±5.7	N/A	>80	N/A	N/A	N/A	>70
No. of BM-MSCs injected	N/A	$3.1±0.2x10^7$	N/A	$4.8-6x10^{10}$	N/A	$3.08±0.52x10^6$	N/A	$7.2±0.9x10^7$	N/A	$2x10^8$	N/A	0.5, 1.6, and $5x10^6$/kg
Route of Delivery	TESI	TESI	IC	IC	IC	IC	IC	IC	IC	IC	IV	IV
Medications at discharge												
Aspirin	42 (93%)	6 (67%)	N/A	N/A	22 (100%)	21 (100%)	28 (100%)	30 (100%)	N/A	N/A	N/A	N/A
Clopidogrel	43 (100%)	9 (100%)	N/A	N/A	22 (100%)	21 (100%)	28 (100%)	30 (100%)	N/A	N/A	N/A	N/A
Oral anticoagulant	1 (2%)	3 (33%)	N/A	N/A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A	N/A	N/A	N/A
ACEI or ARB	43 (100%)	9 (100%)	N/A	N/A	22 (100%)	20 (95.2%)	26 (92.9%)	27 (90%)	N/A	N/A	N/A	N/A
Statin	43 (100%)	9 (100%)	N/A	N/A	22 (100%)	21 (100%)	25 (89.3%)	27 (90%)	N/A	N/A	N/A	N/A
Beta blocker	43 (100%)	9 (100%)	N/A	N/A	19 (86.4%)	17 (81.0%)	26 (92.9%)	28 (93.3%)	N/A	N/A	N/A	N/A

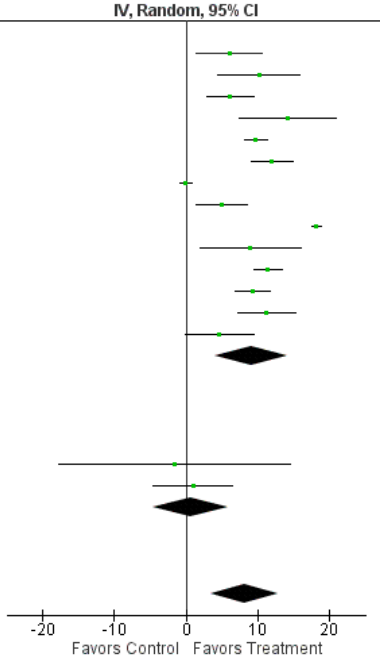
Abbreviations: BM-MSC – bone marrow-derived mesenchymal stem cells, DI – intramyocardial injection, TESI – transendocardial stem cell injection, IV – intravenous infusion, IC – intracoronary infusion, BMI – body mass index, LAD – left anterior descending artery, LCA – left coronary artery, LCX – left circumflex artery, PCI – percutaneous coronary intervention, N/A – not available.

Online Table III. Advantages and Disadvantages of Stem Cell Route of Delivery

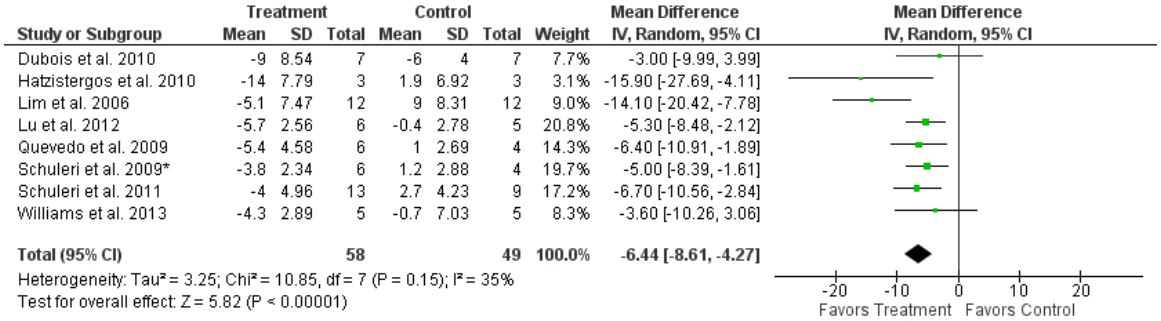
Route of Delivery	Advantages	Disadvantages
TESI	Precise Minimally invasive	Small risk of perforation and arrhythmias
DI	Precise	Most invasive High risk of complications
IV	Most convenient Least invasive	Low level of engraftment
IC	Relatively precise Minimally invasive	Limited cell delivery if poor perfusion

Abbreviations: MSCs – mesenchymal stem cells, DI – intramyocardial injection, TESI – transendocardial stem cell injection, IV – intravenous infusion, and IC – intracoronary infusion.

