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Invasive strategy in patients with resuscitated cardiac arrest and ST elevation myocardial infarction

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Abstract

Coronary artery disease is the most frequent cause of sudden cardiac death. There is general consensus that immediate coronary angiography with percutaneous coronary intervention (PCI) should be performed in all conscious and unconscious patients with ST-elevation myocardial infarction in post-resuscitation electrocardiogram. In these patients acute coronary thrombotic lesion ("ACS" lesion) suitable for PCI is typically present in more than 90%. PCI in these patients is not only feasible and safe but highly effective and there is evidence of improved survival with good neurological outcome. PCI of the culprit lesion is the primary goal while PCI of stable obstructive lesions may be postponed unless post-resuscitation cardiogenic shock is present.

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Key words: Sudden cardiac arrest; ST-elevation myocardial infarction; Coronary angiography; Percutaneous coronary intervention

Core tip: There is general consensus that immediate coronary angiography with percutaneous coronary intervention (PCI) should be performed in all conscious and unconscious patients with ST-elevation myocardial

infarction in postresuscitation electrocardiogram. In these patients, acute coronary thrombotic lesion ("ACS" lesion) suitable for PCI is typically present in more than 90%. PCI in these patients is not only feasible and safe but highly effective and there is evidence of improved survival with good neurological outcome. PCI of the culprit lesion is the primary goal while PCI of stable obstructive lesions may be postponed unless postresuscitation cardiogenic shock is present.

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INTRODUCTION

Coronary artery disease has been documented in almost 80% of patients after resuscitated sudden cardiac arrest (CA)^[1,2]. In the past, most of these patients died either due to profound cardiac failure or post-resuscitation brain injury without any causative treatment^[3]. In year 2002 introduction of hypothermia, which was demonstrated to improve survival and neurological outcome of comatose patients, significantly changed the field of post-resuscitation treatment that became more intensive and cause-oriented^[4,5]. Besides, due to better pre-hospital "chain of survival" increasing numbers of patients after resuscitated cardiac arrest are being nowadays admitted^[6]. These include also patients with ST-elevation myocardial infarction (STEMI) in post-resuscitation electrocardiogram (ECG) requiring immediate coronary angiography (CAG) and percutaneous coronary intervention (PCI).

CAG

Despite the lack of randomized trials demonstrating ef-

Table 1 Non-randomized data on utilization of urgent coronary angiography and primary percutaneous coronary intervention in patients after resuscitated cardiac arrest^[1,7,9-48] *n* (%)

