Coronary Artery Calcium Scoring in the Emergency Department: Identifying Which Patients With Chest Pain Can Be Safely Discharged Home

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前言

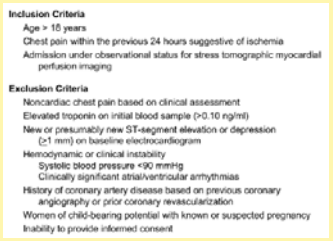
- 每年約有超過 500萬人以胸疼入院，其成本超過 100億美元，但大部分病人（> 60%）被發現有非心臟病胸疼。.
- Stress tomographic myocardial perfusion imaging (SPECT)檢查可以有效地分辨這些低風險的病人，通常需要長時間停留在急診或在留觀區的胸痛單位。
- 急診室需要準確隨時可用的影像檢查方法，快速的分辨缺血性或非缺血性狀況，是否可返家或採取適當入院。
- 冠狀動脈鈣化評分（Coronary artery calcium scoring = CACS)，是以影像學檢查方法來評估冠狀動脈鈣化程度(calcified coronary artery plaque)。
- 正常的CACS評分是0
  - 若CACS爲0會發現較少發現有異常的SPECT檢查, 或重大的冠狀動脈疾病，或急性心肌梗塞。
  - 若CACS爲0可發現正常的SPECT檢查結果和一個良好的短期結果。

研究目的

- 主要目的
  - CACS爲 0,在於不確定是心臟病造成的胸痛中,可分別出低風險的患者可以安全出院，沒有必要做進一步心臟檢查
- 其他目的
  - (1) CACS和異常SPECT結果的相關性
  - (2) CACS 和TIMI risk score 或ATP III score的相關性
  - (3) CACS和SPECT預測結果比單獨 TIMI risk score來的有效益。.

實施方法1/3

- 前瞻性(Prospective), 觀察性(observational)的世代(cohort)研究.
- 於城市學術大醫院(a large, urban, academic, tertiary care hospital)，研究日期從2005/11至2008/02.
- 選擇收案的條件;


Inclusion Criteria
Age > 18 years
Chest pain within the previous 24 hours suggestive of ischemia
Admission under observational status for stress tomographic myocardial perfusion imaging

Exclusion Criteria
Noncardiac chest pain based on clinical assessment
Elevated troponin on initial blood sample (>0.10 ng/ml)
New or presumably new ST-segment elevation or depression (≥1 mm) on baseline electrocardiogram
Hemodynamic or clinical instability
Systolic blood pressure <90 mmHg
Clinically significant atrial/ventricular arrhythmias
History of coronary artery disease based on previous coronary angiography or prior coronary revascularization
Women of child-bearing potential with known or suspected pregnancy
Inability to provide informed consent

實施方法2/3

- 做SPECT檢查的當時,患者也有接受16切multidetector CT掃描評估CACS評分,但未預先使用beta- blocker治療
- 掃描結果;
  - Normal (CACS= 0)
  - Minimal (1 to 10)
  - Mild (11 to 100)
  - Moderate (101 to 400)
  - Severe (>400) calcification

實施方法3/3

- 數據收集及統計
  - 基本資料
  - 心臟血管疾病病史, 心臟疾病危險因子,心臟病病史和目前使用藥物.
  - Serial troponin and ECG result
  - 評估TIMI risk score and ATP III result
  - 在1星期,1個月,和6個月後去做問卷及追蹤個案
- CACS評分定義爲正常 (CACS=0) or異常(CACS>0)
- *P*值 < 0.05認定爲有意義.

結果1/6

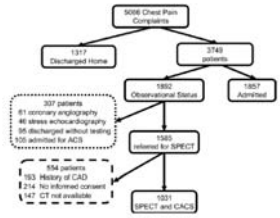


Figure 2. Patient selection for study entry. *ACS*, Acute coronary syndrome; *CAD*, coronary artery disease.

Table 2. CACS of 0: distribution according to age and sex.