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Rat								
Armiñán et al. 2010	32.07	5.72	14	26	6.82	15	6.3%	6.07 [1.50, 10.64]
Buccini et al. 2012	19.8	7.41	7	9.6	2.12	7	6.1%	10.20 [4.49, 15.91]
Gao et al. 2010	28.1	2.83	8	21.9	3.96	8	6.5%	6.20 [2.83, 9.57]
Herrmann et al. 2011	37.81	9	9	23.63	5.64	11	5.9%	14.18 [7.42, 20.94]
Hu et al. 2007	21.63	1.54	10	11.86	2.1	10	6.7%	9.77 [8.16, 11.38]
Jiang et al. 2008*	26.19	3.45	8	14.2	2.35	8	6.6%	11.99 [9.10, 14.88]
Li et al. 2011*	17.98	0.71	6	18.02	0.72	6	6.7%	-0.04 [-0.85, 0.77]
Lian et al. 2011	30.3	4.5	20	25.3	6.1	16	6.5%	5.00 [1.42, 8.58]
Mykhaylichenko et al. 2016	45	0.9	15	26.8	0.8	15	6.7%	18.20 [17.59, 18.81]
Nagaya et al. 2004	29	10.39	12	20	6.63	11	5.9%	9.00 [1.94, 16.06]
Shyu et al. 2006	44.4	2.3	7	32.9	1.4	7	6.7%	11.50 [9.51, 13.49]
Tsubokawa et al. 2010	29.2	5.39	24	19.9	2.45	23	6.6%	9.30 [6.92, 11.68]
Wang et al. 2009	31.51	6.03	12	20.22	4	13	6.4%	11.29 [7.24, 15.34]
Zeng et al. 2008	24.56	5.38	8	19.88	4.27	8	6.3%	4.68 [-0.08, 9.44]
Subtotal (95% CI)			**160**			**158**	**90.0%**	**9.08 [4.05, 14.11]**
Heterogeneity: Tau² = 88.12; Chi² = 1287.16, df = 13 (P < 0.00001); I² = 99%								
Test for overall effect: Z = 3.54 (P = 0.0004)								
Swine								
Lu et al. 2012	35.9	10.8	6	37.5	15.7	5	3.8%	-1.60 [-17.85, 14.65]
van der Spoel et al. 2015	51	4	4	50	4.47	5	6.2%	1.00 [-4.54, 6.54]
Subtotal (95% CI)			**10**			**10**	**10.0%**	**0.73 [-4.52, 5.97]**
Heterogeneity: Tau² = 0.00; Chi² = 0.09, df = 1 (P = 0.77); I² = 0%								
Test for overall effect: Z = 0.27 (P = 0.79)								
Total (95% CI)			**170**			**168**	**100.0%**	**8.18 [3.41, 12.95]**
Heterogeneity: Tau² = 87.90; Chi² = 1302.20, df = 15 (P < 0.00001); I² = 99%								
Test for overall effect: Z = 3.36 (P = 0.0008)								
Test for subgroup differences: Chi² = 5.07, df = 1 (P = 0.02), I² = 80.3%								

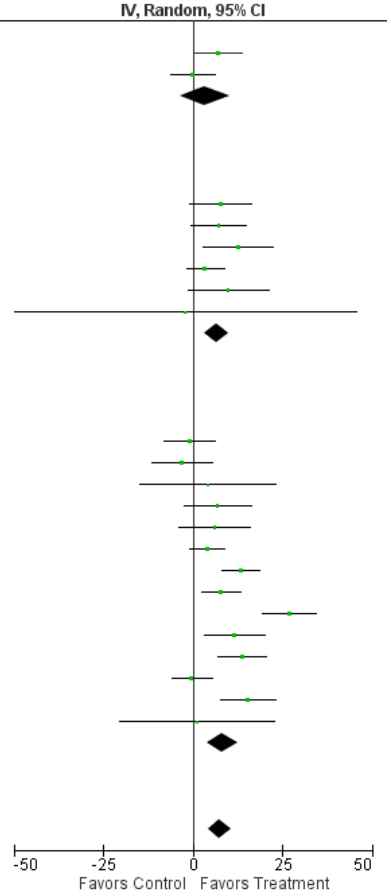


Online Figure I. Forest plot analysis of studies examining fractional shortening (FS; %) grouped by animal model. Result: Favors MSC treatment. Mean effect ± standard deviation (SD) of mesenchymal stem cells (Treatment) or placebo/no treatment (Control) on the improvement of FS (%) for rat and swine studies. Number of animals in each arm of the study (Total). Relative weight of each study (Weight). Mean difference between Treatment and Control with a 95% confidence interval (95% CI), using inverse variance (IV) and random effects model (Random).



