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Original Article

The Usefulness of the Coefficient of Variation of Electrocardiographic RR Interval as an Index of Cardiovascular Function and its Correlation with Age and Stroke

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Abstract

The coefficient of variation (CV) of the time interval between two consecutive R-waves, also known as the RR interval (RRI), is calculated by dividing the standard deviation of RRI (SDNN) by the mean of RRI. CV of RRI is similar to heart rate variability in terms of individual normalization. The purpose of this study was to evaluate the validity of CV of RRI as an index of cardiovascular function and its correlation with age and stroke.

CV of RRI, SDNN, and baroreflex sensitivity (BRS) were evaluated in 31 healthy controls and 25 patients who had suffered ischemic stroke. Resting electrocardiography and arterial blood pressure were recorded for 10 min, once in the supine position in all recruited subjects and once in the head-up tilt position in the controls. BRS was measured using the spontaneous sequence analysis method.

In the healthy controls, CV of RRI, SDNN, and BRS recorded in both the supine ($r = -0.526$, -0.731, and -0.637, respectively; all $p < 0.01$) and head-up tilt positions ($r = -0.785$, -0.697, and -0.703, respectively; all $p < 0.01$) were negatively correlated with age. In contrast, no correlation was found between these indices and age in the stroke patients. Significant correlations were found among CV of RRI, SDNN, and BRS in both the healthy controls and stroke patients (all $p < 0.01$).

In conclusion, CV of RRI measured using simple medical devices may be a potentially useful indicator of cardiovascular function in both healthy individuals and stroke patients. Aging is associated with a decline in SDNN, BRS, and CV of RRI in healthy individuals.

Key words: Coefficient of variation, Heart rate variability, Baroreflex sensitivity, Ischemic stroke

Introduction

Cardiovascular disease creates a considerable impact on the health care system and imposes a heavy socioeconomic burden. Early detection and prevention of cardiovascular disease is the goal of medical systems all over the world. Cardiovascular autoregulation is important in the maintenance of homeostasis, which is essential to cardiovascular health. Individuals with impaired cardiovascular autoregulation are at higher risk of future cardiovascular events[1]. Various indices of cardiovascular autoregulation have been used for risk stratification or diagnosis of certain diseases[2-4]. Among these, baroreflex sensitivity (BRS)[5] and heart rate variability (HRV) have been proved to be related to long-term outcomes[6]. Both BRS and HRV represent fluctuations in blood pressure (BP) and heart rate as a result of interaction between and feedback modulation of sympathetic and parasympathetic nervous

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activity[7-9]. Evaluation of the baroreflex, which is a protective vagal reflex, has significant prognostic value in patients with acute myocardial infarction[10]. However, measurement of BRS requires sophisticated equipment or pharmacological manipulation of BP[5,11]. Measurement of HRV in the time and frequency domains is a noninvasive, convenient tool for the evaluation of autonomic nervous physiology[12]. Estimation of HRV may offer additional prognostic information beyond that provided by the evaluation of traditional risk factors[13]. Clinical application of HRV is limited because short-term HRV can be quite variable, although the measurement settings are standardized[14,15]. Therefore, the coefficient of variation (CV) of the time interval between two consecutive R-waves, also known as the RR interval (RRI), has been proposed as an alternative measurement tool. The CV is calculated by dividing the standard deviation of RRI (SDNN) by the mean of RRI[16]. CV of RRI has characteristics similar to those of HRV and enables individual normalization for patients with cardiovascular disease. CV of RRI is less variable than HRV across time and among individuals[17] and is a potential indicator of cardiovascular autoregulation. The CV and the SDNN are both strong predictors of survival after myocardial infarction[18]. Moreover, CV of RRI can be derived using simple medical devices. The clinical application of CV of RRI is of interest and requires clinical study. To evaluate the usefulness of CV of RRI as an index of cardiovascular autoregulation, we compared its values with those of HRV and BRS in healthy controls and stroke patients. We also evaluated the correlation among these parameters as well as the correlation between these parameters and age in both groups.

Methods

Participants

Twenty-five consecutive patients (14 males, 67.8 ± 10.5 years) who were admitted to our institution with acute ischemic stroke were prospectively recruited for this study. All patients fulfilled the World Health Organization criteria of stroke and exhibited no evidence of hemorrhage on computed tomography or magnetic resonance imaging of the cranium. Patients with unstable vital signs, respiratory distress, significant cardiac arrhythmia (except occasional atrial or ventricular premature beats), peripheral vascular insufficiency, or inability to withhold medication prior to the study because of their clinical condition were excluded. In addition, 31 healthy subjects (14 males, 49.0 ± 21.4 years) were recruited as controls from a group of individuals who received physical check-ups and had no previous history of cardiovascular disease. This study was approved by the Institutional Review Board of our hospital. All participants provided informed consent before entering the study.

Experimental methods

All measurements were performed in a quiet temperature-controlled room. All studies were conducted in the morning $\geq$2 h after the participants had consumed a light breakfast. All subjects were instructed not to exercise or eat 1 h before the test. They were also asked to refrain from consuming any medications known to affect the autonomic nervous or cardiovascular systems or products containing alcohol, caffeine, or nicotine for 10–12 h prior to testing. The participants rested quietly in the supine position on a tilting bed for at least 10 min before the test. Electrocardiography (ECG) and beat-to-beat continuous BP were recorded using a Task Force® Monitor equipped with a high-resolution standard 3-lead ECG device and a servo-controlled plethysmography device (CNSystems, Medizintechnik AG, Graz, Austria). High-resolution ECG enabled accurate calculation of the RRI. A 10-min baseline recording of ECG and BP values was performed for all participants in the supine position. Then, the heads of the 31 healthy controls were tilted up and their bodies were maintained at a 70° angle on the automated tilting bed for another 10 min while ECG and BP were recorded.

Data analysis

Spectral analysis of HRV and BRS was performed using built-in software in the Task Force® Monitor and autoregressive analysis methods[12]. BRS was calculated using the spontaneous sequence method[11]. Successive up events were defined as three or more consecutive rising systolic BP values with a subsequent increase in RRI values. Successive down events were defined as three or more consecutive falling systolic BP values with a subsequent decrease in RRI values in the same spontaneous sequences. The average

slope of up and down events was utilized to measure BRS. Raw data stored in the Task Force® Monitor were exported for further analysis. The exported data included ECG values at a sampling rate of 1000 Hz and BP values at a sampling rate of 100 Hz for at least 10 min. CV of RRI was calculated by dividing SDNN by the mean of RRI. SDNN was calculated from the exported data. The analytical system was developed using the commercial software LabVIEW8.6 (National Instruments, Austin, TX, USA).

Before using CV of RRI as an indicator of cardiovascular autoregulation, the optimal length of time for recording data had to be determined in order to obtain stable and representative CV values in different individuals. A pilot study was therefore performed in 6 healthy subjects recruited additionally (24–35 years; weight, 50–95 kg). In the pilot study, CV of RRI was calculated using accumulated data for heartbeats. CV of RRI reached a steady value within 10 min in all subjects in both the supine and standing positions (Fig. 1). The CV value was calculated using the following equation: $|CV_i - CV_{i+1}| \times 100\%/CV_i$. Deviations in this value were <1% in all 6 subjects within 10 min. Therefore, a 10-min recording time was chosen as the optimal time period for testing in this study.

Statistical analysis

All results are presented as means ± standard deviations. The nonparametric Mann–Whitney test was used to compare the variables recorded in the supine position between the healthy controls and stroke patients, while the paired t-test was used to compare the variables recorded in the supine and head-up tilt positions in the healthy controls. Spearman's rho correlation test was used to determine correlations among all parameters and age. A p-value of <0.05 was considered statistically significant.

Results

The results of the selected parameters as measured in the controls and stroke patients are summarized in Table 1. The stroke patients were older and recorded higher systolic and diastolic BP values compared with the controls. The BRS, CV of RRI, and SDNN were lower in the stroke patients than in the controls, although the difference was not significant (Table 1). The systolic BP, diastolic BP, heart rate, and low frequency/high frequency (LF/HF) ratio significantly increased while HF power decreased in the head-up tilt position in the healthy controls. Furthermore, passive head-up tilt was associated with a significant decrease in BRS and an increase in CV of RRI in the controls. In contrast, no significant changes were observed in SDNN in the head-up tilt position in the controls. BRS, CV of RRI, and SDNN values were

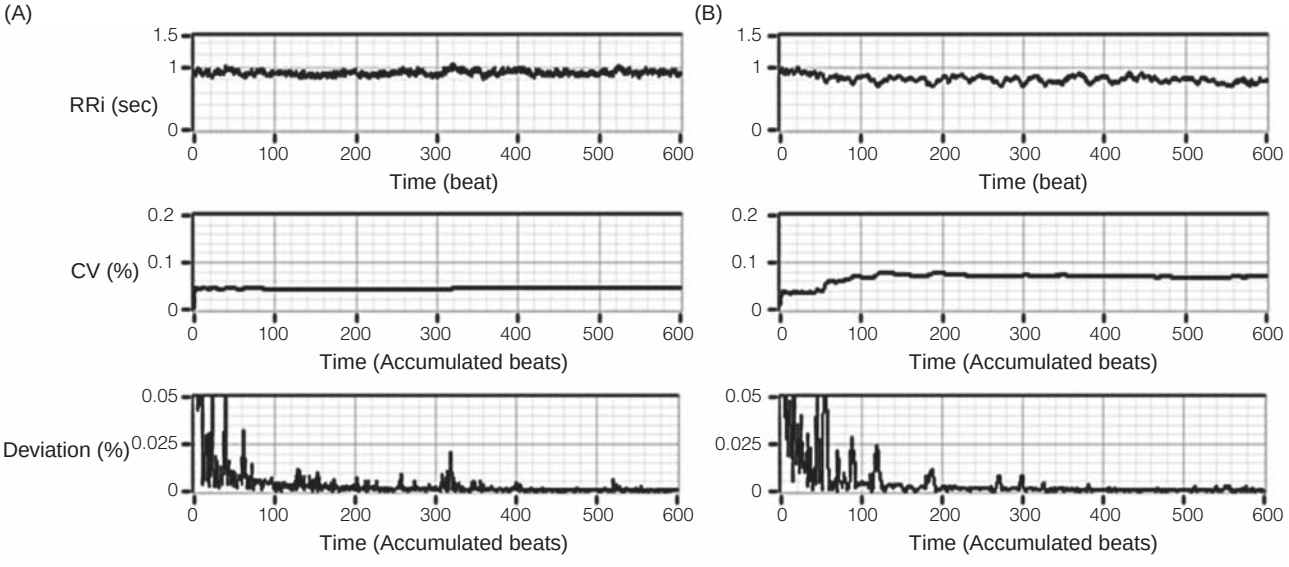

Fig. 1 The results of calculating CV of RR interval in an illustrative subject in supine (A) and head-up tilt (B). Top graphs show the beat-to-beat RR intervals, the middle graphs show the trend of CV value with accumulated beats, and the bottom graphs show the deviation of CV value with accumulated beats.

Table 1. Summary of demographic parameters and study indices in controls and stroke patients.