Author	Year	<i>n</i>	Comatose	STEMI	CA-PCI	PCI success	MIH	Survival	CPC 1 or 2	Survival comatose	CPC 1 or 2 comatose	Survival conscious
Kahn	1995	11	7 (64)	11/11 (100)	11 (100)	7/11 (64)	N	6/11 (55)	6/11 (55)	3/7 (43)	3/7 (43)	3/4 (75)
Spaulding	1997	84	NA	34/84 (40)	37 (44)	28/37 (76)	N	32/84 (38)	30/84 (36)	NA	NA	NA
Lin	1998	10	NA	10/10 (100)	10 (100)	10/10 (100)	N	9/10 (90)	NA	NA	NA	NA
Bulut	2000	10	NA	10/10 (100)	10 (100)	8/10 (80)	N	4/10 (40)	NA	NA	NA	NA
McCollough	2002	22	NA	22/22 (100)	22 (100)	22/22 (100)	N	9/22 (41)	NA	NA	NA	NA
Keelan	2003	15	13 (87)	15/15 (100)	15 (100)	14/15 (93)	N	11/15 (73)	9/15 (60)	NA	NA	NA
Bendz	2004	40	36 (90)	40/40 (100)	40 (100)	38/40 (95)	N	29/40 (73)	NA	NA	NA	NA
Quintero-Moran	2006	27	NA	27/27 (100)	27 (100)	23/27 (85)	NA	18/27 (67)	NA	NA	NA	NA
Sunde	2007	47	NA	NA	30 (64)	NA	Y	NA	NA	NA	NA	NA
Gorjup	2007	135	86 (64)	135 (100)	109 (81)	102/109 (94)	Y	90/135 (67)	74/135 (55)	44/86 (51)	25/86 (29)	49/49 (100)
Garot	2007	186	NA	186 (100)	186 (100)	161/186 (87)	Y	103/186 (70)	89/186 (48)	NA	NA	NA
Richling	2007	46	NA	46 (100)	46 (100)	NA	NA	24/46 (52)	22/46 (48)	NA	NA	NA
Markusohn	2007	25	18 (72)	25 (100)	25 (100)	22/25 (88)	Y	19/25 (76)	17/25 (68)	NA	NA	NA
Werling	2007	24	NA	NA	13 (54)	NA	NA	16/24 (67)	NA	NA	NA	NA
Hovdenes	2007	49	49 (100)	NA	36 (73)	NA	Y	41/49 (84)	34/49 (69)	41/49 (84)	34/49 (69)	NA
Valente	2008	31	31 (100)	31 (100)	31 (100)	NA	NA	23/31 (74)	NA	23/31 (74)	NA	NA
Mager	2008	21	NA	21 (100)	21 (100)	NA	NA	18/21 (86)	NA	NA	NA	NA
Wolfrum	2008	16	16 (100)	16 (100)	16 (100)	16/16 (100)	Y	12/16 (75)	NA	12/16 (75)	11/16 (69)	NA
Pleskot	2008	20	NA	NA	19 (95)	17/19 (89)	NA	NA	NA	NA	NA	NA
Peels	2008	44	NA	44 (100)	44 (100)	38/44 (86)	NA	22/44 (50)	NA	NA	NA	NA
Merchant	2008	30	NA	13 (43)	30 (20)	17/19 (89)	NA	22/30 (80)	NA	NA	NA	NA
Hosmane	2009	98	73 (74)	98 (100)	64 (65)	62/64 (97)	Y	63/98 (64)	57/98 (58)	39/73 (53)	33/73 (45)	24/25 (96)
Anyfantakis	2009	72	NA	23 (32)	27 (38)	24/27 (89)	NA	35/72 (49)	33/72 (46)	NA	NA	NA
Reynolds	2009	96	NA	42 (44)	NA	NA	Y	52/96 (54)	NA	NA	NA	NA
Lettieri	2009	99	NA	99 (100)	99 (100)	79/99 (80)	NA	77/99 (78)	72/99 (73)	NA	NA	NA
Pan	2010	49	NA	49 (100)	49 (100)	42/49 (86)	NA	31/49 (63)	NA	NA	NA	NA
Battista	2010	20	NA	10 (50)	20 (100)	NA	Y	8/20 (40)	6/20 (30)	NA	NA	NA
Dumas	2010	435	NA	134 (31)	202 (46)	177/202 (88)	Y	171/435 (39)	160/435 (37)	NA	NA	NA
Stub	2011	62	62 (100)	27 (44)	31 (50)	29/31 (94)	Y	NA	NA	NA	NA	NA
Tomte	2011	252	NA	NA	NA	NA	NA	140/252 (56)	108/212 (51)	113/171 (66)	73/171 (43)	41/41 (100)
Radsel	2011	212	171 (81)	158 (75)	165 (78)	150/165 (91)	Y	154/212 (73)	NA	NA	NA	NA
Mooney	2011	101	NA	68 (67)	56 (55)	NA	NA	NA	NA	NA	NA	NA
Cronier	2011	91	NA	50 (55)	46 (51)	43/46 (93)	Y	60/91 (66)	NA	NA	NA	NA
Moellmann	2011	65	NA	36 (55)	65 (100)	64/65 (98)	NA	46/65 (71)	NA	NA	NA	NA
Nanjayya	2012	35	35 (100)	31 (89)	21 (60)	NA	Y	20/35 (57)	14/35 (40)	20/35 (57)	14/35 (40)	NA
Bro-Jeppesen	2012	360	360 (100)	116 (32)	198 (55)	101/122 (83)	Y	219/360 (61)	207/360 (58)	219/360 (61)	207/360 (58)	NA
Zanutini	2012	93	93 (100)	32 (34)	NA	NA	Y	50/93 (54)	36/93 (39)	50/93 (54)	36/93 (39)	NA
Liu	2012	81	24 (30)	81 (100)	49 (60)	42/49 (86)	N	36/81 (44)	NA	NA	NA	NA
Zimmermann	2013	48	48 (100)	48 (100)	44 (92)	37/44 (84)	Y	32/48 (67)	16/48 (33)	32/48 (67)	16/48 (33)	NA
Hollenbeck	2013	269	269 (100)	0 (0)	122 (45)	NA	Y	151/269 (56)	NA	151/269 (56)	NA	NA
Velders	2013	224	108 (48)	224 (100)	217 (97)	NA	Y	183/218 (84)	168/218 (77)	NA	NA	NA
Skupaj	2013	3655	1499/1804 (83)	2012/3263 (62)	2253/3179 (71)	1373/1553 (88)	Y	2036/3384 (60)	1158/2241 (52)	747/1238 (60)	452/838 (54)	117/119 (98)

