

Clinical trials of off-pump

TrialResults-center www.trialresultscenter.org

1 CABG surgery

Trial	Treatments	Patients	Trials design and methods
off-pump vs on-pump			
Al-Ruzzeh b , 2006 n=84/84 follow-up: 6 months	off-pump versus coronary artery bypass grafting surgery using cardiopulmonary bypass	patients requiring primary isolated coronary artery bypass grafting surgery	Parallel groups open with blinded assessment UK
Alwan , 2004 n=35/35 follow-up: In-hospital/30-day mortality	beating heart revascularization versus arrested heart revascularization	patients undergoing CABG	Parallel groups open
Ascione , 2006 n=20/20 follow-up: In-hospital	off-pump coronary artery bypass grafting versus artery bypass grafting with cardiopulmonary bypass	patient undergoing CABG	Parallel groups open
Ascione , 2005 n=10/10 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patient undergoing CABG	Parallel groups open
Baker , 2001 n=12/14 follow-up:	off pump surgery using the Octopus II stabilizing system versus conventional CABG cardiopulmonary bypass	elective patients requiring surgery for double or triple vessel disease	open
BBS (Moller) , 2010 [NCT00120991] n=177/164 follow-up: 30 days	off-pump CABG versus on-pump CABG	patients >54 years of age with three-vessel coronary artery disease with EuroSCORE of 5-16 undergoing elective or sub-acute coronary artery bypass grafting	Parallel groups open blind assessor
BHACAS I (Ascione) , 1999 n=100/100 follow-up: 65279;25 months	off-pump versus on-pump	cardiac surgery candidates	Parallel groups open with blinded assessment

continued...

Trial	Treatments	Patients	Trials design and methods
BHACAS II (Angelini) , 2002 n=100/101 follow-up: 13.7 months	off-pump versus on-pump	patients with myocardial infarction in the past month or who required grafting of the circumflex artery distal to the first obtuse marginal branch	Parallel groups open with blinded assessment
Caputo , 2002 n=20/20 follow-up: In-hospital	beating heart surgery (off-pump) versus conventional CABG with cardiopulmonary bypass	patients undergoing coronary artery bypass grafting	Parallel groups open
Carrier , 2003 n=32/33 follow-up: In-hospital/30-day mortality	off-pump CABG versus on-pump CABG	high-risk patients	Parallel groups open
Covino , 2001 n=21/16 follow-up: In-hospital	-	-	open
Czerny , 2000 n=NA	-	-	open
Czerny b , 2001 n=NA	-	-	open
Diegeler , 2000 n=20/20 follow-up: In-hospital	coronary artery bypass operation without cardiopulmonary bypass (off-pump CABG) versus conventional coronary artery bypass operation using cardiopulmonary bypass	cardiac surgery candidates	Parallel groups open
DOORS , 2009 [NCT00123981] n=NA follow-up: 30 days	Off-Pump Coronary Artery Bypass Grafting versus on-pump CABG	elderly patients	Parallel groups open
Dorman , 2004 n=NA	-	-	open
Gasz , 2004 n=NA	-	-	open
Gerola , 2001 n=80/80 follow-up: In-hospital/30-day mortality	off-pump coronary artery bypass versus on-pump CABG	low-risk patients undergoing CABG	Parallel groups open

continued...

Trial	Treatments	Patients	Trials design and methods
Gu , 1998 n=31/31 follow-up: 65279;In-hospital	minimally invasive coronary artery bypass grafting versus conventional coronary artery bypass grafting with cardiopulmonary bypass	patients with isolated stenosis of the left anterior descending coronary artery	Parallel groups open
Guler , 2001 n=NA	-	-	open
Gulielmos , 1999 n=20/20 follow-up: 3 months	off-pump coronary artery bypass with median sternotomy or off-pump procedure and lateral minithoracotomy versus conventional technique or lateral minithoracotomy and cardiopulmonary bypass	patients with coronary artery single-vessel disease	Parallel groups open
Jares , 2006 n=10/10 follow-up: 24 h	off-pump CABG versus on-pump CABG	patients scheduled for coronary bypass grafting	Parallel groups open
Khan , 2004 n=54/49 follow-up: 3 months	off-pump CABG versus conventional "on-pump" surgery	patient undergoing CABG	Parallel groups open
Kobayashi , 2005 n=81/86 follow-up: 30 days	off-pump CABG versus on-pump CABG	patients referred for elective primary CABG	Parallel groups open
Kunes , 2007 n=17/17 follow-up: 7 days	off-pump CABG versus on-pump CABG	patient undergoing CABG	Parallel groups open
Lee , 2003 n=30/30 follow-up:	off-pump CABG versus conventional on-pump CABG	patients undergoing CABG	open
Legare , 2004 [NCT00216957] n=150/150 follow-up: 3.8 years	off-pump CABG versus on-pump CABG	patients undergoing CABG	Parallel groups open
Lingaas , 2003 n=60/60 follow-up: 12 months	off-pump CABG versus on-pump CABG	patient undergoing CABG	Parallel groups open
Matata , 2000 n=10/10 follow-up: In-hospital	off-pump versus on-pump	cardiac surgery candidates	Parallel groups open

continued...