	Controls		Patients
	supine	HUT	supine
Age (yrs)	49.0 ± 21.4	49.0 ± 21.4	67.8 ± 10.5*
Sex (male/female)	14/17	14/17	14/11
Systolic blood pressure (mmHg)	114.61 ± 17.56	122.87 ± 21.38†	133.33 ± 18.53*
Diastolic pressure (mmHg)	73.07 ± 11.20	85.76 ± 14.00*	85.92 ± 13.96*
Heart rate (beat per minute)	73.58 ± 11.13	82.77 ± 11.99*	73.18 ± 9.66
Heart rate variability (by spectral analysis)			
Total power (ms^2)	621.8 ± 708.6	616.6 ± 539.2	370.2 ± 331.7
LF (ms^2)	173.9 ± 222.0	176.3 ± 214.7	81.7 ± 68.8
HF (ms^2)	260.2 ± 381.8	81.2 ± 90.5*	108.2 ± 144.4
LF/HF ratio	1.48 ± 2.39	3.38 ± 3.39*	1.29 ± 1.42
BRS (msec/mmHg)	12.87 ± 10.41	6.94 ± 4.37†	8.59 ± 4.13
CV of RRI (%)	0.049 ± 0.044	0.070 ± 0.058†	0.041 ± 0.016
SDNN (msec)	0.041 ± 0.032	0.053 ± 0.043	0.039 ± 0.015

* : $P < 0.01$ compared with controls in supine position; †: $P < 0.05$ compared with controls in supine position. BRS: baroreflex sensitivity; CV of RRI: coefficient of variance of R-R intervals; HUT: head-up tilt position; LF: power in low frequency range; HF: power in high frequency range; SDNN: standard deviation of R-R intervals.

Table 2. Summary of correlation coefficient between age, BRS, CV of RRI, and SDNN in controls and stroke patients.

	BRS			CV of RRI			SDNN		
	Controls		Patients	Controls		Patients	Controls		Patients
	supine	HUT	supine	supine	HUT	supine	supine	HUT	supine
Age	-0.637*	-0.703*	-0.341	-0.526*	-0.785*	-0.09	-0.731*	-0.697*	0.06
BRS				0.7*	0.834*	0.638*	0.74*	0.847*	0.574*
CV of RRI							0.966*	0.94*	0.785*

*Correlation is significant at the 0.01 level (2-tailed) by Spearman's rank correlation. BRS: baroreflex sensitivity; CV of RRI: coefficient of variance of R-R interval; HUT: head-up tilt position; SDNN: standard deviation of R-R interval.

not significantly different between the control and stroke groups. The parameters derived from spectral analysis of RRI, including total power, LF power, and HF power, were highly variable (as shown by the standard deviations in Table 1), although a trend toward lower values was observed in the stroke patients.

Correlations among age, BRS, CV of RRI, and SDNN in the controls and stroke patients are shown in Table 2. Values for CV of RRI, SDNN, and BRS recorded in both the supine and head-up tilt positions were negatively correlated with age in the healthy controls, but not in the stroke patients (Table 2 and Fig. 2). CV of RRI and SDNN significantly correlated with BRS in both the healthy controls and stroke patients (Table 2). Furthermore, a positive correlation was observed between BRS and SDNN recorded in the supine position in both the healthy controls and stroke patients. A similar correlation was observed between BRS and CV of RRI recorded in the supine position in both the healthy controls and stroke patients (Fig. 3).

Discussion

A significant correlation was observed among CV of RRI, SDNN, and BRS in both the healthy controls and stroke patients in this study. These correlations remained valid in the passive head-up tilt position in the healthy controls. Our findings suggest that CV of RRI may be a potentially useful indicator of cardiovascular health among different individuals, regardless of

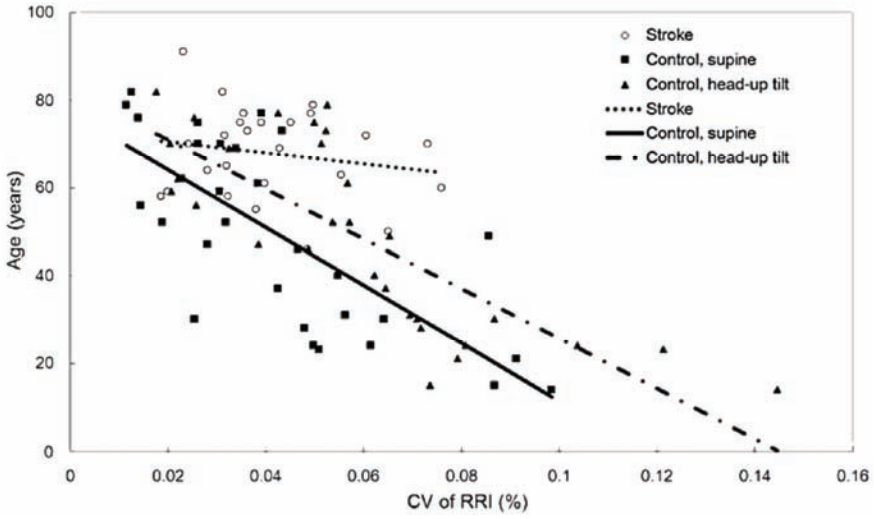

Fig. 2. Relationship between age and CV of RRI in stroke patients (circle), healthy subjects in supine (filled square) and head-up tilt (filled triangle). The CV of RRI is negatively correlated with age in healthy subjects in supine and head-up tilt, but no similar correlation in stroke patients.

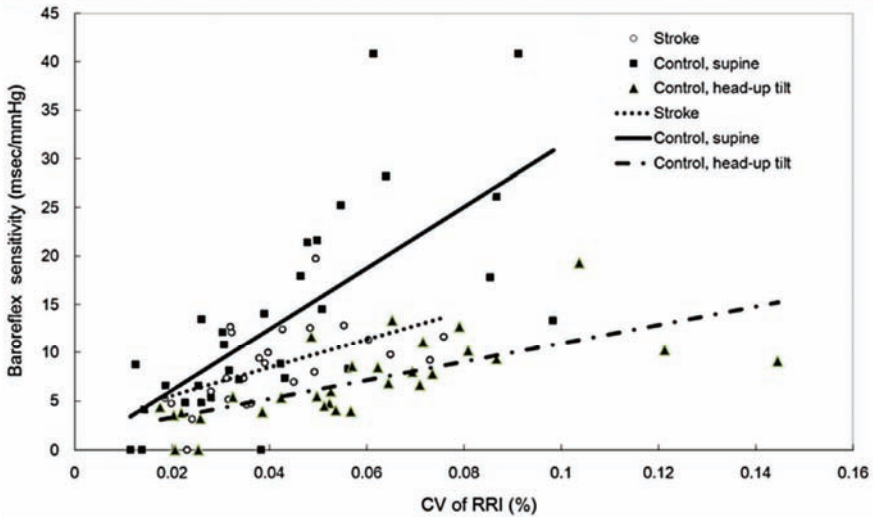

Fig. 3. Relationship between baroreflex sensitivity and CV of RRI in stroke patients (circle), healthy subjects in supine (filled square) and head-up tilt (filled triangle).

body position. Similarly, the accuracy of CV of RRI as an index for estimating the level of daily physical activity has previously been demonstrated[19]. Both CV of RRI and SDNN can potentially be used as a substitute for BRS measurement in healthy individuals and those with disease. In contrast to BRS, which can be evaluated only using expensive or invasive BP-measuring methods, CV of RRI may be evaluated using a simple ECG sensing device in the homecare setting. Although CV of RRI is not widely acknowledged as a valid index of cardiovascular autoregulation, it has proven to be a more reliable parameter than SDNN, the root mean square of successive RR interval differences, and spectral power in different frequency domains in patients with diabetes[20]. CV of RRI can therefore be used as an index for predicting orthostatic hypotension in patients with Parkinson's disease[21] and diabetic gastropathy and for predicting peripheral neuropathy in patients with type 2 diabetes[22].

Aging is associated with a decline in cardiovascular

autoregulation and autonomic nervous system function[23]. In this study, a negative correlation was observed between age and CV of RRI, SDNN, and BRS recorded in both the supine and tilted positions in the healthy controls. In contrast, no correlation between age and CV of RRI, SDNN, and BRS was observed in the stroke patients. Disturbed cardiovascular autoregulation and stress-related sympathetic activation may result from acute stroke and may have masked the effects of aging in the stroke patients in this study. Stroke is a major vascular disease associated with impaired cardiovascular autoregulation[24]. The values for SDNN, CV of RRI, and BRS were lower in the stroke patients than in the healthy controls in this study. The relationship between BRS and RRI-derived indices may represent the distribution of RRI and the coherence with changes in BP. The lower coefficient between these parameters may represent an inability to maintain cardiovascular homeostasis by feedback control in the stroke patients.

The baroreflex is an important mechanism in maintaining homeostasis of the cardiovascular system. Clinically, BRS is able to predict future vascular events and death[10,25]. In this study, HR increased while RRI and CV of RRI decreased in the head-up tilt position. Changes in RRI in response to similar changes in BP may be lesser in the tilted position than in the supine position. Therefore, BRS was lower in the tilted position[26]. In addition, increased outflow in the sympathetic nervous system in the tilted position may have resulted in a decrease in BRS[27]. The passive head-up tilt position also induced significant changes in CV of RRI, but not SDNN. This indicates that CV of RRI may be more sensitive to physiological changes compared with SDNN. Although both CV of RRI and SDNN are derived from the time intervals between consecutive electrocardiographic R-waves, CV of RRI was calculated by dividing by SDNN, which represented the individual baseline value for each subject. Therefore, this value represents individual normalization and would be less variable in healthy individuals and those with disease, enabling detection of differences in variable source data.

Various methods have been used for HRV analysis. HRV may be used as an indicator of autonomic function[28]. Decreased HRV is associated with cardiovascular events and death[29]. Consistent with previous findings[30], we found a marked decrease in HF power of HRV in response to the head-up tilt position in younger subjects. However, clinical application of short-term HRV is limited by the high variability of test results despite standardization of the measurement setting[14]. The high variability in HRV values obtained by spectral analysis was demonstrated by the large standard deviations of LF and HF spectral power in the healthy controls and patients in this study. Traditional HRV parameters may therefore be less sensitive and able to differentiate subtle differences in normal individuals and those with disease.

There are several limitations to this study. It was a cross-sectional study with a small sample size. More prospective studies are needed to confirm the usefulness of CV of RRI in predicting future cardiovascular risk in the general population. The head-up tilt position was not used in the stroke patients in this study because it may be harmful to these labile patients. All data were collected in the hospital; therefore, the application of these results in a homecare setting must be confirmed in a future study.

Conclusions

Significant correlations among CV of RRI, SDNN, and BRS were observed in the stroke patients and healthy controls in this study. CV of RRI was easy to calculate, indicating that it may be useful as a potential indicator of cardiovascular autoregulation or future cardiovascular risk among healthy individuals as well as stroke patients. Furthermore, aging is associated with a decline in SDNN, BRS, and CV of RRI in healthy individuals.