Age Group, Years	Men (%) (N=408)	Women (%) (N=623)	Total (%) (N=1,031)
20–29	14/14 (100)	3/3 (100)	17/17 (100)
30–39	56/68 (82)	52/55 (94)	108/123 (88)
40–49	89/136 (65)	147/166 (88)	236/302 (78)
50–59	43/102 (42)	130/177 (73)	173/279 (62)
60–69	17/61 (28)	52/110 (47)	69/171 (40)
70–79	2/17 (12)	17/66 (26)	19/83 (23)
80–89	0/10 (0)	3/39 (8)	3/49 (6)
>90	0/0 (0)	0/7 (0)	0/7 (0)
Total	221/408 (54)	404/623 (65)	625/1,031 (61)

結果2/6

Table 1. Study population.

Baseline Characteristics	All Patients (N=1,031)	Without Events* (N=999)	With Events† (N=32)
Mean age, y (SD)	54.0 (13.5)	53.8 (13.4)	61.6 (12.8)
Sex, male (%)	408 (40)	387 (38.7)	21 (65.6)
Risk factors for CAD			
Body mass index (SD)	30.6 (7.2)	30.6 (7.3)	28.9 (5.9)
History of hypertension (%)	590 (57.2)	570 (57.0)	20 (62.5)
History of diabetes (%)	152 (14.7)	146 (14.6)	6 (18.8)
History of hyperlipidemia (%)	352 (34.1)	338 (33.8)	14 (43.8)
History of cigarette smoking (%)	192 (18.6)	186 (18.6)	6 (18.8)
Family history of CAD (%)	52 (5.0)	50 (5.0)	2 (6.2)
TIMI risk score, median (range)	2.0 (1-4)	1.0 (1-4)	2.0 (1-4)
1 (%)	656 (63.6)	650 (64.9)	6 (20.7)
2 (%)	258 (25.0)	242 (24.2)	16 (50.0)
3 (%)	106 (10.3)	99 (9.9)	7 (21.9)
4 (%)	11 (1.1)	8 (0.8)	3 (10.4)
ATP III groups (%)			
Low	367 (35.6)	361 (36.2)	6 (18.7)
Moderate	305 (29.6)	298 (29.8)	7 (21.9)
Moderately high	156 (15.1)	149 (14.9)	7 (21.9)
High	203 (19.7)	191 (19.1)	12 (37.5)
CACS median (range)	0 (0–5,871)	0 (0–5,871)	262 (0–4,100)
0 (%)	625 (60.6)	623 (62.4)	2 (6.3)
1–10 (%)	87 (8.4)	87 (8.7)	0
11–100 (%)	136 (13.2)	127 (12.7)	9 (28.1)
101–400 (%)	100 (9.7)	90 (9.0)	10 (31.2)
>400 (%)	83 (8.1)	72 (7.2)	11 (34.4)
Abnormal SPECT (%)	40 (3.9)	20 (2.0)	20 (62.5)

*Patients with no cardiac events during the initial hospitalization or after discharge.
†Patients with a cardiac event (ie, cardiac death, myocardial infarction, unstable angina pectoris) during the initial hospitalization or after discharge.

結果3/6

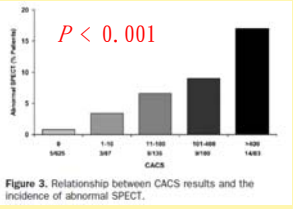


Figure 3. Relationship between CACS results and the incidence of abnormal SPECT.

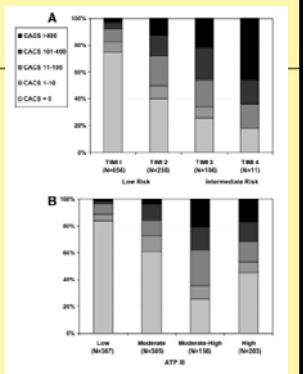
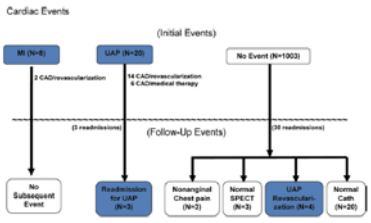


Figure 4. CACS results across *A*, TIMI risk scores and *B*, ATP III groups. Significant heterogeneity in CACS severity results is observed across both low (1 to 2) and intermediate (3 to 4) TIMI risk scores and ATP III groups.

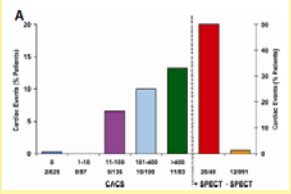
結果4/6



Total Events: Initial (28) + Follow-up (N=7) = 35 events in 32 patients (3.1%)

Figure 5. Cardiac events in the study cohort. Cardiac events during the index admission and after hospital discharge. *MI*, Myocardial infarction; *UAP*, unstable angina pectoris; *Cath*, coronary angiography.