Trial	Treatments	Patients	Trials design and methods
Michaux , 2006 n=25/25 follow-up: 30 days	off-pump CABG versus on-pump CABG	patients scheduled for elective coronary artery bypass surgery	Parallel groups open
Motallebzadeh , 2004 n=15/20 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patients admitted for CABG	Parallel groups open
Motallebzadeh b , 2006 n=108/104 follow-up: 6 months	off-pump CABG versus on-pump CABG	patients admitted for elective coronary artery bypass graft surgery	Parallel groups open
Muneretto , 2003 n=NA	-	-	open
Niranjan , 2006 n=40/40 follow-up: In-hospital	off-pump CABG with or without cell saver blood transfusion versus on-pump CABG with or without cell saver blood transfusion	patient undergoing CABG	open
OCTOPUS (van Dijk) , 2002 n=142/139 follow-up: 5 years	off-pump surgery versus on-pump surgery	patients with predominantly single- or double-vessel coronary disease	Parallel groups open with blinded assessment the Netherlands
Ozkara , 2007 n=22/22 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patients admitted for elective CABG	Parallel groups open
Paparella , 2006 n=15/16 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patient undergoing CABG	Parallel groups open
Parolari , 2003 n=NA	-	-	open
Parolari b , 2003 n=NA	-	-	open
Penttila , 2001 n=11/11 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patients requiring CABG	Parallel groups open
PRAGUE 4 (Widimsky) , 2004 n=208/192 follow-up: 1 y	off pump versus on pump	cardiac surgery candidates	Parallel groups open

continued...

Trial	Treatments	Patients	Trials design and methods
PROMISS (Uva) , 2010 n=75/75 follow-up: 5 weeks (498 days)	off-pump versus on-pump	patients between 30 and 90 years of age with multi-vessel coronary artery disease undergoing CABG with at least three distal coronary anastomoses	Parallel groups open
Puskas , 2004 n=NA	-	-	open
Raja b , 2003 n=150/150 follow-up: In-hospital	on-pump CABG versus off-pump CABG	patients undergoing CABG	Parallel groups open
ROOBY (Shroyer) , 2009 [NCT00032630] n=1104/1099 follow-up: 1 mo (1y)	off-pump CABG versus on-pump CABG	patients scheduled for urgent or elective coronary bypass surgery	Parallel groups open USA
Sahlman , 2003 n=NA	-	-	open
Selvanayagam , 2004 n=30/30 follow-up: In-hospital	off-pump CABG versus on-pump CABG	patients undergoing multivessel CABG	Parallel groups open
SMART (Staton) , 2003 n=100/100 follow-up: 12 months	off-pump coronary artery bypass versus CABG with cardiopulmonary bypass	patients unselected for coronary anatomy, ventricular function, or comorbidities	Parallel groups open with blinded assessment US
Syed , 2004 n=NA	-	-	open
Tang , 2002 n=NA	-	-	open
Tatoulis , 2006 n=50/50 follow-up: 30 days	off-pump CABG versus on-pump CABG	candidates for elective CABG	Parallel groups open
Vedin , 2006 n=NA follow-up:	off-pump CABG versus on-pump CABG	patients between 50 and 80 years with stable angina pectoris, ejection fraction >30% , serum creatinine <150 micromol/l, and lack of tight main stem stenosis	open
Velisaris , 2003 n=NA	-	-	open
Vural , 1995 n=NA	-	-	open

continued...

Trial	Treatments	Patients	Trials design and methods
Wan , 2004 n=NA	-	-	open
Wandschneider , 2000 n=NA	-	-	open
Zamvar , 2002 n=30/30 follow-up: 10 weeks	off-pump CABG versus on-pump CABG	patients undergoing coronary artery bypass graft surgery for triple vessel disease	Parallel groups open UK
GOPCABE <i>ongoing</i> [NCT00719667] n=NA follow-up:	Off-pump CABG versus ON-pump CABG	Elderly	Parallel groups open
OCTOPUS II <i>ongoing</i> n=NA	-	-	
Ontario <i>ongoing</i> [NCT00259493] n=NA follow-up: 3 months	Off-Pump CABG versus On-Pump CABG	-	Parallel groups double blind

9 More details and results :

- off-pump CABG for CABG surgery in all type of patients at <http://www.trialresultscenter.org/go-Q315>

References

Al-Ruzzeh b, 2006:

Al-Ruzzeh S, George S, Bustami M, Wray J, Ilesley C, Athanasiou T, Amrani M Effect of off-pump coronary artery bypass surgery on clinical, angiographic, neurocognitive, and quality of life outcomes: randomised controlled trial. *BMJ* 2006;332:1365 [16740529] [10.1136/bmj.38852.479907.7C](https://doi.org/10.1136/bmj.38852.479907.7C)

Al-Ruzzeh S, Hoare G, Marczin N, Asimakopoulos G, George S, Taylor K, Amrani M Off-pump coronary artery bypass surgery is associated with reduced neutrophil activation as measured by the expression of CD11b: a prospective randomized study. *Heart Surg Forum* 2003;6:89-93 [14640133]

Alwan, 2004:

Alwan K, Falcoz PE, Alwan J, Mouawad W, Oujaimi G, Chocron S, Etievent JP Beating versus arrested heart coronary revascularization: evaluation by cardiac troponin I release. *Ann Thorac Surg* 2004;77:2051-5 [15172263] [10.1016/j.athoracsur.2003.11.004](https://doi.org/10.1016/j.athoracsur.2003.11.004)

Ascione, 2006:

Ascione R, Talpahewa S, Rajakaruna C, Reeves BC, Lovell AT, Cohen A, Angelini GD Splanchnic organ injury during coronary surgery with or without cardiopulmonary bypass: a randomized, controlled trial. *Ann Thorac Surg* 2006;81:97-103 [16368344] [10.1016/j.athoracsur.2005.06.038](https://doi.org/10.1016/j.athoracsur.2005.06.038)

Ascione, 2005:

Ascione R, Ghosh A, Reeves BC, Arnold J, Potts M, Shah A, Angelini GD Retinal and cerebral microembolization during coronary artery bypass surgery: a randomized, controlled trial. *Circulation* 2005;112:3833-8 [16365207] [10.1161/CIRCULATIONAHA.105.557462](https://doi.org/10.1161/CIRCULATIONAHA.105.557462)

Baker, 2001:

Baker RA, Andrew MJ, Ross IK, Knight JL The Octopus II stabilizing system: biochemical and neuropsychological outcomes in coronary artery bypass surgery. *Heart Surg Forum* 2001;4 Suppl 1:S19-23 [[11178303](#)]

BBS (Moller), 2010:

Jensen B, Rasmussen LS, Steinbrchel DA Cognitive outcomes in elderly high-risk patients 1 year after off-pump versus on-pump coronary artery bypass grafting. A randomized trial. *Eur J Cardiothorac Surg* 2008;34:1016-21 [[18778948](#)]

Mller CH, Perko MJ, Lund JT, Andersen LW, Kelbaek H, Madsen JK, Winkel P, Gluud C, Steinbrchel DA No major differences in 30-day outcomes in high-risk patients randomized to off-pump versus on-pump coronary bypass surgery: the best bypass surgery trial. *Circulation* 2010 Feb 2;121:498-504 [[20083683](#)] [10.1161/CIRCULATIONAHA.109.880443](#)

Mller CH, Perko MJ, Lund JT, Andersen LW, Kelbk H, Madsen JK, Winkel P, Gluud C, Steinbrchel DA Three-year follow-up in a subset of high-risk patients randomly assigned to off-pump versus on-pump coronary artery bypass surgery: the Best Bypass Surgery trial. *Heart* 2011;97:907-13 [[21415073](#)] [10.1136/hrt.2010.211680](#)

BHACAS I (Ascione), 1999:

Angelini GD, Taylor FC, Reeves BC, Ascione R Early and midterm outcome after off-pump and on-pump surgery in Beating Heart Against Cardioplegic Arrest Studies (BHACAS 1 and 2): a pooled analysis of two randomised controlled trials. *Lancet* 2002;359:1194-9 [[11955537](#)] [10.1016/S0140-6736\(02\)08216-8](#)

Ascione R, Lloyd CT, Underwood MJ, Gomes WJ, Angelini GD On-pump versus off-pump coronary revascularization: evaluation of renal function. *Ann Thorac Surg* 1999;68:493-8 [[10475418](#)]

Ascione R, Lloyd CT, Underwood MJ, Lotto AA, Pitsis AA, Angelini GD Economic outcome of off-pump coronary artery bypass surgery: a prospective randomized study. *Ann Thorac Surg* 1999;68:2237-42 [[10617009](#)]

Ascione R, Lloyd CT, Gomes WJ, Caputo M, Bryan AJ, Angelini GD Beating versus arrested heart revascularization: evaluation of myocardial function in a prospective randomized study. *Eur J Cardiothorac Surg* 1999;15:685-90 [[10386418](#)]

BHACAS II (Angelini), 2002:

Angelini GD, Taylor FC, Reeves BC, Ascione R Early and midterm outcome after off-pump and on-pump surgery in Beating Heart Against Cardioplegic Arrest Studies (BHACAS 1 and 2): a pooled analysis of two randomised controlled trials. *Lancet* 2002;359:1194-9 [[11955537](#)] [10.1016/S0140-6736\(02\)08216-8](#)

Ascione R, Reeves BC, Taylor FC, Seehra HK, Angelini GD Beating heart against cardioplegic arrest studies (BHACAS 1 and 2): quality of life at mid-term follow-up in two randomised controlled trials. *Eur Heart J* 2004;25:765-70 [[15120887](#)] [10.1016/j.ehj.2003.11.015](#)

Caputo, 2002:

Caputo M, Yeatman M, Narayan P, Marchetto G, Ascione R, Reeves BC, Angelini GD Effect of off-pump coronary surgery with right ventricular assist device on organ function and inflammatory response: a randomized controlled trial. *Ann Thorac Surg* 2002;74:2088-95; discussion 2095-6 [[12643400](#)]

Carrier, 2003:

Carrier M, Perrault LP, Jeanmart H, Martineau R, Cartier R, Pag P Randomized trial comparing off-pump to on-pump coronary artery bypass grafting in high-risk patients. *Heart Surg Forum* 2003;6:E89-92 [[14721990](#)]

Covino, 2001:

Covino E, Santise G, Di Lello F, De Amicis V, Bonifazi R, Bellino I, Spampinato N Surgical myocardial revascularization (CABG) in patients with pulmonary disease: beating heart versus cardiopulmonary bypass. *J Cardiovasc Surg (Torino)* 2001;42:23-6 [[11292901](#)]

Czerny, 2000:

Czerny M, Baumer H, Kilo J, Lassnigg A, Hamwi A, Vukovich T, Wolner E, Grimm M Inflammatory response and myocardial injury following coronary artery bypass grafting with or without cardiopulmonary bypass. *Eur J Cardiothorac Surg* 2000;17:737-42 [[10856869](#)]

Czerny b, 2001:

Czerny M, Baumer H, Kilo J, Lassnigg A, Hamwi A, Vukovich T, Wolner E, Grimm M Inflammatory response and myocardial injury following coronary artery bypass grafting with or without cardiopulmonary bypass. *Eur J Cardiothorac Surg* 2000;17:737-42 [[10856869](#)]

Czerny M, Baumer H, Kilo J, Zuckermann A, Grubhofer G, Chevtchik O, Wolner E, Grimm M Complete revascularization in coronary artery bypass grafting with and without cardiopulmonary bypass. *Ann Thorac Surg* 2001;71:165-9 [[11216739](#)]

Diegeler, 2000:

Diegeler A, Hirsch R, Schneider F, Schilling LO, Falk V, Rauch T, Mohr FW Neuromonitoring and neurocognitive outcome in off-pump versus conventional coronary bypass operation. *Ann Thorac Surg* 2000;69:1162-6 [[10800812](#)]

Gulielmos V, Menschikowski M, Dill H, Eller M, Thiele S, Tugtekin SM, Jaross W, Schueler S Interleukin-1, interleukin-6 and myocardial enzyme response after coronary artery bypass grafting - a prospective randomized comparison of the conventional and three minimally invasive surgical techniques. *Eur J Cardiothorac Surg* 2000;18:594-601 [[11053823](#)]

DOORS, 2009:

Houliand K, Kjeldsen BJ, Madsen SN, Rasmussen BS, Holme SJ, Schmidt TA, Haahr PE, Mortensen PE The impact of avoiding cardiopulmonary by-pass during coronary artery bypass surgery in elderly patients: the Danish On-pump Off-pump Randomisation Study (DOORS). *Trials* 2009;10:47 [[19575814](#)]

Dorman, 2004:

Dorman BH, Kratz JM, Multani MM, Baron R, Farrar E, Walton S, Payne K, Ikonomiois J, Reeves S, Mukherjee R, Spinale FG A prospective, randomized study of endothelin and postoperative recovery in off-pump versus conventional coronary artery bypass surgery. *J Cardiothorac Vasc Anesth* 2004;18:25-9 [[14973794](#)]

Gasz, 2004:

Gasz B, Benk L, Jancs G, Lantos J, Sznt Z, Alotti N, Rth E Comparison of inflammatory response following coronary revascularization with or without cardiopulmonary bypass. *Exp Clin Cardiol* 2004;9:26-30 [[19641693](#)]

Gerola, 2001:

Gerola LR, Buffolo E, Jاسبك W, Botelho B, Bosco J, Brasil LA, Branco JN Off-pump versus on-pump myocardial revascularization in low-risk patients with one or two vessel disease: perioperative results in a multicenter randomized controlled trial. *Ann Thorac Surg* 2004;77:569-73 [[14759439](#)] [10.1016/S0003-4975\(03\)01353-5](#)

Malheiros SM, Massaro AR, Gabbai AA, Pessa CJ, Gerola LR, Branco JN, Lira Filho EB, Christofalo DM, Federico D, Carvalho AC, Buffolo E Is the number of microembolic signals related to neurologic outcome in coronary bypass surgery? *Arq Neuropsiquiatr* 2001;59:1-5 [[11299422](#)]

Gu, 1998:

Gu YJ, Mariani MA, van Oeveren W, Grandjean JG, Boonstra PW Reduction of the inflammatory response in patients undergoing minimally invasive coronary artery bypass grafting. *Ann Thorac Surg* 1998;65:420-4 [[9485239](#)]

Guler, 2001:

Gler M, Kirali K, Toker ME, Bozbuga N, Omeroglu SN, Akinci E, Yakut C Different CABG methods in patients with chronic obstructive pulmonary disease. *Ann Thorac Surg* 2001;71:152-7 [[11216737](#)]

Gulielmos, 1999:

Gulielmos V, Eller M, Thiele S, Dill HM, Jost T, Tugtekin SM, Schueler S Influence of median sternotomy on the psychosomatic outcome in coronary artery single-vessel bypass grafting. *Eur J Cardiothorac Surg* 1999;16 Suppl 2:S34-8 [[10613553](#)]

Gulielmos V, Menschikowski M, Dill H, Eller M, Thiele S, Tugtekin SM, Jaross W, Schueler S Interleukin-1, interleukin-6 and myocardial enzyme response after coronary artery bypass grafting - a prospective randomized comparison of the conventional and three minimally invasive surgical techniques. *Eur J Cardiothorac Surg* 2000;18:594-601 [[11053823](#)]

Jares, 2006:

Clauw DJ, Palmer RH, Thacker K et al. Milnacipran Efficacy in the Treatment of Fibromyalgia Syndrome: a 15 week, randomized, double blind placebo controlled trial *ACR/ARHP* 2007; P517

Jares M, Vanek T, Bednar F, Maly M, Snircova J, Straka Z Off-pump versus on-pump coronary artery surgery. *Int Heart J* 2007;48:57-67 [[17379979](#)]

Khan, 2004:

Khan NE, De Souza A, Mister R, Flather M, Clague J, Davies S, Collins P, Wang D, Sigwart U, Pepper J A randomized comparison of off-pump and on-pump multivessel coronary-artery bypass surgery. *N Engl J Med* 2004;350:21-8 [[14702424](#)] [10.1056/NEJMoa031282](#)

Kobayashi, 2005:

Kobayashi J, Tashiro T, Ochi M, Yaku H, Watanabe G, Satoh T, Tagusari O, Nakajima H, Kitamura S Early outcome of a randomized comparison of off-pump and on-pump multiple arterial coronary revascularization. *Circulation* 2005;112:1338-43 [[16159843](#)] [10.1161/CIRCULATIONAHA.104.524504](#)

Kunes, 2007:

Kunes P, Lonsky V, Mandak J, Kolackova M, Andrys C, Kudlova M, Krejsek J The long pentraxin 3 in cardiac surgery: distinct responses in "on-pump" and "off-pump" patients. *Scand Cardiovasc J* 2007;41:171-9 [[17487767](#)] [10.1080/14017430701324262](#)

Lee, 2003:

Lee JD, Lee SJ, Tsushima WT, Yamauchi H, Lau WT, Popper J, Stein A, Johnson D, Lee D, Petrovitch H, Dang CR Benefits of off-pump bypass on neurologic and clinical morbidity: a prospective randomized trial. *Ann Thorac Surg* 2003;76:18-25; discussion 25-6 [[12842506](#)]

Legare, 2004:

Karolak W, Hirsch G, Buth K, Lgar JF Medium-term outcomes of coronary artery bypass graft surgery on pump versus off pump: results from a randomized controlled trial. *Am Heart J* 2007;153:689-95 [[17383313](#)] [10.1016/j.ahj.2007.01.033](#)

Lgar JF, Buth KJ, King S, Wood J, Sullivan JA, Hancock Friesen C, Lee J, Stewart K, Hirsch GM Coronary bypass surgery performed off pump does not result in lower in-hospital morbidity than coronary artery bypass grafting performed on pump. *Circulation* 2004;109:887-92 [[14757693](#)] [10.1161/01.CIR.0000115943.41814.7D](#)

Lgar JF, Buth KJ, Hirsch GM Conversion to on pump from OPCAB is associated with increased mortality: results from a randomized controlled trial. *Eur J Cardiothorac Surg* 2005;27:296-301 [[15691685](#)] [10.1016/j.ejcts.2004.11.009](#)

Lingaas, 2003:

Lingaas PS, Hol PK, Lundblad R, Rein KA, Tnnesen TI, Svennevig JL, Hauge SN, Vatne K, Fosse E Clinical and Angiographic Outcome of Coronary Surgery with and without Cardiopulmonary Bypass: A Prospective Randomized Trial. *Heart Surg Forum* 2004;7:37-41 [[14980848](#)]

Lingaas PS, Hol PK, Lundblad R, Rein KA, Mathisen L, Smith HJ, Andersen R, Thaulow E, Tnnesen TI, Svennevig JL, Hauge SN, Fredriksen PM, Andersen M, Fosse E Clinical and radiologic outcome of off-pump coronary surgery at 12 months follow-up: a prospective randomized trial. *Ann Thorac Surg* 2006;81:2089-95 [[16731135](#)] [10.1016/j.athoracsur.2005.12.003](#)

Mathisen L, Andersen MH, Hol PK, Lingaas PS, Lundblad R, Rein KA, Tnnesen TI, Mrk BE, Svennevig JL, Wahl AK, Hanestad BR, Fosse E Patient-reported outcome after randomization to on-pump versus off-pump coronary artery surgery. *Ann Thorac Surg* 2005;79:1584-9 [[15854937](#)] [10.1016/j.athoracsur.2004.10.019](#)

Lund C, Hol PK, Lundblad R, Fosse E, Sundet K, Tenne B, Brucher R, Russell D Comparison of cerebral embolization during off-pump and on-pump coronary artery bypass surgery. *Ann Thorac Surg* 2003;76:765-70; discussion 770 [[12963195](#)]

Lund C, Sundet K, Tenne B, Hol PK, Rein KA, Fosse E, Russell D Cerebral ischemic injury and cognitive impairment after off-pump and on-pump coronary artery bypass grafting surgery. *Ann Thorac Surg* 2005;80:2126-31 [[16305857](#)] [10.1016/j.athoracsur.2005.06.012](#)

Mathisen L, Andersen MH, Hol PK, Tenne B, Lund C, Russell D, Lundblad R, Halvorsen S, Wahl AK, Hanestad BR, Fosse E Preoperative cerebral ischemic lesions predict physical health status after on-pump coronary artery bypass surgery. *J Thorac Cardiovasc Surg* 2005;130:1691-7 [[16308017](#)] [10.1016/j.jtcvs.2005.08.008](#)

Matata, 2000:

Matata BM, Sosnowski AW, Galianes M Off-pump bypass graft operation significantly reduces oxidative stress and inflammation. *Ann Thorac Surg* 2000;69:785-91 [[10750762](#)]

Michaux, 2006:

Michaux I, Filipovic M, Skarvan K, Schneiter S, Schumann R, Zerkowski HR, Bernet F, Seeberger MD Effects of on-pump versus off-pump coronary artery bypass graft surgery on right ventricular function. *J Thorac Cardiovasc Surg* 2006;131:1281-8 [[16733158](#)] [10.1016/j.jtcvs.2006.01.035](#)

Motallebzadeh, 2004:

Motallebzadeh R, Kanagasabay R, Bland M, Kaski JC, Jahangiri M S100 protein and its relation to cerebral microemboli in on-pump and off-pump coronary artery bypass surgery. *Eur J Cardiothorac Surg* 2004;25:409-14 [[15019669](#)] [10.1016/j.ejcts.2003.12.018](#)

Motallebzadeh b, 2006:

Motallebzadeh R, Bland JM, Markus HS, Kaski JC, Jahangiri M Health-related quality of life outcome after on-pump versus off-pump coronary artery bypass graft surgery: a prospective randomized study. *Ann Thorac Surg* 2006;82:615-9 [[16863773](#)] [10.1016/j.athoracsur.2006.03.081](#)

Motallebzadeh R, Bland JM, Markus HS, Kaski JC, Jahangiri M Neurocognitive function and cerebral emboli: randomized study of on-pump versus off-pump coronary artery bypass surgery. *Ann Thorac Surg* 2007;83:475-82 [[17257972](#)] [10.1016/j.athoracsur.2006.09.024](#)

Muneretto, 2003:

Muneretto C, Bisleri G, Negri A, Manfredi J, Metra M, Nodari S, Dei Cas L Off-pump coronary artery bypass surgery technique for total arterial myocardial revascularization: a prospective randomized study. *Ann Thorac Surg* 2003;76:778-82; discussion 783 [[12963199](#)]

Niranjan, 2006:

Niranjan G, Asimakopoulos G, Karagounis A, Cockerill G, Thompson M, Chandrasekaran V Effects of cell saver autologous blood transfusion on blood loss and homologous blood transfusion requirements in patients undergoing cardiac surgery on- versus off-cardiopulmonary bypass: a randomised trial. *Eur J Cardiothorac Surg* 2006;30:271-7 [[16829083](#)] [10.1016/j.ejcts.2006.04.042](#)

OCTOPUS (van Dijk), 2002:

van Dijk D, Nierich AP, Jansen EW, Nathoe HM, Suyker WJ, Diephuis JC, van Boven WJ, Borst C, Buskens E, Grobbee DE, Robles De Medina EO, de Jaegere PP Early outcome after off-pump versus on-pump coronary bypass surgery: results from a randomized study. *Circulation* 2001;104:1761-6 [[11591611](#)]

Nathoe HM, van Dijk D, Jansen EW, Suyker WJ, Diephuis JC, van Boven WJ, de la Riviere AB, Borst C, Kalkman CJ, Grobbee DE, Buskens E, de Jaegere PP A comparison of on-pump and off-pump coronary bypass surgery in low-risk patients. *N Engl J Med* 2003;348:394-402 [[12556542](#)] [10.1056/NEJMoa021775](#)

van Dijk D, Nierich AP, Eefting FD, Buskens E, Nathoe HM, Jansen EW, Borst C, Knape JT, Brede JJ, Robles de Medina EO, Grobbee DE, Diephuis JC, de Jaegere PP The Octopus Study: rationale and design of two randomized trials on medical effectiveness, safety, and cost-effectiveness of bypass surgery on the beating heart. *Control Clin Trials* 2000;21:595-609 [[11146152](#)]

van Dijk D, de Jaegere PP Neuropsychological outcome after off-pump versus on-pump coronary bypass surgery: the octopus randomized trial. *Circulation* 2002;105:E179 [[12034669](#)]

Van Dijk D, Jansen EW, Hijman R, Nierich AP, Diephuis JC, Moons KG, Lahpor JR, Borst C, Keizer AM, Nathoe HM, Grobbee DE, De Jaegere PP, Kalkman CJ Cognitive outcome after off-pump and on-pump coronary artery bypass graft surgery: a randomized trial. *JAMA* 2002;287:1405-12 [[11903027](#)]

van Dijk D, Spoor M, Hijman R, Nathoe HM, Borst C, Jansen EW, Grobbee DE, de Jaegere PP, Kalkman CJ Cognitive and cardiac outcomes 5 years after off-pump vs on-pump coronary artery bypass graft surgery. *JAMA* 2007;297:701-8 [[17312289](#)] [10.1001/jama.297.7.701](#)

Ozkara, 2007:

Ozkara C, Guler N, Batyraliev T, Okut H, Agirbasli M Does off-pump coronary artery bypass surgery reduce secretion of plasminogen activator inhibitor-1? *Int J Clin Pract* 2007;61:763-7 [[17343662](#)] [10.1111/j.1742-1241.2006.00952.x](#)

Paparella, 2006:

Paparella D, Galeone A, Venneri MT, Coviello M, Scrascia G, Marraudino N, Quaranta M, de Luca Tupputi Schinosa L, Brister SJ Activation of the coagulation system during coronary artery bypass grafting: comparison between on-pump and off-pump techniques. *J Thorac Cardiovasc Surg* 2006;131:290-7 [[16434256](#)] [10.1016/j.jtcvs.2005.10.018](#)

Parolari, 2003:

Parolari A, Alamanni F, Juliano G, Polvani G, Roberto M, Veglia F, Fumero A, Carlucci C, Rona P, Brambillasca C, Sisillo E, Biglioli P Oxygen metabolism during and after cardiac surgery: role of CPB. *Ann Thorac Surg* 2003;76:737-43; discussion 743 [[12963188](#)]

Parolari b, 2003:

Parolari A, Alamanni F, Juliano G, Polvani G, Roberto M, Veglia F, Fumero A, Carlucci C, Rona P, Brambillasca C, Sisillo E, Biglioli P Oxygen metabolism during and after cardiac surgery: role of CPB. *Ann Thorac Surg* 2003;76:737-43; discussion 743 [[12963188](#)]

Penttila, 2001:

Penttil HJ, Lepojrvi MV, Kiviluoma KT, Kaukoranta PK, Hassinen IE, Peuhkurinen KJ Myocardial preservation during coronary surgery with and without cardiopulmonary bypass. *Ann Thorac Surg* 2001;71:565-71 [[11235707](#)]

PRAGUE 4 (Widimsky), 2004:

Widimsky P, Straka Z, Stros P, Jirasek K, Dvorak J, Votava J, Lisa L, Budesinsky T, Kolesar M, Vanek T, Brucek P One-year coronary bypass graft patency: a randomized comparison between off-pump and on-pump surgery angiographic results of the PRAGUE-4 trial. *Circulation* 2004;110:3418-23 [[15557371](#)]

PROMISS (Uva), 2010:

Sousa Uva M, Cavaco S, Oliveira AG, Matias F, Silva C, Mesquita A, Aguiar P, Bau J, Pedro A, Magalhes MP Early graft patency after off-pump and on-pump coronary bypass surgery: a prospective randomized study. *Eur Heart J* 2010 Jul 1;: [[20595221](#)] [10.1093/eurheartj/ehq210](#)

Puskas, 2004:

Puskas JD, Williams WH, Duke PG, Staples JR, Glas KE, Marshall JJ, Leimbach M, Huber P, Garas S, Sammons BH, McCall SA, Petersen RJ, Bailey DE, Chu H, Mahoney EM, Weintraub WS, Guyton RA Off-pump coronary artery bypass grafting provides complete revascularization with reduced myocardial injury, transfusion requirements, and length of stay: a prospective randomized comparison of two hundred unselected patients undergoing off-pump versus conventional coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 2003;125:797-808 [[12698142](#)] [10.1067/mtc.2003.324](#)

Puskas JD, Williams WH, Mahoney EM, Huber PR, Block PC, Duke PG, Staples JR, Glas KE, Marshall JJ, Leimbach ME, McCall SA, Petersen RJ, Bailey DE, Weintraub WS, Guyton RA Off-pump vs conventional coronary artery bypass grafting: early and 1-year graft patency, cost, and quality-of-life outcomes: a randomized trial. *JAMA* 2004;291:1841-9 [[15100202](#)] [10.1001/jama.291.15.1841](#)

Raja b, 2003:

Raja SG, Haider Z, Ahmad M Predictors of gastrointestinal complications after conventional and beating heart coronary surgery. *Surgeon* 2003;1:221-8 [[15570766](#)]

ROOBY (Shroyer), 2009:

Shroyer AL, Grover FL, Hattler B, Collins JF, McDonald GO, Kozora E, Lucke JC, Baltz JH, Novitzky D On-pump versus off-pump coronary-artery bypass surgery. *N Engl J Med* 2009 Nov 5;361:1827-37 [[19890125](#)]

Sahlman, 2003:

Sahlman A, Ahonen J, Nemlander A, Salmenper M, Eriksson H, Rm J, Vento A Myocardial metabolism on off-pump surgery; a randomized study of 50 cases. *Scand Cardiovasc J* 2003;37:211-5 [[12944209](#)]

Selvanayagam, 2004:

Selvanayagam JB, Kardos A, Francis JM, Wiesmann F, Petersen SE, Taggart DP, Neubauer S Value of delayed-enhancement cardiovascular magnetic resonance imaging in predicting myocardial viability after surgical revascularization. *Circulation* 2004;110:1535-41 [[15353496](#)] [10.1161/01.CIR.0000142045.22628.74](#)

Selvanayagam JB, Petersen SE, Francis JM, Robson MD, Kardos A, Neubauer S, Taggart DP Effects of off-pump versus on-pump coronary surgery on reversible and irreversible myocardial injury: a randomized trial using cardiovascular magnetic resonance imaging and biochemical markers. *Circulation* 2004;109:345-50 [[14732755](#)] [10.1161/01.CIR.0000109489.71945.BD](#)

Selvanayagam JB, Searle N, Neubauer S, Taggart DP Correlation of coronary artery bypass surgery-related myonecrosis with grafted vessel calibre: insights from cardiovascular magnetic resonance imaging. *Heart* 2006;92:1329-30 [[16908713](#)] [10.1136/hrt.2005.080796](#)

Selvanayagam JB, Petersen SE, Francis JM, Robson MD, Kardos A, Neubauer S, Taggart DP Effects of off-pump versus on-pump coronary surgery on reversible and irreversible myocardial injury: a randomized trial using cardiovascular magnetic resonance imaging and biochemical markers. *Circulation* 2004;109:345-50 [[14732755](#)] [10.1161/01.CIR.0000109489.71945.BD](#)

SMART (Staton), 2003:

Puskas JD, Sharoni E, Williams WH, Petersen R, Duke P, Guyton RA Is routine use of temporary epicardial pacing wires necessary after either OPCAB or conventional CABG/CPB? *Heart Surg Forum* 2003;6:E103-6 [[14721993](#)]