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年齡與腦血管疾病對心律變異係數的影響

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摘要

心跳時間區間的變異係數（CV of RRI）由心跳區間的標準差除以其均值而得。其數值代表的特性近似於心律變異度，並且加入個體標準化的計算。本研究目的在於探討 CV of RRI 於評估新血管系統功能的可行性。

本研究採 31 位健康受試者與 25 位缺血性腦中風的病人，探討，比較其 CV of RRI 、心律標準差（SDNN）、壓感反射敏感度（BRS）於 10 分鐘平躺休息與傾斜床試驗的變化，BRS 的計算採用時序分析法。

結果顯示，健康受試者的 CV of RRI 、SDNN 、BRS 與年齡呈顯著負相關在平躺休息狀態（r= -0.526, -0.731, -0.637）及傾斜床試驗（r= -0.785, -0.697, -0.703），而缺血性腦中風病人的 CV of RRI, SDNN, BRS 並無顯著相關性。而 CV of RRI, SDNN, BRS 在健康受試者與缺血性腦中風病人均有顯著的不同 。

CV of RRI 可由簡單的醫療設備量測取得並在心血管系統功能評估上有潛力。而年齡的衰退現象均呈現於 CV of RRI, SDNN, BRS 中。

關鍵詞：變異係數、心跳變異性、感壓反射敏感度、缺血性腦中風

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Original Article

Analysis of Out-of-hospital Cardiac Arrest in A Pediatric Emergency Department: Report from A Regional Teaching Hospital

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Abstract

Background and purpose: Cases of out-of-hospital cardiac arrest (OHCA) are uncommon in pediatric emergency departments. This study aimed to analyze the survival rate, etiology, and epidemiology of OHCA in a pediatric emergency department.
Methods: Children (<18 years) who presented with OHCA at the pediatric emergency department of Jen-Ai Hospital over a 7-year period were enrolled in this study. Patient information was collected from medical charts at the emergency department (ED) and after admission to the ward.
Results: A total of 30 patients (average age, 5 years; range, 15 days–17 years; 15 boys, 15 girls) were enrolled. Causes of OHCA were nontraumatic, traumatic, and drowning in 22, 4, and 4 cases, respectively. Ten patients with nontraumatic OHCA were aged 1–12 months, nine of whom had sudden infant death syndrome (SIDS). Successful initial cardiopulmonary resuscitation (CPR) and return of spontaneous circulation (ROSC) was achieved in seven patients (23%), who were subsequently admitted to the intensive care unit (ICU). However, only three survived to hospital discharge, all with neurological defects.
Conclusions: The overall survival rate of children with OHCA in our study was 10%. Children with nontraumatic OHCA had a higher survival rate than those with traumatic OHCA. In 30% patients, OHCA was caused by SIDS. The incidence of OHCA was higher between January and March.

Key words: out-of-hospital cardiac arrest, emergency room, children

Introduction

Out-of-hospital cardiac arrest (OHCA) is uncommon in children. The epidemiology and physiology of OHCA in children are different from those in adults, and the outcomes are poor with very high mortality and neurological morbidity[1,2]. According to a report by Nadkarni et al.[3], survival rates in OHCA vary greatly from 3% to 17%. Donoghue et al. systematically summarized and analyzed 41 articles and reported that the overall rate of survival to hospital discharge was 12.1%, with an overall rate of 4% for neurologically intact survival[1]. A more recent study by Bardai et al. reported an overall rate of survival

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to hospital discharge of 24%, with an overall rate of neurological recovery of 83%[4].

Similar to the situation in adults, a vast majority of pediatric OHCAs (78% in the study by Bardai et al.) are related to cardiac causes[4]. Noncardiac etiologies include trauma, suffocation, and cerebral vascular attack. The presence of both witnessed cardiac arrest and early effective bystander cardiopulmonary resuscitation is associated with improved survival in children with OHCA[1,2]. The objectives of our study were to (1) determine the survival rate of OHCA in a local population, (2) describe the epidemiology, etiology, and outcomes of OHCA, and (3) identify the predictors of survival.

Methods

Data of all patients under the age of 18 years, who presented at our emergency department (ED) from June 1, 2003 to December 31, 2010 (a 7-year period) following cardiac arrest, were reviewed. Prehospital information was obtained from the public emergency medical services (EMS) records and included the time of receiving the call, the time of arrival at and departure from the scene, the time of initiation of basic life support (BLS), and the time the patient arrived at ED.

Resuscitation efforts were conducted according to the guidelines of the American Heart Association for pediatric resuscitation[5]. The following patient characteristics were recorded and correlated with the outcome: age, sex, location where the cardiac arrest occurred, preexisting illness, cardiac rhythm, duration between onset of cardiac arrest and initiation of cardiopulmonary resuscitation (CPR), duration between onset of cardiac arrest and arrival at hospital, whether or not the cardiac arrest was witnessed, whether or not CPR was administered by a bystander, mode of transport to the hospital, and duration of resuscitation in ED. Successful initial CPR was defined as return of spontaneous circulation (ROSC) after resuscitation for less than 30 min in ED. The following four outcome indices were analyzed: ROSC, subsequent admission to the intensive care unit (ICU), survival to discharge from hospital, and survival to one year postdischarge. Moreover, the time spent in ICU, subsequent course and treatment of the disease, and duration of hospital stay were recorded as well. The neurological status of the patients who survived to one year postresuscitation was determined by reviewing their outpatient records. Causes of death were obtained from a review of case notes and coroners' reports; however, patients exhibiting rigor mortis were excluded.

We divided the patients into two groups: Group 1 comprised patients who did not respond to CPR and died in ED; and Group 2 comprised patients achieving ROSC after CPR in ED. Age, underlying disease, whether or not cardiac arrest was witnessed, CPR administration by a bystander, mode of transport to hospital, location of cardiac arrest, whether or not prehospital BLS was administered, and adrenaline dose administered in ED were compared between the two groups.

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS) software package for Windows version 18.0 (Chicago, IL, USA). Categorical variables were analyzed using chi-square or Fisher's exact test, whereas numerical variables were analyzed using Student's paired *t*-test. Values are expressed as mean ± SD or percentage of the totals. Statistical significance was set at $p < 0.05$.

This study was approved by the Institutional Review Board of Jen-Ai Hospital, which concurred that this retrospective study was a continuous quality improvement initiative to improve patient care and therefore, did not require informed consent.

Results

During the 7-year study period, 30 patients (15 boys and 15 girls) presented at our ED with OHCA. Their median age was 5 years (mean, 6.8 years;

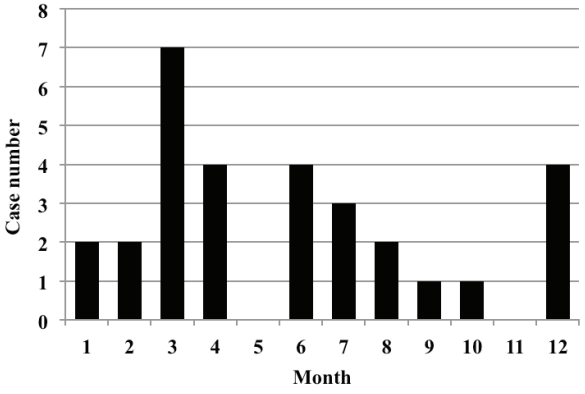

Fig. 1 The seasonal distribution of patients with OHCA in our study.

range, 15 days–17 years). Ten of these suffered underlying diseases: four with cerebral palsy, three with congenital heart disease, one with mitochondrial disorder, one with type 1 diabetes mellitus, and one with muscular dystrophy. Analysis of seasonal variation revealed that most OHCA cases were reported in March, but no cases were reported in May or November. Eleven OHCA cases were reported between January and March, eight between April and June, six between July and September, and five between October and December (Figure 1).

Patients' demographic and clinical characteristics are listed in Table 1. The duration from cardiac arrest to initiation of CPR and that from cardiac arrest

Table 1. Demographics and clinical characteristics of the patients (n=30)

Case	Age (yr)	Underlying disease	EMS	Location (home)	Witness	Initial bystander CPR	PH-BLS (min)	Epinephrine numbers (dose)	Time of CPR at ED (min)	ROSC	Cause of death	Hospital stay (day)
1	9.6	TOF	N	Y	N	N	0	11	120	N	Nontrauma	
2	11.6	VSD	N	N	N	N	0	8	33	N	Nontrauma	
3	1.6	-	Y	N	N	N	0	0	30	N	Trauma	
4	4.7	-	Y	N	N	N	11	10	90	N	Trauma	
5	0.2	-	N	Y	N	Y	0	2	11	N	SIDS	
6	0.1	-	Y	Y	N	N	4	0	21	N	SIDS	
7	0.4	-	Y	Y	Y	Y	3	5	30	N	SIDS	
8	13.8	T1DM	Y	Y	N	N	0	10	74	N	Nontrauma	
9	0.1	-	N	N	N	N	0	0	30	N	SIDS	
10	8.6	-	N	N	N	N	0	0	30	N	Trauma	
11	0.1	-	N	N	N	N	0	0	30	N	SIDS	
12	1.9	-	Y	N	N	N	0	0	30	N	Drowning	
13	10.2	-	Y	N	N	N	0	8	80	N	Trauma	
14	7.3	CP	Y	Y	Y	N	5	8	33	N	Nontrauma	
15	5.8	-	Y	Y	N	N	5	0	30	N	Drwoning	
16	6.4	-	N	Y	N	N	0	20	25	N	Drowning	
17	0.3	-	N	Y	Y	Y	0	8	40	N	SIDS	
18	0.9	Mdis	N	Y	N	N	0	4	47	N	SIDS	
19	4.3	-	N	Y	N	N	10	9	40	N	Drowning	
20	9.3	CP	N	Y	N	N	0	2	33	N	Nontrauma	
21	0.9	-	Y	Y	N	N	9	8	42	N	SIDS	
22	0.5	DS with CHD	Y	Y	N	N	6	7	33	N	Nontrauma	
23	0.9	-	Y	Y	N	N	7	8	39	N	SIDS	
24	1.1	-	N	Y	N	N	0	5	48	Y	Nontrauma	2
25	15.5	Mdys	N	Y	N	N	0	3	49	Y	Nontrauma	2
26	17.4	-	Y	N	N	N	22	4	12	Y	Nontrauma	2
27	9.9	-	N	N	N	N	0	4	20	Y	Nontrauma	3
28	3.6	CP	N	Y	Y	Y	0	0	12	Y	Survival	25
29	7		N	N	Y	N	0	0.8	15	Y	Survival	12
30	10.6	CP	Y	N	N	N	25	11	38	Y	Survival	14

EMS= emergency medical services; PH-BLS=Pre-hospital basic life support; ROSC=Return of spontaneous circulation; SIDS= sudden infant death syndrome, TOF= Tetralogy of Fallot; VSD= ventricular septal defect; T1DM= Type 1diabetes mellitus; Mdis=Mitochondrial disorders; DS with CHD=DiGeorge syndrome with complex heart disease; Mdys=Muscular dystrophy; CP= cerebral palsy; N=No; Y=Yes.

to arrival at hospital were mostly not specified in the medical charts. In seven patients, ROSC was achieved after successful initial CPR in ED: these patients were assigned to Group 2. The remaining patients died in ED and were assigned to Group 1. No statistically significant differences were observed for any of the variables between Groups 1 and 2 (Table 2). Causes of OHCA were nontraumatic, traumatic, and drowning in 22, 4, and 4 cases, respectively. Furthermore, the most common cause of OHCA was SIDS. Traumatic cardiac arrest was caused by suffocation in a fire in one patient and road traffic accident in three. None of the patients with OHCA due to trauma or drowning achieved ROSC. In ED, the body temperature of each of the four patients who drowned was 33.7°C, 37.3°C, 30.9°C, and 37.5°C. Ten patients with nontraumatic OHCA were aged 1–12 months, and nine (30%) had SIDS. Among the 12 other patients with nontraumatic OHCA, seven survived to admission to ICU, but only three survived to hospital discharge. Two of the surviving patients had preexisting cerebral palsy, and all three had developed severe neurological deficits or were in a persistent vegetative state at the one-year follow-up. Duration of hospital stay for patients admitted to ICU is summarized in Table 1. The total mortality rate in our study was 90%.

