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Comparison of Extracorporeal Cardiopulmonary Resuscitation with Conventional Cardiopulmonary Resuscitation: Is Extracorporeal Cardiopulmonary Resuscitation Beneficial?

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Background: With improvements in cardiopulmonary resuscitation (CPR) techniques, the quality and the effectiveness of CPR have been established; nevertheless, the survival rate after cardiac arrest still remains poor. Recently, many reports have shown good outcomes in cases where extracorporeal membrane oxygenation (ECMO) was used during prolonged CPR. Accordingly, we attempted to evaluate the impact of extracorporeal cardiopulmonary resuscitation (ECPR) on the survival of patients who experienced a prolonged cardiac arrest and compared it with that of conventional CPR (CCPR). ***Methods:*** Between March 2009 and April 2014, CPR, including both in-hospital and out-of-hospital CPR, was carried out in 955 patients. The ECPR group, counted from the start of the ECPR program in March 2010, included 81 patients in total, and the CCPR group consisted of 874 patients. All data were retrospectively collected from the patients' medical records. ***Results:*** The return of spontaneous circulation (ROSC) rate was 2.24 times better in CPR of in-hospital cardiac arrest (IHCA) patients than in CPR of out-of-hospital CA (OHCA) patients (p=0.0012). For every 1-minute increase in the CPR duration, the ROSC rate decreased by 1% (p=0.0228). Further, for every 10-year decrease in the age, the rate of survival discharge increased by 31%. The CPR of IHCA patients showed a 2.49 times higher survival discharge rate than the CPR of OHCA patients (p=0.03). For every 1-minute increase in the CPR duration, the rate of survival discharge was decreased by 4%. ECPR showed superiority in terms of the survival discharge in the univariate analysis, although with no statistical significance in the multivariate analysis. ***Conclusion:*** The survival discharge rate of the ECPR group was comparable to that of the CCPR group. As the CPR duration increased, the survival discharge and the ROSC rate decreased. Therefore, a continuous effort to reduce the time for the decision of ECMO initiation and ECMO team activation is necessary, particularly during the CPR of relatively young patients and IHCA patients.

Key words: 1. Cardiac arrest
2. Outcomes
3. Extracorporeal membrane oxygenation

INTRODUCTION

Over the past decades, the survival rate after cardiac arrest (CA) has remained poor despite the technical improvements in and the increased quality and effectiveness of cardiopulmonary resuscitation (CPR) [1-3]. Several factors, including the duration of CPR, initial cardiac rhythm, underlying primary disease, and age, may be related to the outcome [1,4,5].

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Table 1. Baseline characteristics

Characteristic	Conventional CPR (n=874)	Extracorporeal CPR (n=81)	p-value[a)]
Sex			0.4061
Female	310 (35.5)	25 (30.9)	
Male	564 (64.5)	56 (69.1)	
Age (yr)	63.5±17.6	59.0±18.6	0.0268
Main diagnosis			<0.0001
Acute coronary syndrome	355 (40.6)	54 (66.7)	
Heart failure	63 (7.2)	15 (18.5)	
Pulmonary thromboembolism	11 (1.3)	1 (1.2)	
Other	445 (50.9)	11 (13.6)	
Location			<0.0001
Out-of-hospital cardiac arrest	683 (78.1)	20 (24.7)	
In-hospital cardiac arrest	191 (21.9)	61 (75.3)	
CPR duration (min)	30 (15–48)	43 (21–60)	0.0269
Initial electrocardiogram			<0.0001
Ventricular tachycardia or ventricular fibrillation	129 (14.8)	34 (42.0)	
Pulseless electrical activity	314 (35.9)	28 (34.6)	
Asystole	390 (44.6)	10 (12.3)	
Other	41 (4.7)	9 (11.1)	
pH	6.98 (6.86–7.09)	7.14 (6.97–7.35)	0.0035
Lactate	10.4 (6.3–13.7)	9.9 (5.2–13.9)	<0.0001
pO_2	52.1 (25.0–83.0)	72.1 (43.3–124.6)	0.8154
pCO_2	67.5 (46.3–92.0)	41.1 (28.7–69.3)	0.0003
Diabetes mellitus	259 (29.6)	28 (35.0)	0.3165
Hypertension	346 (39.6)	45 (56.3)	0.0037
Dyslipidemia	541 (61.9)	14 (17.5)	<0.0001
Malignancy	83 (9.5)	5 (6.3)	0.3368
Stroke	81 (9.3)	2 (2.5)	0.0398
Chronic renal failure	80 (9.2)	7 (8.8)	0.9045
Cardiovascular disease	105 (13.4)	60 (98.4)	<0.0001