Puskas JD, Williams WH, Duke PG, Staples JR, Glas KE, Marshall JJ, Leimbach M, Huber P, Garas S, Sammons BH, McCall SA, Petersen RJ, Bailey DE, Chu H, Mahoney EM, Weintraub WS, Guyton RA Off-pump coronary artery bypass grafting provides complete revascularization with reduced myocardial injury, transfusion requirements, and length of stay: a prospective randomized comparison of two hundred unselected patients undergoing off-pump versus conventional coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 2003;125:797-808 [[12698142](#)] [10.1067/mtc.2003.324](#)

Puskas JD, Williams WH, Mahoney EM, Huber PR, Block PC, Duke PG, Staples JR, Glas KE, Marshall JJ, Leimbach ME, McCall SA, Petersen RJ, Bailey DE, Weintraub WS, Guyton RA Off-pump vs conventional coronary artery bypass grafting: early and 1-year graft patency, cost, and quality-of-life outcomes: a randomized trial. *JAMA* 2004;291:1841-9 [[15100202](#)] [10.1001/jama.291.15.1841](#)

Staton GW, Williams WH, Mahoney EM, Hu J, Chu H, Duke PG, Puskas JD Pulmonary outcomes of off-pump vs on-pump coronary artery bypass surgery in a randomized trial. *Chest* 2005;127:892-901 [[15764773](#)] [10.1378/chest.127.3.892](#)

Syed, 2004:

Syed A, Fawzy H, Farag A, Nemlander A. *Heart lung and Circulation*. 2004; 13: 168172

Tang, 2002:

Tang AT, Knott J, Nanson J, Hsu J, Haw MP, Ohri SK A prospective randomized study to evaluate the renoprotective action of beating heart coronary surgery in low risk patients. *Eur J Cardiothorac Surg* 2002;22:118-23 [[12103384](#)]

Tatoulis, 2006:

Ernest CS, Worcester MU, Tatoulis J, Elliott PC, Murphy BM, Higgins RO, Le Grande MR, Goble AJ Neurocognitive outcomes in off-pump versus on-pump bypass

surgery: a randomized controlled trial. *Ann Thorac Surg* 2006;81:2105-14 [[16731138](#)] [10.1016/j.athoracsur.2006.01.008](#)

Ernest CS, Murphy BM, Worcester MU, Higgins RO, Elliott PC, Goble AJ, Le Grande MR, Genardini N, Tatoulis J Cognitive function in candidates for coronary artery bypass graft surgery. *Ann Thorac Surg* 2006;82:812-8 [[16928490](#)] [10.1016/j.athoracsur.2006.04.005](#)

Tatoulis J, Rice S, Davis P, Goldblatt JC, Marasco S Patterns of postoperative systemic vascular resistance in a randomized trial of conventional on-pump versus off-pump coronary artery bypass graft surgery. *Ann Thorac Surg* 2006;82:1436-44 [[16996948](#)] [10.1016/j.athoracsur.2006.04.053](#)

Vedin, 2006:

Vedin J, Nyman H, Ericsson A, Hylander S, Vaage J Cognitive function after on or off pump coronary artery bypass grafting. *Eur J Cardiothorac Surg* 2006;30:305-10 [[16828295](#)] [10.1016/j.ejcts.2006.03.037](#)

Vedin J, Jensen U, Ericsson A, Bitkover C, Samuelsson S, Bredin F, Vaage J Cardiovascular function during the first 24 hours after off pump coronary artery bypass grafting—a prospective, randomized study. *Interact Cardiovasc Thorac Surg* 2003;2:489-94 [[17670103](#)] [10.1016/S1569-9293\(03\)00119-1](#)

Velisaris, 2003:

Velisaris T, Tang A, Murray M, El-Minshawy A, Hett D, Ohri S A prospective randomized study to evaluate splanchnic hypoxia during beating-heart and conventional coronary revascularization. *Eur J Cardiothorac Surg* 2003;23:917-24; discussion 924 [[12829067](#)]

Vural, 1995:

Vural KM, Tasdemir O, Karagz H, Emir M, Tarcan O, Bayazit K Comparison of the early results of coronary artery bypass grafting with and without extracorporeal circulation. *Thorac Cardiovasc Surg* 1995;43:320-5 [[8775856](#)]

Wan, 2004:

Wan IY, Arifi AA, Wan S, Yip JH, Sihoe AD, Thung KH, Wong EM, Yim AP Beating heart revascularization with or without cardiopulmonary bypass: evaluation of inflammatory response in a prospective randomized study. *J Thorac Cardiovasc Surg* 2004;127:1624-31 [[15173716](#)] [10.1016/j.jtcvs.2003.10.043](#)

Wandschneider, 2000:

Wandschneider W, Thalmann M, Trampitsch E, Ziervogel G, Kobinia G Off-pump coronary bypass operations significantly reduce S100 release: an indicator for less cerebral damage? *Ann Thorac Surg* 2000;70:1577-9 [[11093490](#)]

Zamvar, 2002:

Zamvar V, Williams D, Hall J, Payne N, Cann C, Young K, Karthikeyan S, Dunne J Assessment of neurocognitive impairment after off-pump and on-pump techniques for coronary artery bypass graft surgery: prospective randomised controlled trial. *BMJ* 2002;325:1268 [[12458242](#)]

GOPCABE, :

ongoing trial NCT00719667

OCTOPUS II, :

ongoing trial

Ontario, :

ongoing trial NCT00259493