EMS ambulances were used for transport to ED in 47% (14/30) patients, whereas private transport was used in the remaining 53%. Sixty percent (18/30) collapses occurred at home, whereas the remaining occurred in public places or schools. Of the patients in whom OHCA did not occur at home, only one was witnessed by bystanders, but this patient did not receive CPR prior to arrival of the EMS personnel. On the other hand, of the patients in whom OHCA occurred at home, 22% (4/18) received CPR from family members, but only one survived to hospital discharge. The most common initial cardiac rhythm was asystole (97%; 29/30). Only one patient exhibited pulseless electrical activity on arrival at ED, and he survived to hospital discharge.

Table 2. Comparison of the data of age, underlying disease, EMS, location, bystander CPR, pre-hospital BLS, adrenaline numbers and the time of CPR at ED of Group 1 (died in the ED) and Group 2 (ROSC after successful initial CPR) at the ED patients.

	Group 1	Group 2	*p* value
Patient numbers (males/females)	23 (11/12)	7 (4/3)	
Age (yr)	4.34 ± 4.40	9.21 ± 6.07	0.122
Underlying disease	7/23	3/7	0.645
EMS	12/23	2/7	0.172
Location (home/total)	15/23	3/7	0.604
Witness	3/23	1/7	0.604
Bystander CPR	3/23	1/7	0.356
Pre-hospital BLS	2.61 ± 3.73	6.71 ± 11.50	0.425
Adrenaline numbers (dose)	5.57 ± 5.10	3.97 ± 3.59	0.550
CPR at ED (min)	42.23 ± 25.15	27.717 ± 16.76	0.193

EMS= emergency medical services; ROSC= return of spontaneous circulation; CPR= cardiopulmonary resuscitation; BLS= basic life support; ED= emergency department.

Discussion

The rate of survival to hospital discharge among pediatric patients with OHCA in this study was 10% (3/30), and all three patients who survived had poor neurological outcomes. A review of pediatric patients with OHCA by Young and Seidel reports that although only 8.4% patients survived to hospital discharge, 41% of these exhibited good neurological outcomes[6]. In an epidemiologic review of 41 published articles involving 5363 patients, Donoghue et al. reported that 12.1% patients survived to hospital discharge and 4% survived neurologically intact[1]. Nevertheless, the reason for these differences is unclear. Intact neurological survival was significantly worse in our study, and this may be because two of the surviving patients suffered from preexisting neurological deficits due to cerebral palsy and also because our patient population was small. Leung et al. reported that large cities tend to have lower survival rates because of slower EMS response times as a result of highrise buildings and traffic congestion[7].

The most common cause of cardiac arrest in our patients was SIDS, followed by other nontraumatic conditions, trauma, and drowning. This is similar to the pattern observed in previous pediatric studies and has apparently not changed over the past 20 years[1,8]. Of patients with nontraumatic cardiac arrest, six of them had underlying diseases as followings: three had congenital heart disease, two had cerebral palsy, and one had type 1 diabetes mellitus. However, Tham et al. reported that the most common causes of cardiac arrest were respiratory disorders (32.9%), cardiac

diseases (23.3%), and trauma (12.5%)[2]; the difference between these results and those of the present study may be attributable to differences in sleeping routines for infants between Asian and Caucasian families, as Asian infants are more likely to be put to sleep in the supine position and share the same bedroom as their parents[2]. Diagnosis of SIDS in our patients was established by investigation of the scene of death and a review of the medical history, without the involvement of complete autopsy; in other words, these patients had an unexpected history, and a thorough postmortem examination failed to adequately demonstrate the cause of death. If complete autopsy had been performed, the SIDS rate might have been lower than 30%.

In our study, none of the four patients with sustained cardiac arrest due to traumatic causes survived. Previous studies reported that children with traumatic OHCA had lower survival rates (1%–4%) than those with nontraumatic OHCA[1,5-9]. In addition, none of the four patients with OHCA due to drowning survived. In a review by Donoghue et al., overall survival to hospital discharge and intact neurological survival were higher in patients with submersion injuries than those for the overall sample[1]. These authors did not provide a reason for this phenomenon; however, they mentioned that Orlowsk reported that early institution of resuscitative efforts had the greatest impact on survival for drowning victims[10].

The important factors associated with successful CPR and a higher survival rate include prehospital BLS, shorter duration of resuscitation in ED, shorter intervals of collapse to first CPR and collapse to first defibrillatory shock, fewer doses of epinephrine, and an initial rhythm of ventricular fibrillation/ventricular tachycardia[1,2,4,6,11,12]. In our study, all three surviving patients were older than 3 years. One of these patients was at home at the time of cardiac arrest and received initial CPR from a bystander but the other two patients did not. The interval between arrest and CPR was not recorded in most charts because some arrests were not witnessed, and in others, initial CPR was performed by EMS or bystanders. However, there were no statistically significant differences with regard to age, underlying disease, EMS, location of cardiac arrest, presence of witnesses, bystander CPR, prehospital BLS, epinephrine dose, or duration of CPR in ED between the two groups. In other words, none of the factors appeared to be associated with the outcome of CPR in ED. This observation could be explained by the disparity in numbers between the two groups.

The rescue of children with OHCA usually takes place in an emotionally charged situation, and the decision to stop resuscitation efforts is difficult. According to Schindler et al., resuscitative efforts in ED after an OHCA should be limited to 20 min and two doses of epinephrine[11]; however, Lin et al. suggested performing inhospital CPR for at least 23 min on children with nontraumatic OHCA[13]. In our study, most parents understood the apparent irreversible death of patients after 30 min of resuscitation, and CPR was subsequently stopped. However, resuscitative efforts in two patients were undertaken for more than 1 h at the parents' request.

There are certain limitations to this study, the most important is the small number of cases extracted from our retrospective review of medical records. The small sample size and disparity in number of patients between the two groups may have affected the statistical results. In addition, some data could not be collected for every patient from the retrospective review of the medical records, such as prehospital information and duration between cardiac arrest and initiation of CPR. Moreover, because all surviving patients were transferred to a medical center for further care, acquisition of follow-up information and data on patients' final condition was difficult. Finally, this study encompasses the experiences of one hospital alone, and a prospective study covering multiple medical centers involved with pediatric OHCA is required.

In conclusion, the overall survival rate of children with OHCA was 10%. Children with nontraumatic OHCA had a higher survival rate than those with traumatic OHCA. In our study, 30% patients with OHCA had SIDS, and the incidence of OHCA was higher between January and March.

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Ethical approval: The Institutional Review Board of the Ethical Committee of Jen-Ai Hospital approved this research (Project no.: 98-05) prior to initiating.

Competing interest: None declared

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一兒童急診室到院前心跳停止之分析：一區域教學醫院之報告

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摘要

背景及目的：到院前心肺功能停止並不常見於兒科急診部門，此研究主旨在分析某區域教學醫院之兒科急診部門，到院前心跳停止兒童的存活率，病因，及流行病學。

方法：研究對象收集自在過去 7 年的時間內於仁愛醫院兒科急診部門，其兒童年齡小於 18 歲者且抵達醫院前即已呈心肺功能停止狀態做為研究對象，病童資料的收集則是來自在急診部門和辦理住院到病房後的醫療紀錄。

結果：在所有的 30 位病童中 , 由平均年齡為 6.8 歲（最小年齡為 15 天大新生兒，最大年齡為 17 歲，中位數 5 歲；15 位男孩，15 位女孩）所組成。有 22 位病童是非創傷性的個案，4 位病童是創傷性和 4 位病童是溺水，10 位（33%）非創傷性的個案中，其年齡在 1-12 個月大，又其中的 9 位是導因於突發嬰幼兒猝死症候群，季節的變化則呈現出多數事件的發生在春季和冬季。有 7 位（23%）在事件發生的最初即因成功的心肺復甦術並恢復自發性的循環狀態，隨後入住緊急加護單位中；又當中僅有 3 位病童是在醫院中存活下來並得以出院，而這 3 位病童皆有神經學上的缺失。

結論：非創傷性到院前心肺功能停止的病童比起因創傷而到院前死亡的病童有較高的存活率。18 歲以下病人到院前心肺功能停止之存活率在我們研究中的比率是 10%；及有 30% 的到院前心跳停止是導因於突發的嬰幼兒猝死症候群。在我們的研究中也發現到到院前心肺功能停止的情形在一月份至三月有較高的發生率。

關鍵詞：到院前心跳停止 、急診室 、兒童

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Case Report

急性心梗塞併發心室中膈破裂：病例報告及文獻回顧

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摘要

一名 68 歲患有糖尿病、肺癌及腎細胞癌婦女，因突發性胸痛至急診求助。住院後經診斷為急性心肌梗塞，入心導管室行介入性治療。因持續低血壓性休克，經心臟超音波檢查發現有心室中膈破裂情形，因拒絕手術治療，後死於心因性休克。急性心梗塞併發心室中膈破裂是發生率低，卻有著高死亡率的心臟急症。

關鍵詞：心肌梗塞、心室破裂、房室缺損修補

前　言

心室中膈破裂是一種罕見且危及生命的急性心梗塞併發症。通常發生在心肌梗塞後的 2-8 天，而且常常造成或加速心因性休克。心室中膈破裂的患者中約有 3.9% 併發心因性休克。心室中膈破裂常合併發生在前壁心肌梗塞，其比例（60%）高於其它區域的心肌梗塞患者。而血管的再灌注治療（reperfusion therapy）是可以減低心室中膈破裂的發生率的。在沒有血管的再灌注治療的年代，急性心梗塞合併心室中膈破裂的發生率約爲 1-3%，在一個包含 41021 個病人的臨床研究（GUSTO-I）中指出，有接受血管的再灌注治療（溶血栓藥物）的急性心梗塞患者，發生心室中膈破裂有約 0.2-0.34%，由結果顯示，再灌注治療是可以減少急性心梗塞併發心室中膈破裂的發生率。當急性心梗塞合併心室中膈破裂，死亡率是非常高的，爲了避免這種疾病的高死亡率，快速診斷及緊急行外科手術治療是必需的。

個案報告

一位 68 歲婦女，過去病史有糖尿病、肺癌及腎細胞癌。主訴求診當天晚上約九點時突發嚴重胸痛、胸悶伴隨有冒冷汗及嘔吐情形。被送到急診時約爲晚上 10 點左右，當時疼痛指數爲 6 分，血壓 BP：117/70 mmHg，心跳：62 bpm，呼吸：20/min，體溫：36'C。於急診室做了各項血液檢查（含心肌酵素）及 X 光放射檢查，除血色素較低外（Hb：7.8，Hct：25%），心肌酵素無明顯升高之情形，隨即給了嗎啡 10 mg 和止吐劑（primperan 1 amp）注射緩解病人疼痛和嘔吐之情形。約莫一小時後，因仍感胸痛不適，疼痛指數 8 分，再次給予嗎啡 10mg 注射，並安排胸部電腦斷層檢查。於急診室留觀至隔天早上收住胸腔科病房，同時於住院前追蹤了一張心電圖檢查。心電圖顯示了右束支傳導阻斷合併急性前壁心肌梗塞（STEMI, anterior wall），如（圖 1）。

因爲急性心肌梗塞，當下即給予口服抗血小板製劑（Plavix 4#, Bokey 3#）及注射抗凝血劑（Clexane 60 mg），隨即安排進心導管室行血管成型術再灌注治療，進導管室前之生命徵象爲：體溫：36.4'C 心跳：102 bpm：呼吸：20/min，血壓：80/60 mmHg，已有低血壓休克現象。心導管攝影檢查發現，左前降枝出口有 50% 狹窄及中段完全阻塞，左迴旋枝 OM 有 80% 狹窄，當下行氣球擴張和支架置放於左前降枝狹窄和阻塞處，血管打通效果並非很好（Only TIMI 1-2 flow was established.）。由於持續有心因性休克情形，主動脈氣球