Online Figure II. Forest plot analysis of swine studies examining change in infarct size (ΔIS; % of left ventricle [LV]). Result: Favors MSC treatment. Mean effect ± standard deviation (SD) of mesenchymal stem cells (Treatment) or placebo/no treatment (Control) on the reduction of ΔIS (% of LV) for swine studies. Number of animals in each arm of the study (Total). Relative weight of each study (Weight). Mean difference between Treatment and Control with a 95% confidence interval (95% CI), using inverse variance (IV) and random effects model (Random).

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Mouse								
Grauss et al. 2008	-8	9.49	10	-15	6	12	5.3%	7.00 [0.21, 13.79]
Nakamura et al. 2007	0	5.29	4	0	4.25	6	5.6%	0.00 [-6.20, 6.20]
Subtotal (95% CI)			**14**			**18**	**10.9%**	**3.36 [-3.50, 10.21]**
Heterogeneity: Tau² = 13.49; Chi² = 2.23, df = 1 (P = 0.14); I² = 55%								
Test for overall effect: Z = 0.96 (P = 0.34)								
Rat								
Afzal et al. 2010	1	8.01	6	-6.7	7.03	6	4.6%	7.70 [-0.83, 16.23]
Dai et al. 2005	-3.8	11.66	10	-11	3.79	10	5.0%	7.20 [-0.40, 14.80]
Gao et al. 2010	6.8	8.63	8	-5.8	10.91	8	4.2%	12.60 [2.96, 22.24]
Guarita-Souza et al. 2006	-1.07	8.3	13	-4.53	6.48	21	5.9%	3.46 [-1.84, 8.76]
Herrmann et al. 2011	0.3	14.24	9	-9.64	10.54	11	3.6%	9.94 [-1.26, 21.14]
Rasmussen et al. 2014	-4.5	55.02	9	-2.3	42.41	7	0.4%	-2.20 [-49.94, 45.54]
Subtotal (95% CI)			**55**			**63**	**23.8%**	**6.61 [3.20, 10.02]**
Heterogeneity: Tau² = 0.00; Chi² = 3.40, df = 5 (P = 0.64); I² = 0%								
Test for overall effect: Z = 3.80 (P = 0.0001)								
Swine								
Dubois et al. 2010	1	6.24	7	2	7.55	7	5.1%	-1.00 [-8.26, 6.26]
Hashemi et al. 2008*	-4.08	6.77	24	-1.05	11.05	7	4.6%	-3.03 [-11.65, 5.59]
Hatzistergos et al. 2010	8.5	15.12	3	4.4	7.27	3	1.9%	4.10 [-14.88, 23.08]
Lim et al. 2006	0.6	6.4	12	-6.3	15.1	12	4.3%	6.90 [-2.38, 16.18]
Lu et al. 2012	7.4	9.08	6	1.3	7.75	5	4.1%	6.10 [-3.85, 16.05]
Price et al. 2006	-8	3.3	7	-12	6.1	8	6.1%	4.00 [-0.88, 8.88]
Schuleri et al. 2008	8.9	7.56	10	-4.5	3.18	6	5.9%	13.40 [8.07, 18.73]
Schuleri et al. 2011	3.6	8.43	13	-4.2	4.36	9	5.9%	7.80 [2.40, 13.20]
van der Spoel et al. 2015	17	5.4	4	-10	6.01	5	5.0%	27.00 [19.53, 34.47]
Williams et al. 2013	9.3	7.34	5	-2.38	6.18	5	4.7%	11.68 [3.27, 20.09]
Yang et al. 2006	11.8	5.94	6	-1.9	5.83	6	5.4%	13.70 [7.04, 20.36]
Yang et al. 2008	-2.2	4.9	6	-1.9	5	6	5.8%	-0.30 [-5.90, 5.30]
Yu et al. 2010	17.13	7.41	6	1.7	6.06	6	5.0%	15.43 [7.77, 23.09]
Zhang et al. 2007	2.2	19.73	6	1	18.52	6	1.5%	1.20 [-20.45, 22.85]
Subtotal (95% CI)			**115**			**91**	**65.3%**	**8.12 [3.78, 12.47]**
Heterogeneity: Tau² = 49.36; Chi² = 59.92, df = 13 (P < 0.00001); I² = 78%								
Test for overall effect: Z = 3.66 (P = 0.0002)								
Total (95% CI)			**184**			**172**	**100.0%**	**7.52 [4.48, 10.55]**
Heterogeneity: Tau² = 32.99; Chi² = 69.43, df = 21 (P < 0.00001); I² = 70%								
Test for overall effect: Z = 4.86 (P < 0.00001)								
Test for subgroup differences: Chi² = 1.33, df = 2 (P = 0.51), I² = 0%								