Values are presented as number of patients (%), mean±standard deviation, or median (interquartile range), unless otherwise indicated. CPR, cardiopulmonary resuscitation.
[a)]Calculated using chi-square test, Student t-test, or Wilcoxon's rank-sum test, as appropriate.

Because of the low survival rate after prolonged CPR, more aggressive methods have been suggested to increase the success rate. Hence, several mechanical devices and techniques that may extend the accepted duration of CPR and eventually increase the survival rate have been developed.

Since 2008, when Chen et al. [6] reported that extracorporeal CPR (ECPR) significantly increases the survival rate in selective patients as compared to conventional CPR (CCPR), the application of ECPR has increased dramatically worldwide. Recently, advances in extracorporeal membrane oxygenation (ECMO) technologies and devices and the improvements in biocompatible percutaneous cannulas have made ECMO a more powerful resuscitation tool. Several studies have reported the advantages of ECPR such as hemodynamic stabilization, increased frequency of the return of spontaneous circulation (ROSC), and improved survival with a good neurologic outcome when compared to CCPR [7-11]. Further, recently, many studies have demonstrated that ECPR leads to more favorable outcomes in in-hospital CA (IHCA) patients than in out-of-hospital CA (OHCA) patients [12,13]. Moreover, primarily, an early decision and insertion of ECMO with appropriate indication is essential for improving the prognosis of patients with prolonged CPR [12-14].

In this study, we have attempted to evaluate the impact of

Table 2. ROSC analysis

Variable	ROSC		p-value[a)]
	No (n=244)	Yes (n=711)	
Sex			0.4931
Female	90 (26.9)	245 (73.1)	
Male	154 (24.8)	466 (75.2)	
Age (yr)	66.1±18.1	62.1±17.5	0.0022
CPR			0.0098
Conventional CPR	233 (26.7)	641 (73.3)	
Extracorporeal CPR	11 (13.6)	70 (86.4)	
Main diagnosis			0.0014
Acute coronary syndrome	128 (31.3)	281 (68.7)	
Heart failure	14 (17.9)	64 (82.1)	
Pulmonary thromboembolism	5 (41.7)	7 (58.3)	
Others	97 (21.3)	359 (78.7)	
Location			<0.0001
Out-of-hospital cardiac arrest	213 (30.3)	490 (69.7)	
In-hospital cardiac arrest	31 (12.3)	221 (87.7)	
CPR duration (min)	39 (25–55)	27 (12–46)	<0.0001
Initial electrocardiogram			0.0187
Ventricular tachycardia or ventricular fibrillation	27 (16.6)	136 (83.4)	
Pulseless electrical activity	86 (25.1)	256 (74.9)	
Asystole	117 (29.3)	283 (70.8)	
Others	14 (28.0)	36 (72.0)	
pH	7.0 (6.8–7.1)	7.0 (6.9–7.2)	0.0341
Lactate	10.2 (6.3–14.0)	10.4 (6.4–13.7)	0.7065
pO_2	54.2 (20.0–80.9)	54.0 (27.2–88.2)	0.1007
pCO_2	62.3 (44.2–89.5)	66.2 (43.5–90.6)	0.6449

Values are presented as number of patients (%), mean±standard deviation, or median (interquartile range), unless otherwise indicated.
ROSC, return of spontaneous circulation; CPR, cardiopulmonary resuscitation.
[a)]Calculated using chi-square test, Fisher's exact test, Student t-test, or Wilcoxon's rank-sum test, as appropriate.

ECPR on the survival of patients who experienced prolonged CA and compared it with that of CCPR.