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圖 1　右束支傳導阻斷合併急性前壁心肌梗塞（STEMI, anterior wall）。

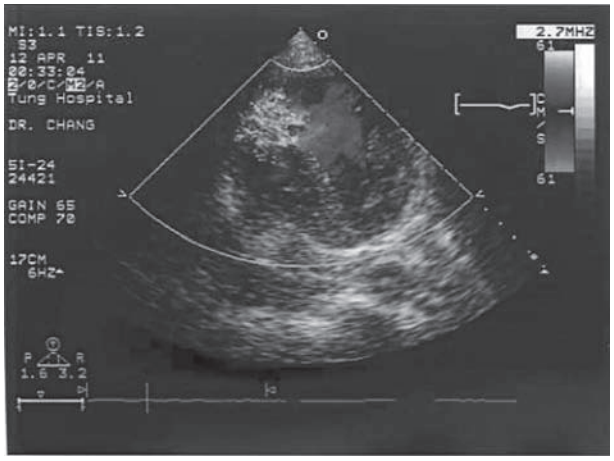

圖 2　心臟超音波顯示嚴重左心室功能不良與左心室射出分率（EF）僅：28%。

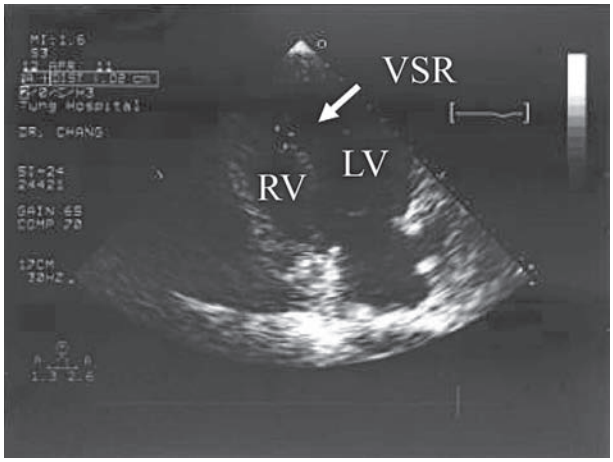

圖 3　箭頭所指之處爲心室中膈破裂（VSR）。

幫浦，升壓劑和強心劑也一併使用。回到心臟科加護病房後，病患仍有持續性低血壓。理學檢查發現有一 II/VI 級收縮期心雜音在左胸骨下緣，追蹤心臟超音波顯示嚴重左心室功能不良，其左心室射出分率（EF）僅有 28%（圖 2）以及心室中膈破裂（圖 3），向家屬解釋立即開心手術修補的重要性，家屬考量病人年紀大及慢性病（肺癌，腎癌）纏身，拒絕手術治療並簽屬拒急救同意書，因病患持續有心博過慢，無血壓呈現及無脈性心電氣活動（Pulseless electrical activity, PEA），當天晚上家屬辦理病危自動出院。

討　論

心室中膈破裂是急性心梗塞後少見但會危及生命的機械性併發症中發生率較高的一種（圖 4），其發生的高峰時間是急性梗塞後的 24 小時內及 3-5 天內，時間範圍

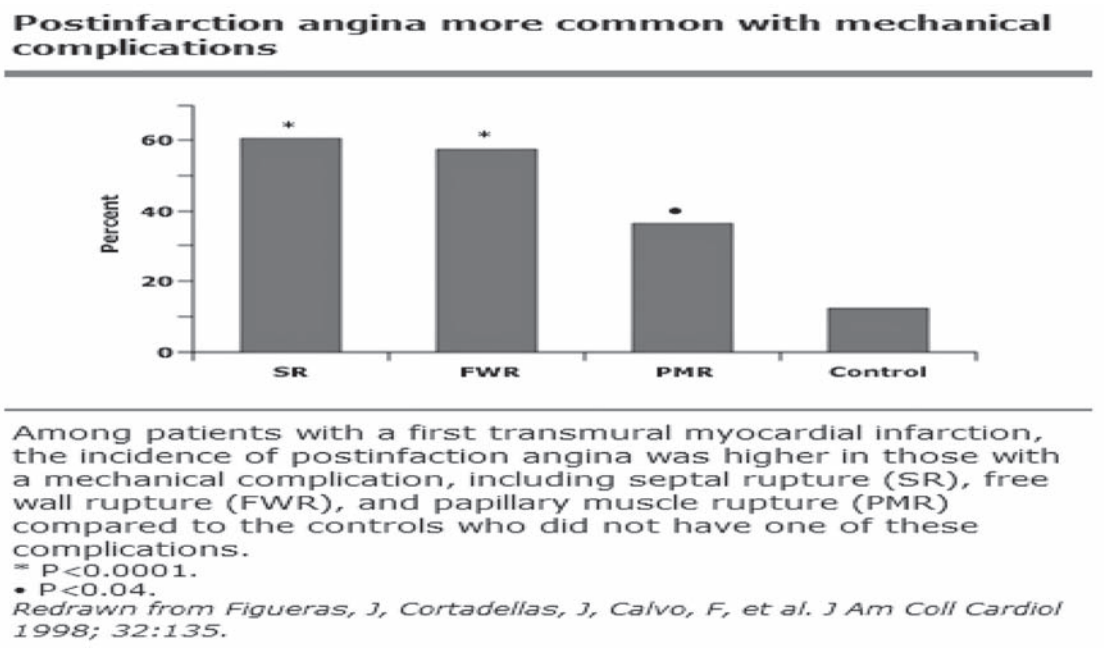

圖 4　心室中膈破裂（SR）是急性心梗塞後機械性併發症中發生率較高的一種。

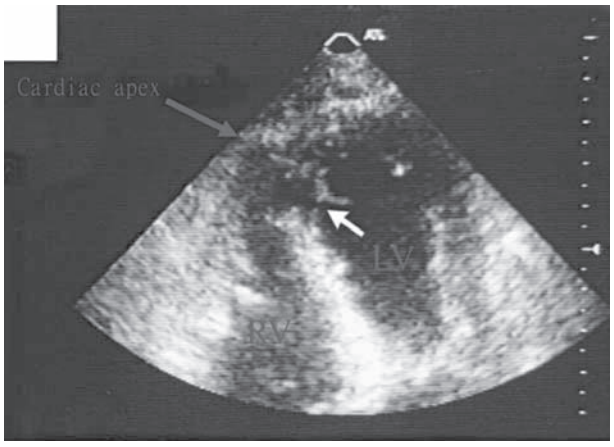

圖 5　白色箭頭所指之處爲心室中膈破裂，靠近心尖處。

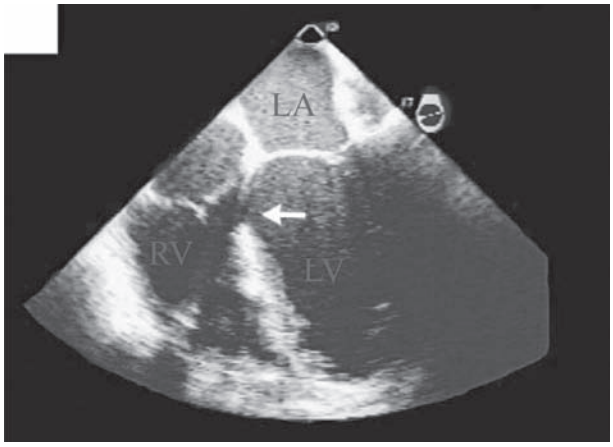

圖 6　箭頭所指之處爲心室中膈破裂，靠近基底中膈處。位於下壁與後壁之間。

爲 1-14 天。危險因子包含了沒有好的側枝循環、年紀大、女性、高血壓和前壁範圍的心肌梗塞。極少數的案例提到有關心導管檢查的過程中發生心室中膈破裂之可能狀況是，導管進入冠狀動脈時誤入其中膈分支而促進了梗塞壞死處中膈的破裂，但其發生的機率非常微小。心室中膈破裂發生時的血液動力學變化包含了低心輸出量及急性肺水腫。在診斷的部分可藉由心音聽診有一大而吵雜的全收縮期雜音在左胸骨下緣，可能伴隨有胸前震顫（thrill），心臟超音波和肺動脈攝影可見左向右的血液分流現象（shunt）。心室中膈破裂的位置因心肌梗塞位置不同而有所差別，前壁心肌梗塞好發於近心尖部位（圖 5），而下壁心肌梗塞則位於基底中膈處（圖 6），預後也較差。

對於急性心肌梗塞的再灌注治療，在未有血栓溶解劑的時期，急性心肌梗塞合併心室中膈破裂的發生率約爲 1-3%。接受血栓溶解劑治療時期發生率約爲 0.2%-0.34%（GUSTO-I trial）。在心導管發展時期，有研究報告發現，未接受血栓溶解劑治療的患者，接受早期的心

導管介入治療（Primary PCI）對照於選擇性的心導管介入治療（elective PCI）有明顯減少急性心梗塞併發心室中膈破裂的發生率。也有相關的研究報告指出，心室中膈破裂鮮少發生在梗塞後已接受血管成型術且冠狀動脈通暢的情況之下，反之，常見典型的心室中膈破裂是發生在已梗塞區域卻沒成功完成血流再灌注的。由結果顯示，儘早的再灌注治療是可以減少急性心梗塞併發心室中膈破裂的發生率。當急性心梗塞合併心室中膈破裂，死亡率是非常高的，爲了避免這種疾病的高死亡率，快速診斷及緊急行外科手術治療是必需的。

急性心肌梗塞合併心室中膈破裂發生心因性休克約爲 3.9%，其預後是非常不好的，有接受外科手術治療的死亡率約達 45%，而只接受內科藥物治療者死亡率更是高達 90%。在名爲 SHOCK 臨床研究中發現，心室中膈破裂造成的心因性休克其死亡率明顯高於其他原因造成的心因性休克（87.3% 對照 59.2%）。在內科治療方面，可使用降低後負荷治療、利尿劑、及強心劑等支持療法，若有心因性休克現象可藉由主動脈氣球幫浦（IABP）的輔助治療維持心臟功能，但死亡率仍高達 90%-100%。

在外科手術而言，急性心肌梗塞合併心室中膈破裂，手術方式之一是將整個壞死的心肌切除後，直接縫起來修補心室中膈缺損，冠狀動脈繞道手術往往也是一併進行，視病患血管阻塞情形而定。另一種手術方式是膜片修補（endocardial patch repair），它是利用一內膜片將破損的心室中膈蓋住，將兩端縫補在未梗塞壞死的心肌上用以固定膜片，阻隔心室中隔的破損處及分流現象。在 2010 發表之一臨床研究統計發現，1988-2007 共 68 人接受心室修補手術，其中有 48 人（71%）接受冠狀動脈繞道手術，其 30 天的死亡率爲 35%。

目前另一種被廣泛考慮修補方式是 transcatheter closure 的使用，利用內科心導管途徑將 closure device 運用於心室中膈破損的修補上。執行過程的成功率約爲 73.6%-91%，但是執行的成功率並不代表能有效的改善預後，病人的術前血液動力學的狀態是主要影響手術存活率的關鍵。在一相關醫學研究報告中指出，2003-2008 年間共計有 29 個病人接受心導管放置 closure device 的處置，其成功率爲 86%。其術後發生的主要併發症包含了心室間的分流（shunt），左心室破裂及發生血栓情形，其發生率約爲 41%，而 30 天內的存活率爲 35%。

結　論

心肌梗塞患者合併心室中隔破損的個案極少見，發生率低於 1%，整體來說，大部分的病人在遭逢急性心肌梗塞後的心室中隔破損是需要緊急開刀進行手術治療的。當然，任何延遲診斷或轉介都可能會造成多器官衰竭而未能及時有效的接受外科手術治療。在此次個案，本身有肺癌合併腎癌轉移，雙癌症併發急性心肌梗塞很是罕見。一個肺癌末期病人出現急性胸痛至急診室求診，癌症引發之胸痛首先被考慮。雖心肌酵素未明顯上升，但早期的理學檢查，心電圖檢視及心血管急症仍應被謹慎考慮在內，以爭取血流再灌注時間。若疑有併發心室中膈破裂，更應及早安排相關影像檢查確診，並穩定血液動力學，避免心因性休克或多重器官衰竭，且應盡早開刀處置，以挽救生命。

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Acute Myocardial Infarction Complicated with Ventricular Septal Rupture: Case Report and Literature Review

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Abstract

A 68-year-old female with sudden-onset chest pain was suspected of having acute myocardial infarction and admitted to our hospital. She had a history of diabetes mellitus, lung cancer, and transitional cell carcinoma. We treated her by performing percutaneous coronary intervention. However, hypotension with unstable hemodynamic parameters persisted. Ventricular septal rupture was identified by echocardiography. Her family refused surgical repair of the ventricular defect, and subsequently she died from cardiogenic shock.