結果5/6



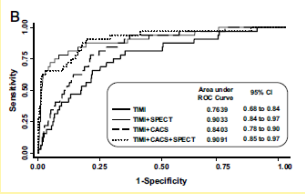


Figure 6. Incidence of *A*, cardiac events and *B*, receiver operating characteristic (ROC) curve analysis, according to CACS and SPECT results and in relation to TIMI risk score. +, Abnormal SPECT; –, normal SPECT.

結果顯示多加SPECT或CACS發現可超越曲線下面積比起單獨使用TIMI risk score （P <0.002）

結果6/6

Table 3. Sensitivity, specificity and predictive values of SPECT and CACS for predicting all cardiac events.

Test Characteristics	SPECT (%)	95% CI	CACS (%)*	95% CI	*P* Value
Sensitivity	20/32 (62.5)	43.7–78.3	30/32 (93.8)	77.8–98.9	.04
Specificity	979/999 (98)	96.9–98.7	623/999 (62.4)	59.3–65.4	.0001
PPV	20/40 (50)	34.1–65.9	30/406 (7.4)	5.1–10.5	—
NPV	979/991 (98.8)	97.8–99.3	623/625 (99.7)	98.7–99.9	—

PPV, Positive predictive value; NPV, negative predictive value.
*CACS—dichotomized as normal (CACS=0) or abnormal (CACS>0).

兩個檢查(CACS 和SPECT) 結果顯示都有高度的陰性預測值 (Negative predictive value) 但CACS的敏感度(Sensitivity)較高,SPECT的特異性(Specificity)較高

限制

- 研究結果皆由單一的醫學中心但未能代表全部的人口
- 我們的人口相當於低風險性的急性冠狀動脈症候群，卻導致了很高的陰性預測值
- 運用嚴格的定義針對急性冠狀動脈症候群
- 另一個考量若CACS爲0可能會忽略到在非鈣化斑塊(noncalcified plaque)造成的急性冠狀動脈症候群.
- 主治醫師評估的變異性，可能導致以後的評估偏差(evaluation bias)。

討論 1/2

- 在我們的病人中CACS爲0的沒有一個是有SPECT異常的結果。
- 7個月內有良好的無事件生存率(99.7% event-free survive),表示可以讓CACS爲0的病患安全的返家。
- “理想的篩選試驗”，能方便且直接由急診返家或安排入院。
- 幾個小型研究表明在CACS評估價值(高敏感度檢測急診低風險性病患有心臟事件與高度陰性預測值識別低風險牲患者無事件)

Table 4. Studies examining the relationship between CACS and acute coronary syndrome in the ED setting.

Authors	Year	N	CACS=0 (%)	Sensitivity, %	Specificity, %	PPV, %	NPV, %
Laudon et al[10]	1999	105	59 (59)	100	63	30	100
McLaughlin et al[11]	1999	134	48 (36)	100	38	8	100
Georgiou et al[12]	2001	192	76 (40)	97	55	48	97
Hoffman et al[13]*	2009	368	197 (54)	97	59	18	99.5
Current study		1,031	625 (61)	93.8	62.4	7.4	99.7

*Based on no evidence of calcified plaque on CT coronary angiography.

討論 2/2

- 對於陰性預測值排除急性冠狀動脈症候群在正常的CT冠狀動脈造影是非常高，佔96%至100%，但類似的報導爲CACS爲 0。
- 有利於CACS的因素，它是一種快速，簡便，低成本，更普遍使用的影像方式，以減少病患暴露輻射(less radiation hazards) 比起其他SPECT或 Coronary CT angiography。
- CACS有較高的敏感度在SPECT對於識別患者的事件，沒有進一步的測試需要在61%的患者誰將會有一個正常的研究結果。 CACS had a higher sensitivity than SPECT for identifying patients with events, with no further testing required in the 61% of patients who will have a normal study result.

結論

- 探討不確定心臟病所引起的胸痛病患,大部分患者(61% of sample) 在CACS爲0，可預測患者有正常的SPECT的結果和一個短期的結果。
- 研究結果顯示，病患若CACS爲0能出院返家，不需進一步的做心臟檢查。