METHODS

1) Study population

This study enrolled patients who received CPR at our institution between March 2009 and April 2014. The total number of patients, including both in-hospital CPR patients and out-of-hospital CPR patients, was 955. Since the start of the ECPR program at our hospital in March 2010, there have been a total of 81 patients treated with ECPR; these patients were included in the ECPR group. The other 874 patients, who were treated with CCPR, were included in the CCPR group. All data were retrospectively collected from the medical records and CPR input forms of the emergency department.

2) Indications for extracorporeal cardiopulmonary resuscitation

The ECMO team was activated, and the team decided whether or not to initiate ECPR in all patients who did not show the ROSC after 10 minutes of advanced cardiac life support or when the repetitive arrest events occurred without ROSC for more than 20 minutes. The contraindications of ECPR were patient conditions such as terminal malignancy, irreversible brain damage, multi-organ failure, and certain circumstances when a patient's family did not want additional

Table 3. Results of multiple logistic regression analysis of return of spontaneous circulation

Variable	Odds ratio (95% confidence interval)	p-value[a)]
Age (unit: 10 yr)	0.92 (0.83–1.02)	0.1264
CPR		
Conventional CPR	Reference	
Extracorporeal CPR	1.11 (0.40–3.07)	0.8403
Main diagnosis		
Acute coronary syndrome	0.63 (0.44–0.90)	0.0115
Heart failure	1.43 (0.53–3.84)	0.4827
Pulmonary thromboembolism	0.63 (0.12–3.32)	0.5876
Other	Reference	
Location		
Out-of-hospital cardiac arrest	Reference	
In-hospital cardiac arrest	2.24 (1.37–3.65)	0.0012
CPR duration (min)	0.99 (0.99–1.00)	0.0228
Initial electrocardiogram		
Ventricular tachycardia or ventricular fibrillation	0.67 (0.18–2.48)	0.5489
Pulseless electrical activity	0.38 (0.11–1.34)	0.1316
Asystole	0.37 (0.10–1.28)	0.1146
Other	Reference	

CPR, cardiopulmonary resuscitation.
[a)]Calculated using chi-square test, Fisher's exact test, Student t-test, or Wilcoxon's rank-sum test, as appropriate.

treatment with the ECMO. Further, ECPR was not performed in OHCA cases of unwitnessed CA, missed previous performance of bystander CPR, or in patients aged over 80 years. If the initial electrocardiogram (ECG) rhythm was at a standstill, we did not perform ECPR.

3) Data collection

Clinical data such as the patient's age, sex, and other basic characteristics, and the location of CA, CPR, and defibrillation were collected. The peak level of lactate before the CPR, the results of an arterial blood gas analysis, and the initial ECG rhythm were also collected and analyzed. The primary end point in this study was all causes of death in hospital. The secondary end point was the ROSC rate.

4) Statistical analysis

All data were entered into an Excel spreadsheet (Microsoft, Bellevue, WA, USA). Data were analyzed using the SAS statistical program ver. 9.4 (SAS Institute Inc., Cary, NC, USA) to compare the clinical outcomes of each treatment modality. The univariate data analysis included t-tests for continuous variables and Fisher's exact test for discrete variables. A multivariate analysis with logistic regression was also performed. Data were reported as the mean±standard error of the mean. A value of $p<0.05$ was considered statistically significant.

RESULTS

There was no difference in sex between the two groups. The patients were younger in the ECPR group than in the CCPR group (59.0±18.6 years vs. 63.5±17.6 years, p=0.027). The diagnosis of acute coronary syndrome was significantly more frequent in the ECPR group (66.7% vs. 40.6%, $p<0.0001$). Ventricular fibrillation and tachycardia, and pulseless electrical activity were the majority of the initial ECG findings in the ECPR group (42.0% and 34.6%, $p<0.0001$). Asystole was noted only in 12.3% of the initial ECGs in the ECPR group. There were more cases of OHCA in the CCPR group than in the ECPR group (78.1% vs. 24.7%, $p<0.0001$). Further, the CPR duration was significantly longer during the ECPR (43 minutes vs. 30 minutes, p=0.027). The peak lactate level was higher in the CCPR group (10.4 vs. 9.9, $p<0.0001$). While there were more patients with hypertension and a past