Key words: acute myocardial infarction, ventricular septal rupture, repair of ventricular defect.

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Case Report

以矯正鞋墊治療髖痛：病例報告

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摘要

髖關節是人體最大且重要的關節，穩定性極佳，主要功能為支撐身體的重量及維持正常的步態。若髖部疼痛便會影響到活動功能。引起髖部疼痛的原因很多，疾病史及理學檢查對鑑別診斷相當重要。但年輕成人髖部疼痛的表現常不明顯，病史及檢查多為正常，其原因大多為局部髖關節或腰椎受傷所致。若排除常見疾病後，可能應考慮是否有下肢生物力學結構的問題，例如足內翻或外翻、腿長不等及肌肉無力等情況，因而造成髖部疼痛。本文提供年輕成人髖部疼痛的個案，以下肢生物力學的觀點，發現個案有足部過度旋前及腿長不等的問題，利用適當的矯正鞋墊矯正身體力學結構上的不平衡，不需依賴藥物便使病人症狀緩解，並可預防髖部疼痛的反覆發作。

關鍵詞：髖部疼痛、腿長不等、矯正鞋墊

前　言

髖關節是人體最大且重要的關節，穩定性極佳，主要功能爲支撐身體的重量，維持正常的步態[1]。若髖部疼痛便會影響到步行功能。一般來說眞正髖部疼痛的表現是痛在鼠蹊部或者有時痛至膝部[2]。引起髖部疼痛的原因很多，疾病史及理學檢查對鑑別診斷相當重要，須詳加鑑別才能對症下藥。小孩子髖痛常見原因爲急性暫時性滑膜炎、Perthes' disease 、Slipped capital femoral epiphysis（SCFE）、先天性髖關節發育不全等疾病；成人髖痛常見原因有骨折、股骨頭缺血性壞死、肌肉拉傷或肌腱炎、滑液囊炎、關節唇裂傷、關節炎等[3]。至於年輕成人髖部疼痛的表現常不明顯，病史及檢查多爲正常，其原因大多爲局部髖關節或腰椎受傷所致[4]。若排除常見疾病後，可能應另外考慮是否有下肢生物力學結構的問題，例如足內翻或外翻、腿長不等及肌肉無力等情況，皆可能因此造成髖部疼痛而影響功能，可利用適當的足部裝具矯正下肢力學結構，不需依賴藥物便使病人症狀緩解，並進而減緩將來關節退化磨損的程度，同時改善生活品質。

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病　例

病例一

病患爲二十七歲未婚女性，身高 168 公分，體重 80 公斤，職業是加護病房護士，通常每星期上五天班，每班工作八小時，其中約五至六小時須常常走動，主訴上班後左側髖部疼痛，偶爾於早晨起床時有左腳跟疼痛，並且於站立較久時會有左膝部疼痛，爲期六個月。嚴重時會持續疼二至三天，休息後症狀會改善，但常常復發，所以至門診求診。追溯其病史，並無重大創傷，也無明顯的運動傷害。在理學檢查及神經學檢查方面，髖關節並無明顯活動受限，亦無肌肉萎縮、明顯壓痛點及神經根病變。以生物力學觀點評估下肢情況，左側休息跟骨站立位置（resting calcaneal stance position, RCSP）-6 度，正中跟骨站立位置（neutral calcaneal stance position, NCSP）+2 度，左側全部旋前 8 度；右側休息跟骨站立位置（RCSP）-4 度，正中跟骨站立位置（NCSP）+1 度，右側全部旋前 5 度（圖 1）。左側後足旋前程度大於右側 3 度。檢查前足狀況，並無外翻的情形。以納氏評估系統（Najjarine Assessment System, NAS）[5] 做臨床評估，將兩側腸骨前上棘（anterior superior iliac spine, ASIS）維持齊高，發現左側腿較右側長 6 公釐（圖 2）。給予

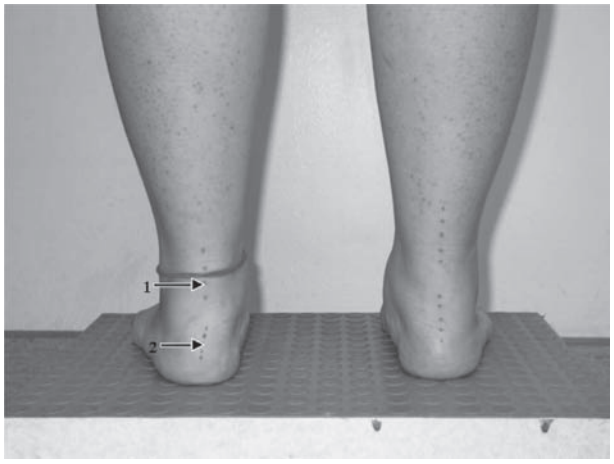

圖 1　箭號 1 是以目測方式在小腿的中央點畫線，箭號 2 則是在跟腱中央點畫線，此時線與地面之垂直線所成之夾角即爲 RCSP 之角度。將足踝位置調整成 NCSP 的狀態（即前述兩線段調整成一直線），此時線與地面之垂直線所成之夾角即爲 NCSP 之角度。由照片可見左側後足旋前程度明顯大於右側。

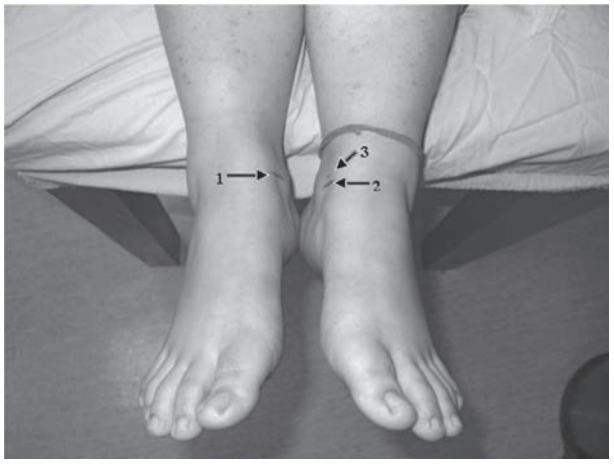

圖 2　箭號 1 是右內踝下緣標記，箭號 2 是左內踝下緣標記，箭號 3 是兩側腿長差距標記。

安排製作矯正鞋墊支撐，使矯正後足部於正中跟骨站立位置，並以 4 公釐厚度足跟踮高墊片矯正右側短腿（圖 3）。追蹤半年後，疼痛指數（visual analog scales, VAS）從 5 分降爲 0 分，症狀緩解；而且患者對鞋墊產生依賴性，若未穿鞋墊，便會有不舒服感。

病例二

二十六歲未婚女性，身高 160 公分，體重 45 公斤，職業是加護病房護士，通常每星期上五天班，每班工作八小時，約六至七小時須常常走動，主訴原本有脊椎側彎，兩個月前發生車禍後，左側下背部及髖部疼

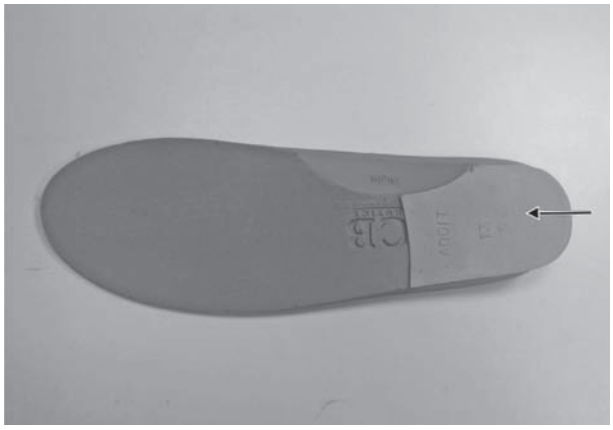

圖 3　矯正鞋墊，箭號所指灰色部分是足跟踮高墊片

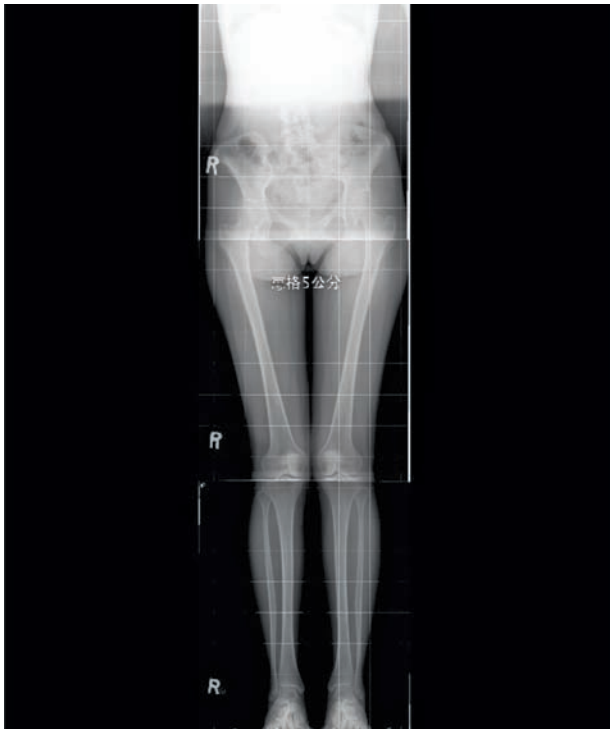

圖 4　scanography，左側腿較右側腿長

痛，當時急診檢查爲挫傷，但至今站久或走久仍會感到疼痛，休息後會較緩解，故至門診求診。理學檢查及神經學檢查，髖關節並無明顯活動受限，亦無肌肉萎縮及神經根病變。以生物力學觀點評估下肢情況，左側休息跟骨站立位置（RCSP）-5 度，正中跟骨站立位置（NCSP）+2 度，左側全部旋前 7 度，左側前足外翻 -5 度；右側休息跟骨站立位置（RCSP）-5 度，正中跟骨站立位置（NCSP）+2 度，右側全部旋前 7 度，右側前足外翻 -8 度。以 scanography 檢查發現左側腿較右側腿長

12 公釐（圖 4）。給予安排製作矯正鞋墊支撐，使矯正後足部於正中距骨站立位置，並以 6 公釐厚度足跟踮高墊片矯正右側短腿，及以 4 度前足外側踮高墊片矯正兩側前足外翻，追蹤五個月後，疼痛指數（VAS）從 4 分降爲 0 分，症狀緩解。