Online Figure III. Forest plot analysis of studies examining change in left ventricular ejection fraction (ΔLVEF; %) grouped by animal model. Result: Favors MSC treatment. Mean effect ± standard deviation (SD) of mesenchymal stem cells (Treatment) or placebo/no treatment (Control) on the improvement of ΔLVEF (%) for mouse, rat, and swine studies. Number of animals in each arm of the study (Total). Relative weight of each study (Weight). Mean difference between Treatment and Control with a 95% confidence interval (95% CI), using inverse variance (IV) and random effects model (Random).

References

1. Nakamura Y, Wang X, Xu C, Asakura A, Yoshiyama M, From AH, Zhang J. Xenotransplantation of long-term-cultured swine bone marrow-derived mesenchymal stem cells. *Stem cells*. 2007;25:612-620
2. Grauss RW, van Tuyn J, Steendijk P, Winter EM, Pijnappels DA, Hogers B, Gittenberger-De Groot AC, van der Geest R, van der Laarse A, de Vries AA, Schalij MJ, Atsma DE. Forced myocardin expression enhances the therapeutic effect of human mesenchymal stem cells after transplantation in ischemic mouse hearts. *Stem cells*. 2008;26:1083-1093
3. Shyu KG, Wang BW, Hung HF, Chang CC, Shih DT. Mesenchymal stem cells are superior to angiogenic growth factor genes for improving myocardial performance in the mouse model of acute myocardial infarction. *Journal of biomedical science*. 2006;13:47-58
4. Buccini S, Haider KH, Ahmed RP, Jiang S, Ashraf M. Cardiac progenitors derived from reprogrammed mesenchymal stem cells contribute to angiomyogenic repair of the infarcted heart. *Basic research in cardiology*. 2012;107:301
5. Li TS, Cheng K, Malliaras K, Smith RR, Zhang Y, Sun B, Matsushita N, Blusztajn A, Terrovitis J, Kusuoka H, Marban L, Marban E. Direct comparison of different stem cell types and subpopulations reveals superior paracrine potency and myocardial repair efficacy with cardiosphere-derived cells. *Journal of the American College of Cardiology*. 2012;59:942-953
6. Lian WS, Cheng WT, Cheng CC, Hsiao FS, Chen JJ, Cheng CF, Wu SC. In vivo therapy of myocardial infarction with mesenchymal stem cells modified with prostaglandin i synthase gene improves cardiac performance in mice. *Life sciences*. 2011;88:455-464
7. Yao Y, Huang J, Geng Y, Qian H, Wang F, Liu X, Shang M, Nie S, Liu N, Du X, Dong J, Ma C. Paracrine action of mesenchymal stem cells revealed by single cell gene profiling in infarcted murine hearts. *PloS one*. 2015;10:e0129164
8. Nagaya N, Fujii T, Iwase T, Ohgushi H, Itoh T, Uematsu M, Yamagishi M, Mori H, Kangawa K, Kitamura S. Intravenous administration of mesenchymal stem cells improves cardiac function in rats with acute myocardial infarction through angiogenesis and myogenesis. *American journal of physiology. Heart and circulatory physiology*. 2004;287:H2670-2676
9. Dai W, Hale SL, Martin BJ, Kuang JQ, Dow JS, Wold LE, Kloner RA. Allogeneic mesenchymal stem cell transplantation in postinfarcted rat myocardium: Short- and long-term effects. *Circulation*. 2005;112:214-223
10. Li Z, Guo J, Chang Q, Zhang A. Paracrine role for mesenchymal stem cells in acute myocardial infarction. *Biological & pharmaceutical bulletin*. 2009;32:1343-1346
11. Li Y, Yao Y, Sheng Z, Yang Y, Ma G. Dual-modal tracking of transplanted mesenchymal stem cells after myocardial infarction. *International journal of nanomedicine*. 2011;6:815-823