Table 4. Survival discharge rate

Variable	Survival discharge		p-value[a)]
	Non-survivor (n=817)	Survivor (n=138)	
Sex			0.9092
Female	286 (85.4)	49 (14.6)	
Male	531 (85.6)	89 (14.4)	
Age (yr)	64.1±17.5	57.3±18.0	<0.0001
CPR			0.0376
Conventional CPR	754 (86.3)	120 (13.7)	
Extracorporeal CPR	63 (77.8)	18 (22.2)	
Main diagnosis			<0.0001
Acute coronary syndrome	346 (84.6)	63 (15.4)	
Heart failure	52 (66.7)	26 (33.3)	
Pulmonary thromboembolism	11 (91.7)	1 (8.3)	
Other	408 (89.5)	48 (10.5)	
Location			<0.0001
Out-of-hospital cardiac arrest	625 (88.9)	78 (11.1)	
In-hospital cardiac arrest	192 (76.2)	60 (23.8)	
CPR duration (min)	33 (19–52)	10 (5–25)	<0.0001
Initial electrocardiogram			<0.0001
Ventricular tachycardia or ventricular fibrillation	111 (68.1)	52 (31.9)	
pulseless electrical activity	282 (82.5)	60 (17.5)	
Asystole	391 (97.8)	9 (2.3)	
Other	33 (66.0)	17 (34.0)	
pH	6.98 (6.9–7.1)	7.10 (7.0–7.3)	<0.0001
Lactate	10.8 (7.1–14.0)	7.0 (3.6–9.2)	<0.0001
Diabetes mellitus	242 (84.3)	45 (15.7)	0.4461
Hypertension	323 (82.6)	68 (17.4)	0.0261
Dyslipidemia	477 (85.9)	78 (14.1)	0.7502
Malignancy	81 (92.0)	7 (8.0)	0.0721
Stroke	75 (90.4)	8 (9.6)	0.1992
Chronic renal failure	68 (78.2)	19 (21.8)	0.0369
Cardiovascular disease	133 (80.6)	32 (19.4)	0.0020

Values are presented as number of patients (%), mean±standard deviation, or median (interquartile range), unless otherwise indicated.
CPR, cardiopulmonary resuscitation.
[a)]Calculated using chi-square test, Student t-test, or Wilcoxon's rank-sum test, as appropriate.

history of cardiovascular disease in the ECPR group ($p<0.05$), the number of cases with a past history of stroke was higher in the CCPR group (9.3% vs. 2.5%, $p<0.04$) (Table 1).

Looking at the univariate analysis of ROSC results, factors such as age, CCPR, main diagnosis, CPR location, CPR duration, initial ECG, and pH had a statistically significant relationship with the ROSC rate (Table 2). However, in the multivariate logistic regression analysis, the main diagnosis of acute coronary syndrome (ACS) and the CPR location of OHCA patients were the only significant negative risk factors for ROSC. The ROSC rate of ACS patients was 0.63 times lower than that of the others (p=0.0115). IHCA in the CPR location was 2.24 times better than OHCA (p=0.0012). For every 1-minute increase in the CPR duration, the ROSC rate fell by 1% (p=0.0228) (Table 3).

In the univariate analysis, relatively young age, CPR location, CPR duration, initial ECG, pH, peak lactate level, arterial blood gas analysis, the history of hypertension, chronic renal failure, and cardiovascular disease were the statistically significant factors that showed a relationship with the survival