STEMI: ST-elevation myocardial infarction; PCI: Percutaneous coronary intervention; CA: Cardiac arrest; NA: Not available; MIH: Mild induced hypothermia

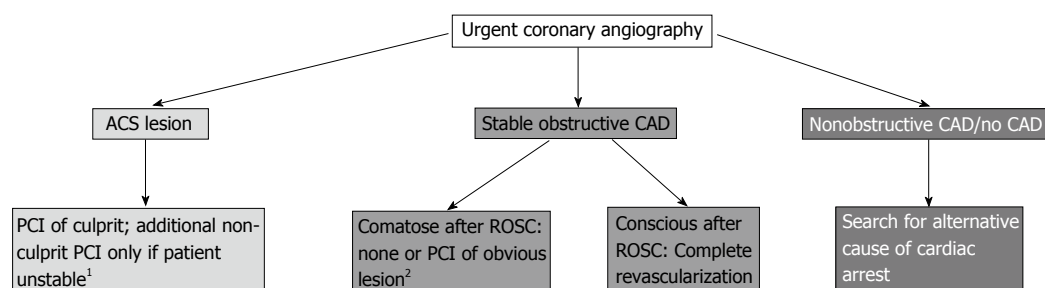


Figure 1 Revascularization strategy based on coronary angiography findings. ¹If ischemia or cardiogenic shock after successful culprit PCI; ²If considered responsible for cardiac arrest or beneficial for hemodynamic stability. ROSC: Return of spontaneous circulation; PCI: Percutaneous coronary intervention; CAD: Coronary artery disease.

fectiveness of immediate CAG and PCI in patients with resuscitated CA, we gradually increased the number of patients undergoing such immediate invasive coronary strategy. We extrapolated knowledge from randomized studies on acute coronary syndrome patients^[7] and generated our own experience on combination of immediate invasive coronary strategy mild induced hypothermia^[8,9]. After favorable experience with STEMI patients in post-resuscitation ECG, we applied the same protocol also to patients without STEMI in whom no obvious non-coronary cause of cardiac arrest was present. We were encouraged also by increasing number of independent peer-review experience by other investigators in more than 3500 patients cumulatively (Table 1). Patient selection and time to invasive procedure in these studies was different therefore results cannot be compared. Nevertheless we can appreciate that urgent PCI is feasible and highly effective in this population. There is also recent meta analysis of 10 observational studies showing immediate invasive coronary strategy to as independent predictor of survival (OR = 2.78; 95%CI: 1.89-4.10, $P < 0.001$)^[10].

Pubmed observational cohort studies on utilization of immediate CAG/PCI in patients with resuscitated sudden cardiac arrest (Table 1)^[1,8,11-49].

REPERFUSION STRATEGY

According to revascularization guidelines for STEMI without preceding CA^[50], CA-PCI should be primary directed towards “ACS lesions” for which we can assume direct cause-effect relationship with CA (Figure 1). The rationale is to reduce infarct size and improve hemodynamic and electrical stability. Patients who regain consciousness after return of spontaneous circulation have excellent prognosis (Table 1). Their survival is comparable or is even better than in general STEMI population without preceding CA. This may be partly explained by shorter ischemic times because of shorter patient delay. Index multi vessel and not only “culprit” PCI seems to be indicated only patients with post-resuscitation cardiogenic shock^[51]. We can speculate that complete revascularization improves left ventricular function, which may facilitate survival from post-resuscitation cardiogenic shock.

DISCUSSION

Nowadays, there is a question whether we should base our revascularization strategy for patients with STEMI in post-resuscitation ECG on non-randomized observational cohort studies. We believe, based on our experience and experience of others, that it would be very difficult to perform such prospective randomized trial. On the other hand we think such trial is needed for patients without STEMI in post-resuscitation ECG. However, regardless of this, we think patients with resuscitated cardiac arrest should be included in existing “STEMI networks” with direct transportation to the specialized “cardiac arrest centers” of excellence. Because of critical role of immediate CAG and PCI, interventional cardiologists should be an essential member of post-resuscitation team. However, when treating post CA patients we should avoid futility. In unfavorable settings of cardiac arrest (unwitnessed arrest, long delays to pre-hospital team arrival, no BLS, “non-shockable” first rhythm, long ACLS, recurrent arrest) or severe pre-arrest comorbidities, aggressive post-resuscitation treatment is not likely to result in quality survival.

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