12. Khan M, Meduru S, Mohan IK, Kuppusamy ML, Wisel S, Kulkarni A, Rivera BK, Hamlin RL, Kuppusamy P. Hyperbaric oxygenation enhances transplanted cell graft and functional recovery in the infarct heart. *Journal of molecular and cellular cardiology*. 2009;47:275-287
13. Jiang S, Haider H, Idris NM, Salim A, Ashraf M. Supportive interaction between cell survival signaling and angiocompetent factors enhances donor cell survival and promotes angiomyogenesis for cardiac repair. *Circulation research*. 2006;99:776-784
14. Tsubokawa T, Yagi K, Nakanishi C, Zuka M, Nohara A, Ino H, Fujino N, Konno T, Kawashiri MA, Ishibashi-Ueda H, Nagaya N, Yamagishi M. Impact of anti-apoptotic and anti-oxidative effects of bone marrow mesenchymal stem cells with transient overexpression of heme oxygenase-1 on myocardial ischemia. *American journal of physiology. Heart and circulatory physiology*. 2010;298:H1320-1329
15. Jiang S, Kh Haider H, Ahmed RP, Idris NM, Salim A, Ashraf M. Transcriptional profiling of young and old mesenchymal stem cells in response to oxygen deprivation and reparability of the infarcted myocardium. *Journal of molecular and cellular cardiology*. 2008;44:582-596
16. Furlani D, Li W, Pittermann E, Klopsch C, Wang L, Knopp A, Jungebluth P, Thedinga E, Havenstein C, Westien I, Ugurlucan M, Li RK, Ma N, Steinhoff G. A transformed cell population derived from cultured mesenchymal stem cells has no functional effect after transplantation into the injured heart. *Cell transplantation*. 2009;18:319-331
17. Afzal MR, Haider H, Idris NM, Jiang S, Ahmed RP, Ashraf M. Preconditioning promotes survival and angiomyogenic potential of mesenchymal stem cells in the infarcted heart via nf-kappab signaling. *Antioxidants & redox signaling*. 2010;12:693-702
18. Zeng B, Chen H, Zhu C, Ren X, Lin G, Cao F. Effects of combined mesenchymal stem cells and heme oxygenase-1 therapy on cardiac performance. *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery*. 2008;34:850-856
19. Gao LR, Zhang NK, Bai J, Ding QA, Wang ZG, Zhu ZM, Fei YX, Yang Y, Xu RY, Chen Y. The apelin-apj pathway exists in cardiomyogenic cells derived from mesenchymal stem cells in vitro and in vivo. *Cell transplantation*. 2010;19:949-958
20. Flynn A, Chen X, O'Connell E, O'Brien T. A comparison of the efficacy of transplantation of bone marrow-derived mesenchymal stem cells and unrestricted somatic stem cells on outcome after acute myocardial infarction. *Stem cell research & therapy*. 2012;3:36
21. Wang T, Sun S, Wan Z, Weil MH, Tang W. Effects of bone marrow mesenchymal stem cells in a rat model of myocardial infarction. *Resuscitation*. 2012;83:1391-1396
22. Wang M, Tan J, Wang Y, Meldrum KK, Dinarello CA, Meldrum DR. Il-18 binding protein-expressing mesenchymal stem cells improve myocardial protection after ischemia or infarction. *Proceedings of the National*

Academy of Sciences of the United States of America. 2009;106:17499-17504

23. Herrmann JL, Abarbanell AM, Wang Y, Weil BR, Poynter JA, Manukyan MC, Meldrum DR. Transforming growth factor-alpha enhances stem cell-mediated postischemic myocardial protection. *The Annals of thoracic surgery*. 2011;92:1719-1725
24. Rasmussen JG, Frobert O, Holst-Hansen C, Kastrup J, Baandrup U, Zachar V, Fink T, Simonsen U. Comparison of human adipose-derived stem cells and bone marrow-derived stem cells in a myocardial infarction model. *Cell transplantation*. 2014;23:195-206
25. Hu X, Wang J, Chen J, Luo R, He A, Xie X, Li J. Optimal temporal delivery of bone marrow mesenchymal stem cells in rats with myocardial infarction. *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery*. 2007;31:438-443
26. Dai W, Hale SL, Kloner RA. Role of a paracrine action of mesenchymal stem cells in the improvement of left ventricular function after coronary artery occlusion in rats. *Regenerative medicine*. 2007;2:63-68
27. Mykhaylichenko VY, Kubyshkin AV, Samarin SA, Fomochkina, II, Anisimova LV. Experimental induction of reparative morphogenesis and adaptive reserves in the ischemic myocardium using multipotent mesenchymal bone marrow-derived stem cells. *Pathophysiology : the official journal of the International Society for Pathophysiology / ISP*. 2016;23:95-104
28. Arminan A, Gandia C, Garcia-Verdugo JM, Lledo E, Trigueros C, Ruiz-Sauri A, Minana MD, Solves P, Paya R, Montero JA, Sepulveda P. Mesenchymal stem cells provide better results than hematopoietic precursors for the treatment of myocardial infarction. *Journal of the American College of Cardiology*. 2010;55:2244-2253
29. Shujia J, Haider HK, Idris NM, Lu G, Ashraf M. Stable therapeutic effects of mesenchymal stem cell-based multiple gene delivery for cardiac repair. *Cardiovascular research*. 2008;77:525-533
30. Jiang W, Ma A, Wang T, Han K, Liu Y, Zhang Y, Zhao X, Dong A, Du Y, Huang X, Wang J, Lei X, Zheng X. Intravenous transplantation of mesenchymal stem cells improves cardiac performance after acute myocardial ischemia in female rats. *Transplant international : official journal of the European Society for Organ Transplantation*. 2006;19:570-580
31. Guarita-Souza LC, Carvalho KA, Simeone BR, Franscisco JC, Miyague N, Olandoski M. Functional outcome of bone marrow stem cells: Mononuclear versus mesenchymal stem cells after cellular therapy in myocardial scar in wistar rats. *Transplantation proceedings*. 2006;38:1953-1954
32. Amado LC, Saliaris AP, Schuleri KH, St John M, Xie JS, Cattaneo S, Durand DJ, Fitton T, Kuang JQ, Stewart G, Lehrke S, Baumgartner WW, Martin BJ, Heldman AW, Hare JM. Cardiac repair with intramyocardial injection of allogeneic mesenchymal stem cells after myocardial infarction.