Table 5. Results of multiple logistic regression analysis of survival discharge

Variable	Odds ratio (95% confidence interval)	p-value[a)]
Age (unit: 10 yr)	0.69 (0.59–0.80)	<0.0001
CPR		
Conventional CPR	Reference	
Extracorporeal CPR	0.37 (0.13–1.06)	0.0647
Main diagnosis		
Acute coronary syndrome	1.80 (0.95–3.38)	0.0697
Heart failure	2.62 (1.08–6.36)	0.0341
Pulmonary thromboembolism	0.92 (0.09–8.98)	0.9426
Other	Reference	
Location		
Out-of-hospital cardiac arrest	Reference	
In-hospital cardiac arrest	2.49 (1.35–4.57)	0.0034
CPR duration (min)	0.96 (0.95–0.98)	<0.0001
Initial electrocardiogram		
Ventricular tachycardia or ventricular fibrillation	0.81 (0.29–2.20)	0.6730
Pulseless electrical activity	0.20 (0.07–0.57)	0.0024
Asystole	0.05 (0.02–0.15)	<0.0001
Other	Reference	
Hypertension		
No	Reference	
Yes	1.79 (1.00–3.22)	0.0517
Malignancy		
No	Reference	
Yes	0.85 (0.32–2.24)	0.7435
Stroke		
No	Reference	
Yes	0.69 (0.24–1.99)	0.4960
Chronic renal failure		
No	Reference	
Yes	1.61 (0.74–3.50)	0.2302
Cardiovascular disease		
No	Reference	
Yes	1.85 (0.93–3.67)	0.0782

CPR, cardiopulmonary resuscitation.
[a)]Calculated using chi-square test, Fisher's exact test, Student t-test, or Wilcoxon's rank-sum test, as appropriate.

discharge ratio (Table 4). However, only young age, heart failure, IHCA, and history of cardiovascular disease showed a higher rate of survival discharge in the multiple logistic regression analysis. As for the patient age, for every 10-year decrease in age, the rate of survival discharge increased by 31%. The CPR location of IHCA patients showed a 2.49-fold higher survival discharge rate that of OHCA patients (p=0.03). Further, with every 1-minute increase in CPR duration, the rate of survival discharge fell by 4%. If the patient had an asystole in the initial ECG, he had a very low possibility of survival. Overall, ECPR was superior to CCPR in terms of the rate of survival discharge in the univariate analysis (22.2% vs. 13.7%, p=0.0376), although with no statistical significance in the multivariate analysis (p=0.0647) (Table 5).

The survival curve of the ECPR group obtained using the log-rank test after the adjustment for the CPR duration was not better than that of the CCPR group. However, the ECPR group showed a higher survival rate after 400 days, although without any statistical significance (p=0.183) (Fig. 1).

We also analyzed the survival discharge rate of subgroups

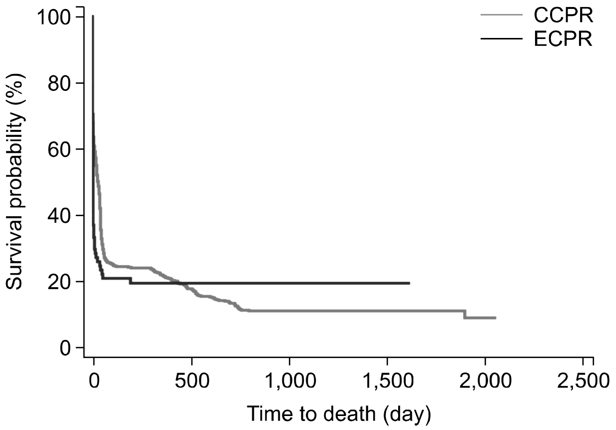

Fig. 1. Kaplan-Meier curve for survival discharge for extracorporeal cardiopulmonary resuscitation (ECPR) and conventional cardiopulmonary resuscitation (CCPR). p-value=0.183, as obtained by using log-rank test.

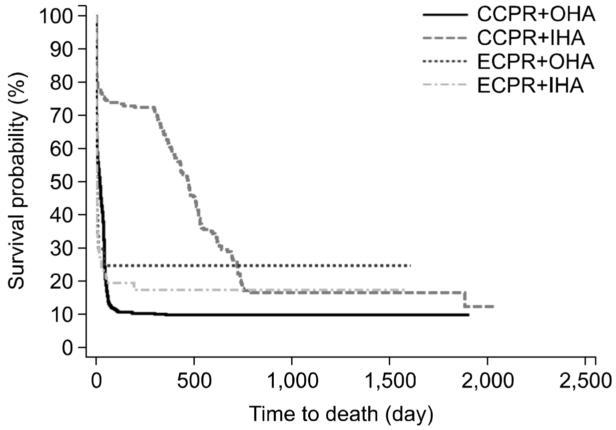

Fig. 2. Kaplan-Meier curve for survival discharge for different CPR types and locations. p-value<0.001, as obtained by using log-rank test. CCPR, conventional cardiopulmonary resuscitation; OHA, out of hospital cardiac arrest; IHA, in hospital cardiac arrest; ECPR, extracorporeal cardiopulmonary resuscitation.

divided by CPR type and cardiac arrest location. CCPR in IHCA patients showed a survival discharge rate superior to that of CCPR in OHCA patients ($p<0.001$) (Fig. 2). The mortality rate of CCPR in IHCA patients was 0.45 times lower than that of CCPR in OHCA patients.