討　論

年輕成人髖部疼痛的表現常不明顯，病史及檢查多爲正常，因此要找到造成疼痛的原因並給予適當治療並不容易；其原因大多爲局部髖關節或腰椎受傷所致，常見可能原因有運動傷害、關節炎、酗酒、紅斑狼瘡、使用類固醇等 [4]。除此之外一些機械因素，如：肥胖、關節不穩定及腿長不等亦會引起或加重症狀 [6]。病例一的個案只有腿長不等，而病例二的個案亦有腿長不等情形，但原本並沒有的症狀在挫傷後卻一直未痊癒，可能是受傷使得原本的身體代償被改變，而腿長不等又加重症狀所致。

腿長不等是很常見的問題，Subotnick[7] 報告在超過 4000 位運動員中發現約有 40% 腿長不等相差超過 3 公釐；腿長不等可分爲兩類：一爲結構性腿長不等，是因兩下肢骨頭長度不等所造成，可能爲先天或後天因素，常見先天因素有先天性髖關節脫臼、半側萎縮或肥大等，而常見後天因素有感染、麻痺、腫瘤及手術等 [8]；另一爲功能性腿長不等，是因下肢力學改變所致，可能爲下肢或脊椎的肌肉緊繃無力或關節過緊、單側足內翻或外翻、膝關節過度伸展及腰椎側彎等 [8]，有些人可能兩類情況同時存在。腿長不等者在站立行走時會有代償作用，以期減少腿長不等所帶來的副作用 。長側腿可能會有足過度旋前 、膝關節過度屈曲，而短側腿的足過度旋後或踮腳尖、膝關節過度伸展；另外長側腿的髖關節因骨盆傾斜而處於內翻位置，造成股骨頭與髖臼接觸面積減少及外展肌因拉長而張力增加，進而承受到較大的壓力 [8,10]。Gofton 等人 [9] 報告 62 位原發性髖關節炎者中，36 位是發生在髖關節上外側且 29 位是在長側腿；Friberg[10] 報告 254 位腿長不等者有慢性髖痛，其中 226 位（88.9%）痛在長側腿；而且 27 位有嚴重原發性髖關節炎者中，24 位是發生在長側腿。本篇兩病例的髖痛亦是發生在長側腿。

腿長不等的檢查評估方法有很多 ，臨床檢查有直接用皮尺測量腿長的方法及間接測量站立時骨盆高度的方法，但因腿骨測量點精確定位不易或骨盆不對稱，使得腿長測量易造成誤差，一般可用在初步篩檢；而影像學檢查如放射線檢查、電腦斷層檢查、磁振造影檢查及超音波檢查等，則較能夠正確測量腿長 [8]，但需要較複雜的機器設備，且部分項目需暴露於輻射。臨床上除非要手術矯正，其實不一定要精確測量腿長 [11]。病例一的個案便是因本身考量不願暴露放射檢查風險，故只用臨床檢查方法即納氏評估系統判斷爲腿長不等，經矯正鞋墊治療後達到不錯的效果。

腿長不等的治療方法有鞋墊或手術，如骨頭增長或縮短手術及生長板融合術（epiphysiodesis），一般差距超過 6 公分較嚴重者可能要考慮手術治療 [12]，至於腿長不等差距較少者宜接受何種治療才較恰當，文獻報告並沒有明確定論；Gofton 等人 [9] 報告腿長不等差距 1/2 至 1 吋便與髖關節炎發生有關，Sharpe[13] 亦報告腿長不等差距 1/2 吋爲臨床上有意義，Gross[14] 認爲差距小於 2 公分不須矯正。Friberg[10] 報告共有 79 位腿長不等超過 5 公釐的慢性髖痛者接受鞋墊治療及追蹤六個月以上，其中 56 位完全不再有疼痛症狀。就我們臨床上的經驗與觀察，筆者建議若發現腿長不等是造成病患主訴症狀的原因就需要處理治療。因爲雖然身體對腿長不等會有自動代償，於姿勢、步態、運動表現等，可能不會有立即的影響，但畢竟存在有不正常，經年累月長期下來可能會引起一些症狀，如下背痛、髖痛、脊柱側彎等，只要適當使用矯正鞋墊便可矯正及預防，何樂而不爲。

矯正治療須同時考慮長側腿的足弓自動代償和兩側腿長差距的大小，若單用踮高墊片只能矯正短側腿長，須同時使用適當的鞋墊才能矯正長側腿的代償 [5]。製作矯正鞋墊時，首先穩定足弓，調整矯正鞋墊使足部於正中跟骨站立位置，再用合適高度的踮高墊片，矯正兩側腿長的差距；臨床上先以測量腿長差距值的一半開始踮，觀察後續效果，再分次逐漸踮高 [15]，以求最佳治療效果，不一定要踮到兩側等長；此外鞋墊需要穿一段時間來適應，剛開始一天穿 1 至 2 個小時，之後逐漸增加時間直到達到舒適感覺 [5]。

反覆發作的疼痛，最讓患者和臨床工作者感到沮喪，所以臨床工作者應學習除了症狀治療外，尚須具有詳細探討潛在致病原因的能力，以期能以全方位的完整治療協助患者。本文兩個案以生物力學的觀點，用矯正鞋墊處理改善其症狀，不但可減免因藥物治療、物理治療或活動型態改變所需花費的成本與時間 [16]，同時不影響原本的日常生活活動，其效益應是值得參考。

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Use of Foot Orthosis to Treat Hip Pain: A Case Report

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Abstract

The hip is the largest and most important joint in the human body, characterized by extremely good stability. The major functions of the hip joint are to support the body's weight and maintain normal gait. Hip pain, which may be caused by several reasons, affects the normal functioning of several activities. Although medical history and physical examination are important in differential diagnosis, they often present as normal because the symptoms of hip pain in young adults are not always obvious. The most common cause is local injury of the hip joint or lumbar spine. Ruling out common diseases of the hip joint, we considered biomechanical problems of the lower limb. For example, foot varus or valgus, discrepancy in leg length, or muscle weakness may also induce hip pain. This article presents the case report of a young adult with hip pain. Using biomechanic concepts, excessive pronation of the foot and discrepancy in leg length were found. Using suitable foot orthosis to correct the imbalance in body mechanics without the use of medication can relieve the symptoms of hip pain and prevent relapse.

Key words: hip pain, leg length discrepancy, foot orthosis

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Case Report

不可避免的細胞診子宮癌偽陰性抹片之案例報告

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摘要

子宮頸抹片（pap smear）對於子宮頸癌（uterine cervical cancer）的早期診斷有很大的幫忙。在篩檢採樣時，以採樣器自子宮頸口移行帶刷取表皮細胞，作為檢驗標的物，但在檢查時常會發生偽陰性或偽陽性的問題。

在本案例中，因子宮內膜基質肉瘤突於子宮頸口，惡性腫瘤之表面覆蓋了嚴重壞死組織，因此抹片、切片都只呈現壞死組織細胞，真正惡性腫瘤細胞無法表現，而形成不可避免的偽陰性。

子宮頸抹片篩檢前，婦科內診是必要的，它可提醒臨床醫師對局部異常所見應有所警覺，做進一步的診斷與治療。

關鍵詞：子宮頸抹片、偽陰性、子宮頸癌

前 言

子宮頸抹片（pap smear）篩檢對於子宮頸癌的早期診斷有很大的幫忙[1]。

自民國 84 年衛生署開始大力推動抹片篩檢之後，民國 84-88 年間，30 歲以上婦女的年篩檢率逐漸上升，民國 89 年以後逐漸趨緩，呈現穩定。目前每年皆有 180 萬以上的婦女接受檢查，佔該年齡層婦女的 30% 左右，累積 3 年篩檢率為 50%，而台灣子宮頸侵襲癌的發生率，自民國 84 年來，各年齡層皆呈現持續的下降[1,2]，子宮頸抹片篩檢如將沒有癌症的抹片，報告成有陽性，此種陽性案例參稱為偽陽性（false positive cases），若是癌症的抹片被當作陰性時，此案例稱為偽陰性（false negative cases）。偽陽性，會造成病人之恐慌，而偽陰性卻會使惡性癌症被疏忽，而延誤治療的黃金時機，因此準確率的品管特別要注意偽陰性與偽陽性。如何提升子宮頸抹片篩檢的準確性，及降低偽陰性與偽陽性的比率就成為實驗室品管的重要課題，特別是偽陰性，更會造成婦女們的誤解而忽略癌症的存在，以致於延誤癌症的治療。我們在此提出一例，連續三年傳統抹片均呈陰性結果，而實際上卻是子宮內膜惡性肉瘤合併嚴重組織壞死而造成的偽陰性結果。在此提供大家參考。

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案 例

病人為一位 74 歲經產婦，中等身材，已停經多年。最近 3 年來常主訴有白帶及水樣分泌物。每年都在社區接受家醫科醫師的抹片檢查，其抹片報告都是發炎[2]，沒有見到任何癌細胞。

3 個月前曾經因為直腸瘻管而開刀。

一個月前，因白帶及水樣分泌物，赴婦產科就醫，婦產科醫師發現其子宮頸沾粘一層黃綠色包膜，而轉介到我們門診作進一步檢查與處置。在婦產科內診時發現子宮脹大，子宮頸上唇完全由蘑菇樣贅生物所佔據（圖 1），子宮兩側摸不到硬塊，但在子宮右後方，卻可感受到沾粘。因此進一步施行薄層細胞抹片（圖 10-12）、陰道鏡檢、超音波掃描、D-R70，及子宮頸切片。

陰道鏡檢只能看到菇狀突出物，約鵝蛋大，沒有能看到子宮頸（圖像 1-3），菇狀突出物完全由壞死組織所包被。做深部的切片，其大小深處達 1.5 公分深，切片的病理報告，僅為壞死性炎症反應，無正常組織。（圖 5-6）。