Proceedings of the National Academy of Sciences of the United States of America. 2005;102:11474-11479

33. Price MJ, Chou CC, Frantzen M, Miyamoto T, Kar S, Lee S, Shah PK, Martin BJ, Lill M, Forrester JS, Chen PS, Makkar RR. Intravenous mesenchymal stem cell therapy early after reperfused acute myocardial infarction improves left ventricular function and alters electrophysiologic properties. *Int J Cardiol*. 2006;111:231-239
34. Schuleri KH, Amado LC, Boyle AJ, Centola M, Saliaris AP, Gutman MR, Hatzistergos KE, Oskouei BN, Zimmet JM, Young RG, Heldman AW, Lardo AC, Hare JM. Early improvement in cardiac tissue perfusion due to mesenchymal stem cells. *American journal of physiology. Heart and circulatory physiology*. 2008;294:H2002-2011
35. Hatzistergos KE, Quevedo H, Oskouei BN, Hu Q, Feigenbaum GS, Margitich IS, Mazhari R, Boyle AJ, Zambrano JP, Rodriguez JE, Dulce R, Pattany PM, Valdes D, Revilla C, Heldman AW, McNiece I, Hare JM. Bone marrow mesenchymal stem cells stimulate cardiac stem cell proliferation and differentiation. *Circulation research*. 2010;107:913-922
36. Zhao JJ, Liu XC, Kong F, Qi TG, Cheng GH, Wang J, Sun C, Luan Y. Bone marrow mesenchymal stem cells improve myocardial function in a swine model of acute myocardial infarction. *Molecular medicine reports*. 2014;10:1448-1454
37. Fan CQ, Leu S, Sheu JJ, Zhen YY, Tsai TH, Chen YL, Chung SY, Chai HT, Sun CK, Yang JL, Chang HW, Ko SF, Yip HK. Prompt bone marrow-derived mesenchymal stem cell therapy enables early porcine heart function recovery from acute myocardial infarction. *International heart journal*. 2014;55:362-371
38. Halkos ME, Zhao ZQ, Kerendi F, Wang NP, Jiang R, Schmarkey LS, Martin BJ, Quyyumi AA, Few WL, Kin H, Guyton RA, Vinten-Johansen J. Intravenous infusion of mesenchymal stem cells enhances regional perfusion and improves ventricular function in a porcine model of myocardial infarction. *Basic research in cardiology*. 2008;103:525-536
39. Yang YJ, Qian HY, Huang J, Geng YJ, Gao RL, Dou KF, Yang GS, Li JJ, Shen R, He ZX, Lu MJ, Zhao SH. Atorvastatin treatment improves survival and effects of implanted mesenchymal stem cells in post-infarct swine hearts. *European heart journal*. 2008;29:1578-1590
40. Hashemi SM, Ghods S, Kolodgie FD, Parcham-Azad K, Keane M, Hamamdzic D, Young R, Rippy MK, Virmani R, Litt H, Wilensky RL. A placebo controlled, dose-ranging, safety study of allogenic mesenchymal stem cells injected by endomyocardial delivery after an acute myocardial infarction. *European heart journal*. 2008;29:251-259
41. Dubois C, Liu X, Claus P, Marsboom G, Pokreisz P, Vandenwijngaert S, Depelteau H, Streb W, Chaothawee L, Maes F, Gheysens O, Debyser Z, Gillijns H, Pellens M, Vandendriessche T, Chuah M, Collen D, Verbeken E, Belmans A, Van de Werf F, Bogaert J, Janssens S. Differential effects of progenitor cell populations on left ventricular remodeling and myocardial

neovascularization after myocardial infarction. *Journal of the American College of Cardiology*. 2010;55:2232-2243