To determine the cutoff value of the CPR duration for survival discharge, we analyzed the data by using the receiver operating characteristic (ROC) curve. We found that the area under the ROC curve (AUC) in the CCPR group was 0.784.

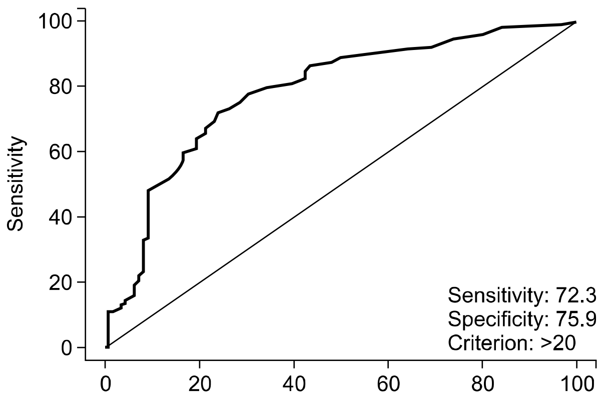

Fig. 3. Area underthereceiver operating characteristic curvefor conventional cardiopulmonary resuscitation.

The sensitivity was 72.35 (95% confidence interval [CI], 69.0–75.5), and the specificity was 75.93 (95% CI, 66.7–83.6). The cutoff value of the CPR duration for survival in the CCPR group was 20 minutes (Fig. 3). However, the AUC in the ECPR group was just 0.582. This value was not statistically significant. According to these data, the CPR duration in the ECPR group did not affect the survival rate.

DISCUSSION

Extracorporeal life support (ECLS) has been proposed as the fundamental rescue method in prolonged CA patients unresponsive to CCPR [6,15-18]. ECLS refers to a technology that is used for supporting the circulation of a patient with severe cardiac failure. The physiological objective is to provide temporary circulatory support to the vital organs and to unload the failing heart as the injured myocardium attempts to recover. In fact, ECLS has been suggested as a therapeutic option in cases of refractory CA since 1976 [19].

With respect to the baseline characteristics, the patient age in the ECPR group was significantly lower than that in the CCPR group. In general, old age is one of the factors that makes the physician reluctant to decide to initiate ECPR, and although not documented, there are many medical centers internationally where old age is in the exclusion criteria for ECPR. The fact that a large portion of CPR cases are treated in the emergency department and that few cases are suitable for ECPR, has resulted in the large number of out-of-hospital patients in the CCPR group.

The results showed more persistent electrical activity (PEA), ventricular tachycardia, and fibrillation in the initial ECG of the ECPR group, which means that the ECPR group had a shorter duration of CA and higher reversibility. The results of the arterial blood gas analysis in the CCPR group (higher level of pH and peak lactate) may be related to the inclusion of many cases in which CPR was continued for more than 1 hour.