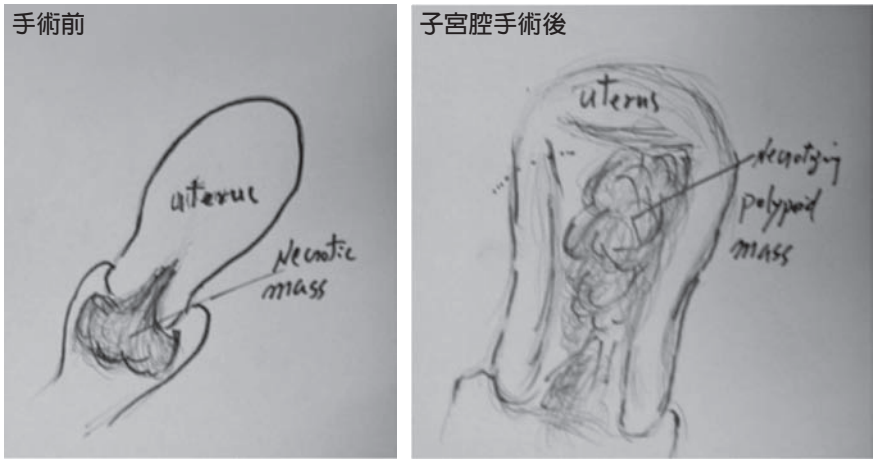

圖 1　手術前後簡圖

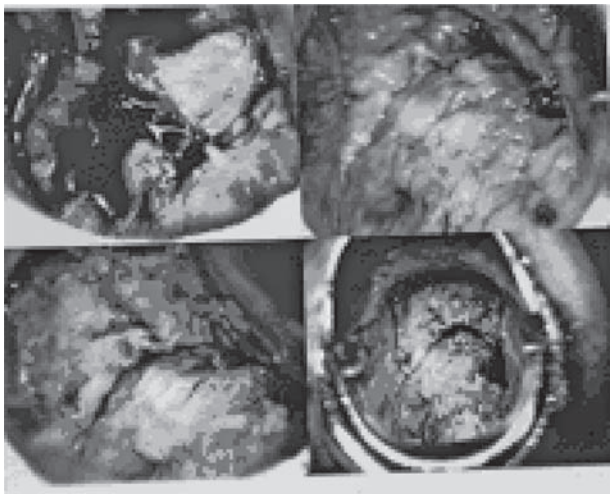

圖 2　陰道鏡檢 : 僅見壞死組織

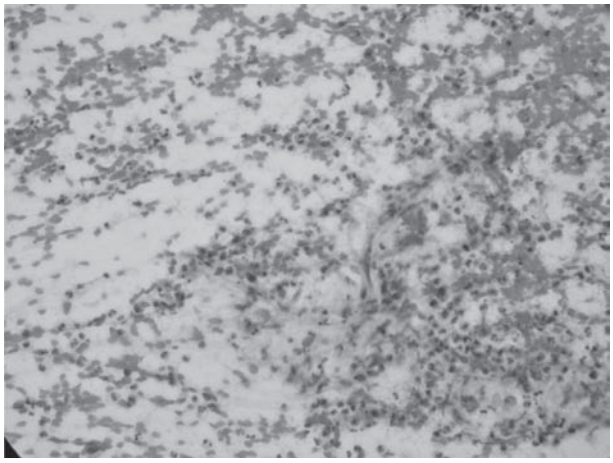

圖 3　傳統抹片壞死與出血 200x

在超音波掃描下、可見有 hetrogenesity ECHO 在子宮體後壁並延伸到下部，子宮頸管有突出於陰道之菇狀贅生物（圖 2），子宮有些腫脹。子宮腔脹大。

爲確認病人的診斷，安排病人，接受子宮頸圓錐切除術。在子宮頸圓錐切除時，發現菇狀贅生物非常脆爛，用 kelly 即可將所有菇狀贅生物去除之，大約有 150 gm（圖 3）。菇狀贅生物送病理檢查，組織切片僅呈現爲嚴重壞死與炎正變化，菇狀贅生物去除之後才能看到子宮頸口，確定菇狀贅生物是由子宮體下部，經子宮頸管及子宮頸口外，凸出於陰道，切取時不大會流血，子宮頸口被壓迫成薄片狀。菇狀贅生物在子宮頸管部份之軟組織，有如腦的組織，以此軟組織作捺印抹片，分別給予 95% 酒精固定及自然乾燥。 95% 酒精固定之捺印抹片送檢驗室作 Pap stain；自然乾燥之捺印抹片作劉氏染色 Liu stain（圖 4）。菇狀贅生物在切除後均送病理檢查。（圖 3-4）

病理檢查報告爲由子宮內膜基質細胞而來的子宮內膜基質肉瘤 Endometrial stroma sarcoma with extensive necrosis 形成息肉狀突出子宮頸口到陰道內，將子宮頸口完全遮蔽。

討　論

子宮頸陰道抹片是防治子宮頸癌的利器已是眾所周知。自民國 84 年衛生署開始大力推展子宮頸陰道抹片，其篩檢率已逐年提升到 50%[1,2]，依據加拿大卑詩省 Geog. Anderson 之說法篩檢率能超過 30% 以上即可將罹患率逐年減半 [3,4]。在篩檢的過程中，品質管制最爲重要，僞陽性是指本來沒有癌症者被誤診爲有癌症，而僞陰性則是有癌症卻沒有被診斷出來 [3,4]，二者在抹片品質管控上都有問題，僞陽性者會因經進一步確認進而排除；然而僞陰性者卻因被認爲無癌病而被疏忽，因而耽誤早期發現早期治療的契機，李寧 [5] 與黃文哲 [6] 等

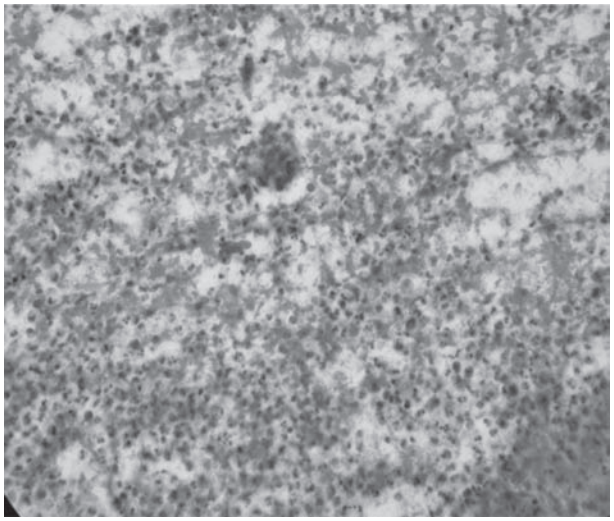

圖 4　嚴重炎症反應 200x

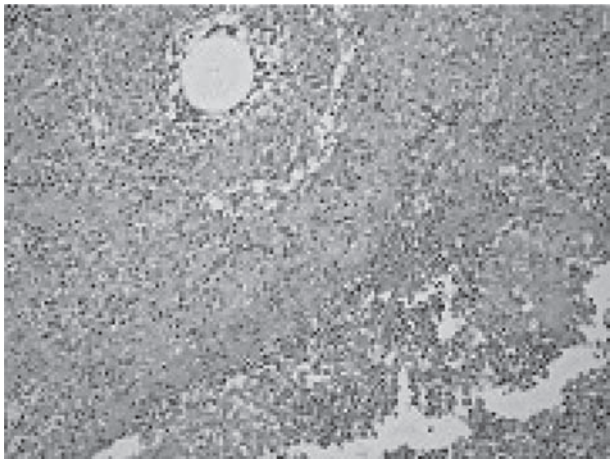

圖 5　組織切片呈現出壞死與炎症反應

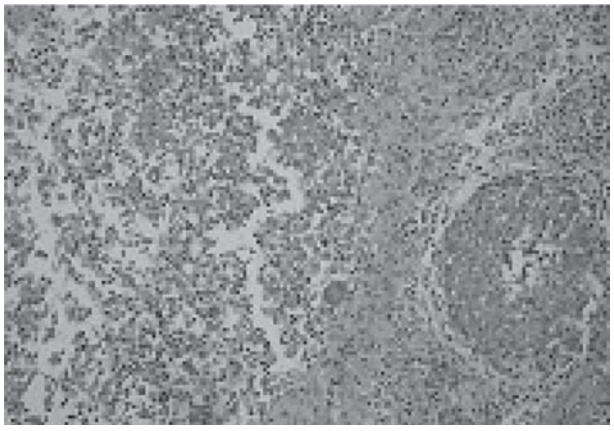

圖 6　組織切片呈現出壞死與炎症反應 200x

在細胞醫檢師培訓時，就一再的強調，在傳統抹片中僞陰性率常高達 20-40% 其主要原因是細胞的撿驗品管不佳，抹片判讀錯誤或採技術不良所致。爲降低僞陽性及僞陰性率，除了從持續品管教育著手之外，也嘗試用電腦閱片 [7]，他可將僞陰性率降到 3%，但如本案例者，子宮頸口完全爲壞死組織所覆蓋者（圖 5-6），卻是無法避免會形成僞陰性，婦產科醫師在施行子宮頸抹片篩檢前，由婦科內診，發現可提醒臨床醫師對局部異常所見應有所警覺，才是臨床防止僞陰性發生之關鍵。

結　論

在本案例中，惡性腫瘤之表面覆蓋了厚重的壞死組織，因此抹片、切片都只呈現壞死組織細胞，眞正惡性腫瘤細胞無法表現，而形成僞陰性。子宮頸抹片篩檢同時，婦科內診是必要的，它可提醒臨床醫師對局部異常所見應有所警覺，才是臨床防止僞陰性發生之關鍵。

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6. 黃文哲：子宮頸抹片篩檢之敏感度和全面篩檢政策之制定。細胞醫檢師訓。
7. 王福楠：子宮頸癌診斷利器電腦細胞分層掃描判讀系統。北市醫誌39卷12期p38-42.

圖像

最後病理檢查報告爲由子宮內膜基質細胞而來的子宮內膜基質肉瘤 Endometrial stroma sarcoma with extensive necrosis 形成息肉狀突出子宮頸口到陰道內，而整個壞死息肉將子宮頸口完全遮蔽。

A Case of Inevitable False Negative Cytological Findings of Cervical Cancer

Cheng-Hsiung Roan[1,2]*, Chen-Jong Chien[1], Bi-Biao Huang[2], Su-Yeh Chiu[2], Yi Cao-Tang[2]

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Abstract

Pap smear is a useful tool for early detection of cervical cancer, although it is essential to obtain the sample from the cervical transformation zone. Here, we report a case of endometrial stromal sarcoma protruding from the endocervical canal. The tumor bulk was extensively composed of necrotic tissue, but showed a false-negative result via Pap smear microscopy and biopsy-obtained tissue analysis. In addition to Pap smear, a vaginal examination can aid in the diagnosis of cervical and uterine diseases; therefore, a thorough physical examination and further diagnostic procedures are essential to accurately detect cervical cancer.

Key words: Pap smear, false negative, uterine cervical cancer

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2. Monographs:
   Plum F, Posner JB: Diagnosis of Stupor and Coma. 3rd ed. Philadelphia: Davis, 1980:132-3.
3. Monographs with multiple authors:
   Levinsky NG: Fluid and electrolytes. In: Thorn GW, Adams RD, Braunwald E, Isselbacher K, Petersdprf RG eds. Harrison's Principles of Internal Medicine, 8th ed. New York: Mcgraw-Hill, 1977:364-75.

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例：One of the first well documented reports of ECH poisoning with fatality in young children was reported by Miller et al. in 1970[2].

例：Boulet 等人 [3] 報告氣喘患者接受衛教後的知識改變量不受個人因素影響。

三、參考範例

A. 期刊：[作者姓名：題目。雜誌簡稱 年代；卷數（期數）：起迄頁數]

1. 許吟姿、楊光道、張恆鴻：結締組織疾病併發間質性肺病變患者 99mTc-DTPA 肺廓清率之臨床研究。內科學誌 1992;3:79-83.
2. Yang KTA, Chen HD: A semi-automated method for edge detection in the evaluation of left ventricular function using ECG-gated single-photon emission tomography. Eur J Nucl Med 1994;21:1206-11.

B. 單行本：[作者姓名：書名，版數（卷數）。發行地；出版公司，年代：引用部份頁數]。

1. 楊志良：生物統計學新論，一版。台北；巨流圖書公司，1984：33-8.
2. Plum F, Posner JB: Diagnosis of Stupor and Coma. 3rd ed. Philadelphia: Davis, 1980:132-3.

C. 多重作者之單行本：[有關文章作者姓名：書名，版數（卷數）。發行地；出版公司，年代：引用部份頁數]。

1. 蔣欣欣：護理與健康，編輯：顧乃平：護理專業導論，一版。台北；匯華出版公司，1991：83-121。
2. Levinsky NG: Fluid and electrolytes. In: Thorn GW, Adams RD, Braunwald E, lsselbacher K, Petersdprf RG eds. Harrison's Principles of Internal Medicine, 8th ed. New York: Mcgraw-Hill, 1977: 364-75.

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