42. Song L, Yang YJ, Dong QT, Qian HY, Gao RL, Qiao SB, Shen R, He ZX, Lu MJ, Zhao SH, Geng YJ, Gersh BJ. Atorvastatin enhance efficacy of mesenchymal stem cells treatment for swine myocardial infarction via activation of nitric oxide synthase. *PloS one*. 2013;8:e65702
43. Lim SY, Kim YS, Ahn Y, Jeong MH, Hong MH, Joo SY, Nam KI, Cho JG, Kang PM, Park JC. The effects of mesenchymal stem cells transduced with akt in a porcine myocardial infarction model. *Cardiovascular research*. 2006;70:530-542
44. Feygin J, Mansoor A, Eckman P, Swingen C, Zhang J. Functional and bioenergetic modulations in the infarct border zone following autologous mesenchymal stem cell transplantation. *American journal of physiology. Heart and circulatory physiology*. 2007;293:H1772-1780
45. Krause U, Harter C, Seckinger A, Wolf D, Reinhard A, Bea F, Dengler T, Hardt S, Ho A, Katus HA, Kuecherer H, Hansen A. Intravenous delivery of autologous mesenchymal stem cells limits infarct size and improves left ventricular function in the infarcted porcine heart. *Stem cells and development*. 2007;16:31-37
46. Qi CM, Ma GS, Liu NF, Shen CX, Chen Z, Liu XJ, Hu YP, Zhang XL, Teng GJ, Ju SH, Ma M, Tang YL. Transplantation of magnetically labeled mesenchymal stem cells improves cardiac function in a swine myocardial infarction model. *Chinese medical journal*. 2008;121:544-550
47. Lu M, Zhao S, Liu Q, Jiang S, Song P, Qian H, Zhang Y, Ling J, Yan C, Cheng H, Ma N, Zhao H, Liu Y. Transplantation with autologous mesenchymal stem cells after acute myocardial infarction evaluated by magnetic resonance imaging: An experimental study. *Journal of thoracic imaging*. 2012;27:125-135
48. Zhang H, Song P, Tang Y, Zhang XL, Zhao SH, Wei YJ, Hu SS. Injection of bone marrow mesenchymal stem cells in the borderline area of infarcted myocardium: Heart status and cell distribution. *The Journal of thoracic and cardiovascular surgery*. 2007;134:1234-1240
49. Chen Y, Teng X, Chen W, Yang J, Yang Z, Yu Y, Shen Z. Timing of transplantation of autologous bone marrow derived mesenchymal stem cells for treating myocardial infarction. *Science China. Life sciences*. 2014;57:195-200
50. Quevedo HC, Hatzistergos KE, Oskouei BN, Feigenbaum GS, Rodriguez JE, Valdes D, Pattany PM, Zambrano JP, Hu Q, McNiece I, Heldman AW, Hare JM. Allogeneic mesenchymal stem cells restore cardiac function in chronic ischemic cardiomyopathy via trilineage differentiating capacity. *Proceedings of the National Academy of Sciences of the United States of America*. 2009;106:14022-14027
51. Williams AR, Suncion VY, McCall F, Guerra D, Mather J, Zambrano JP, Heldman AW, Hare JM. Durable scar size reduction due to allogeneic mesenchymal stem cell therapy regulates whole-chamber remodeling. *Journal of the American Heart Association*. 2013;2:e000140