In the CoSTR 2010 (2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations) [14], the ILCOR (International Liaison Committee on Resuscitation) concluded that there was very little evidence as to whether the routine use of ECPR for CA should be recommended. Therefore, ECPR should be performed with strict indications, which has gained a worldwide consensus. Recently, the number of ECMO cases has substantially increased in Korea (from 900 cases in 2006 to 1,494 cases in 2013) [20]. Among them, the ECPR presumably accounted for more than 30% of all cases. Since an indiscriminate application of ECPR may be associated with financial waste and ethical problems, the establishment of indications for ECPR in Korea is required. The AHA-G 2010 (2010 American Heart Association Guidelines) [21] recommend, on the basis of previous reports [22-24], that a class IIb procedure should be performed under the following conditions: when ECPR can be quickly prepared for introduction; when the duration of circulatory arrest due to CA is short; and when reversal of the causes of CA can be expected. Unresponsive CA means that repetitive arrest events occur without the return of ROSC for more than 20 minutes [25]. However, nowadays, many ECPR centers have set their own indication for ECPR as unresponsive CA for 10 minutes on the basis of Chen et al. [6]'s study. An important point in the use of CPR after CA is rapid ROSC. This can reduce the CPR duration and maintain the circulation; thus, it can reduce the ischemic damage in tissues and organs. The advantage of ECPR in CA cases lies in the fact that it can increase the rate of ROSC, maintain the perfusion, and recover the oxygen metabolism. ECPR showed a relatively high ROSC rate in our study as well (Table 2). Further, because right can rapidly supply oxygenated blood to a failing myocardium, it can prevent irreversible ischemia and earn the time prior to intervention for revascularization, which makes it similar to percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). However, because excessively high oxygenation (high fractionated O^2) by ECPR can induce the formation of a superoxide, it is important for physicians to pay considerable attention to this issue [26].

Girotra et al. [27] reported that ventricular tachycardia or ventricular fibrillation on the initial ECG rhythm showed better survival than PEA or asystole. Further, IHCA patients have a shorter CPR duration, a higher probability of a witness, and more known causes of CA than OHCA patients. As a result, IHCA patients have a higher probability of inclusion in the ECPR indication. Our data also showed more ventricular tachycardia or ventricular fibrillation on the initial ECG and a higher number of IHCA patients in the ECPR group.

The ECPR group did not show any statistical significance in the multivariate logistic regression analysis for the ROSC rate and the survival discharge rate. There are several reasons that may have led to this result. First, the ECPR group included more severe patients than the CCPR group, because the patients in the ECPR group were patients who did not show ROSC after 10 minutes of CCPR. Second, the CPR duration of the ECPR group was longer (Table 1), since a period of at least 30 minutes was needed to activate the ECPR team and to start the ECMO during CCPR. Therefore, considering these circumstances, we think that ECPR may have had a positive influence on the results of ROSC and survival discharge rates of CPR.

Because a rapid revascularization by direct PCI or emergency CABG could be performed in CA patients with ACS, they had higher ROSC and survival discharge rates. It is very natural that IHCA patients showed a higher ROSC rate (2.24 times) and a higher survival discharge rate (2.59 times) than OHCA patients. This study proved that with every 1-minute increase in the CPR duration, the ROSC rate decreased by 1% and the rate of survival discharge decreased by 4% in both groups. In the end, we can assume that by increasing the ROSC rate, we can also increase the survival discharge rate. Therefore, a well-organized ECMO team must be prepared in order to reduce the time from the activation of the ECMO team to the actual start of the ECMO.

Another important point to be discussed in this study is that we showed that the cutoff value of the CPR duration is 20 minutes for possible survival discharge in the CCPR group. Therefore, we have been trying to reduce the activation time of the ECPR team from 10 minutes to 7 minutes in order to reduce the CPR duration. Further, in the near future, we plan to investigate whether the reduced CPR time of 7 minutes has any statistically significant influence on the survival discharge rate. Unfortunately, we could not obtain the cutoff value in the ECPR group, but by collecting more data, we are expecting to obtain this valuable information in the near future.

We are expecting that based on the preliminary results of this study, we may obtain more important and significant results of ECPR in the future, by acquiring more data and carrying out some analysis using propensity score matching, which may increase the statistical power.

1) Limitations

This is a retrospective observational study. We included all causes of CA in this study. Previous studies that analyzed the ECPR mainly included only the cardiac-originated arrest patients, which accounts for about half of the total CA patients. Therefore, by limiting the patient range to cardiac-originated arrest patients, it is possible to obtain more unified information. However, since extra-cardiac-originated CA patients also comprise the other half and considering that they are also possible candidates for ECPR, we have included all cases of cardiac arrests in this study irrespective of the cause.

2) Conclusion

The survival discharge rate of the ECPR group was comparable to that of the CCPR group. With an increase in the CPR duration, the survival discharge rate and the ROSC rate decreased. Therefore, a continuous effort to reduce the time taken for the decision of ECMO initiation and for ECMO team activation is necessary, particularly during the CPR of relatively young patients and IHCA patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

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