52. Schuleri KH, Centola M, Choi SH, Evers KS, Dawoud F, George RT, Lima JA, Lardo AC. Ct for evaluation of myocardial cell therapy in heart failure: A comparison with cmr imaging. *JACC. Cardiovascular imaging*. 2011;4:1284-1293
53. Karantalis V, Suncion-Loescher VY, Bagno L, Golpanian S, Wolf A, Sanina C, Premer C, Kanelidis AJ, McCall F, Wang B, Balkan W, Rodriguez J, Rosado M, Morales A, Hatzistergos K, Natsumeda M, Margitich I, Schulman IH, Gomes SA, Mushtaq M, DiFede DL, Fishman JE, Pattany P, Zambrano JP, Heldman AW, Hare JM. Synergistic effects of combined cell therapy for chronic ischemic cardiomyopathy. *Journal of the American College of Cardiology*. 2015;66:1990-1999
54. van der Spoel TI, Gathier WA, Koudstaal S, van Slochteren F, Of Lorkeers SJ, Sluijter JP, Hoefer IE, Steendijk P, Cramer MJ, Doevendans PA, van Belle E, Chamuleau SA. Autologous mesenchymal stem cells show more benefit on systolic function compared to bone marrow mononuclear cells in a porcine model of chronic myocardial infarction. *Journal of cardiovascular translational research*. 2015;8:393-403
55. Huang SD, Lu FL, Xu XY, Liu XH, Zhao XX, Zhao BZ, Wang L, Gong DJ, Yuan Y, Xu ZY. Transplantation of angiogenin-overexpressing mesenchymal stem cells synergistically augments cardiac function in a porcine model of chronic ischemia. *The Journal of thoracic and cardiovascular surgery*. 2006;132:1329-1338
56. Schuleri KH, Feigenbaum GS, Centola M, Weiss ES, Zimmet JM, Turney J, Kellner J, Zviman MM, Hatzistergos KE, Detrick B, Conte JV, McNiece I, Steenbergen C, Lardo AC, Hare JM. Autologous mesenchymal stem cells produce reverse remodelling in chronic ischaemic cardiomyopathy. *European heart journal*. 2009;30:2722-2732
57. Yu YS, Shen ZY, Ye WX, Huang HY, Hua F, Chen YH, Chen K, Lao WJ, Tao L. Akt-modified autologous intracoronary mesenchymal stem cells prevent remodeling and repair in swine infarcted myocardium. *Chinese medical journal*. 2010;123:1702-1708
58. Yang ZJ, Ma DC, Wang W, Xu SL, Zhang YQ, Chen B, Zhou F, Zhu TB, Wang LS, Xu ZQ, Zhang FM, Cao KJ, Ma WZ. Experimental study of bone marrow-derived mesenchymal stem cells combined with hepatocyte growth factor transplantation via noninfarct-relative artery in acute myocardial infarction. *Gene therapy*. 2006;13:1564-1568
59. Rodrigo SF, van Ramshorst J, Hoogslag GE, Boden H, Velders MA, Cannegieter SC, Roelofs H, Al Younis I, Dibbets-Schneider P, Fibbe WE, Zwaginga JJ, Bax JJ, Schalij MJ, Beeres SL, Atsma DE. Intramyocardial injection of autologous bone marrow-derived ex vivo expanded mesenchymal stem cells in acute myocardial infarction patients is feasible and safe up to 5 years of follow-up. *Journal of cardiovascular translational research*. 2013;6:816-825
60. Chen SL, Fang WW, Ye F, Liu YH, Qian J, Shan SJ, Zhang JJ, Chunhua RZ, Liao LM, Lin S, Sun JP. Effect on left ventricular function of intracoronary transplantation of autologous bone marrow mesenchymal

stem cell in patients with acute myocardial infarction. *The American journal of cardiology*. 2004;94:92-95

61. Gao LR, Pei XT, Ding QA, Chen Y, Zhang NK, Chen HY, Wang ZG, Wang YF, Zhu ZM, Li TC, Liu HL, Tong ZC, Yang Y, Nan X, Guo F, Shen JL, Shen YH, Zhang JJ, Fei YX, Xu HT, Wang LH, Tian HT, Liu da Q, Yang Y. A critical challenge: Dosage-related efficacy and acute complication intracoronary injection of autologous bone marrow mesenchymal stem cells in acute myocardial infarction. *International journal of cardiology*. 2013;168:3191-3199
62. Lee JW, Lee SH, Youn YJ, Ahn MS, Kim JY, Yoo BS, Yoon J, Kwon W, Hong IS, Lee K, Kwan J, Park KS, Choi D, Jang YS, Hong MK. A randomized, open-label, multicenter trial for the safety and efficacy of adult mesenchymal stem cells after acute myocardial infarction. *Journal of Korean medical science*. 2014;29:23-31
63. Wang X, Xi WC, Wang F. The beneficial effects of intracoronary autologous bone marrow stem cell transfer as an adjunct to percutaneous coronary intervention in patients with acute myocardial infarction. *Biotechnology letters*. 2014;36:2163-2168
64. Hare JM, Traverse JH, Henry TD, Dib N, Strumpf RK, Schulman SP, Gerstenblith G, DeMaria AN, Denktas AE, Gammon RS, Hermiller JB, Jr., Reisman MA, Schaer GL, Sherman W. A randomized, double-blind, placebo-controlled, dose-escalation study of intravenous adult human mesenchymal stem cells (prochymal) after acute myocardial infarction. *Journal of the American College of Cardiology*. 2009;54:2277-2286