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Lung function after coronary artery surgery using the internal mammary artery and the saphenous vein

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ABSTRACT Lung volumes and arterial blood gas tensions in patients undergoing coronary artery surgery were compared in 77 patients given an internal mammary artery graft (group 1) and 33 patients given a saphenous vein graft only (group 2). Patients in both groups developed a severe restrictive ventilatory defect after surgery, more pronounced in those receiving an internal mammary artery graft. Mean (SEM) vital capacity in groups 1 and 2 was reduced to 36% (1·2%) and 45% (2·0%) of preoperative values on the second postoperative day (1·56 and 1·85 l respectively), with some recovery by day 4 to 56% (1·2%) and 63% (2·1%) of preoperative values. The mean (SEM) arterial oxygen tension was 7·34 (0·13) kPa for group 1 and 7·46 (0·20) kPa for group 2 on day 2, rising to 8·39 (0·13) and 9·01 (0·23) kPa on day 4. Analgesic requirements were greater in the group receiving an internal mammary artery graft. Possible explanations for the differences between the effects of the two grafts include the higher frequency of pleurotomy, the placing of pleural drains, and additional surgical trauma when internal mammary artery grafts are used.

Introduction

Improved survival of the internal mammary artery graft has recently led to its preferential use in coronary artery surgery.[1-3] The technique is surgically more demanding and is associated with an increased incidence of pleurotomy. We present the results of lung function tests and blood gas tensions in patients receiving an internal mammary artery graft and in those receiving a saphenous vein graft.

Patients and methods

We studied 110 consecutive male patients before and after uncomplicated coronary artery surgery. Before operation all patients had a forced expiratory volume in one second (FEV_1) greater than 50% predicted and a forced expiratory ratio (FER) greater than 60%.

In the 48 hours before surgery functional residual capacity (FRC, closed circuit helium dilution) and vital capacity (VC) were measured at the bedside with a portable system (Pulmonet III, Gould Godart Ltd). Forced vital capacity (FVC), FEV_1, and peak expiratory flow (PEF) were measured with a Respiradyne pulmonary function monitor.[4] All measurements were made with the patient sitting upright in a chair. A sample of arterialised capillary blood was taken from the patient's earlobe with the patient breathing room air and analysed immediately for arterial oxygen (Pao_2) and carbon dioxide ($Paco_2$) tension.[5]

Patients returned to the surgical ward on the first or second day after surgery and were encouraged to sit in a chair and walk. FRC and VC were measured at the same time each day with the patient seated.[6] Arterialised blood was taken on the second and fourth days with the patient breathing room air. The amount of analgesic taken in each 24 hours was quantified by means of a scoring system that takes account of the type and dose of analgesia (table 1). The criterion for a diagnosis of chest infection was a postoperative temperature greater than 38·5°C with radiographic evidence of collapse or consolidation.

The independent t test was used to analyse results that were normally distributed and the Mann-Whitney test for ranked data. Qualitative data were analysed with the χ^2 test with Yates's correction. Probability values of less than 0·05 were regarded as significant.

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Table 1 *Quantification of postoperative analgesia*

Preparation	*Dose unit*	*Method of administration*	*Score*
Paracetamol	1000 mg	Oral	1
Co-proxamol	715 mg	Oral	2
Dihydrocoedine tartrate	30 mg	Oral	3
Buprenorphine	200 μg	Sublingual	4
Papaveretum	5 mg	Intravenous	5
Papaveretum	10 mg	Intramuscular	5

Results

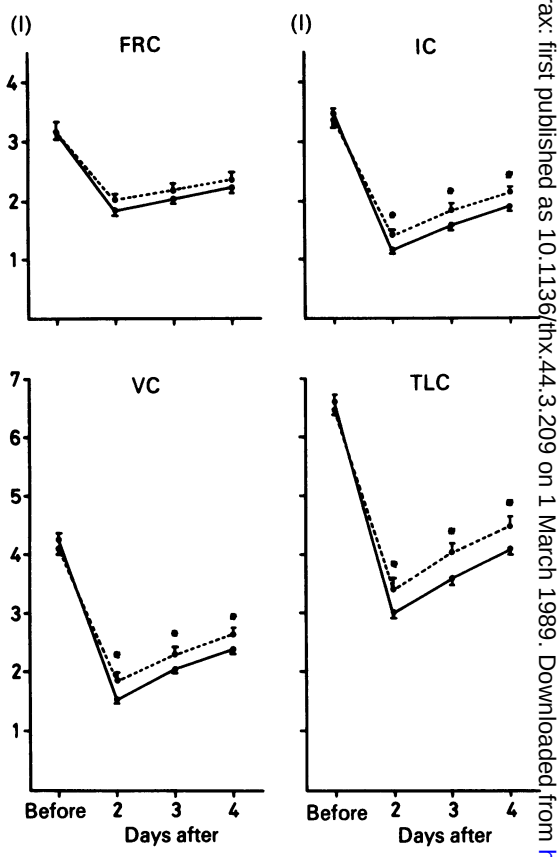
Seventy seven patients (group 1) received an internal mammary artery graft, two patients receiving bilateral grafts; in 72 of the patients the saphenous vein was also used. In the remaining 33 patients (group 2) the saphenous vein only was used. Before operation there was no difference in lung function between the two groups (table 2). Fifteen patients in group 1 and four patients in group 2 had smoked cigarettes in the six weeks before surgery ($\chi^2 = 0.44$; NS). There was no difference in duration of cardiopulmonary bypass, transfusion requirements, or the length of time that patients were ventilated after surgery.

Lung volumes in both groups were reduced on the second day ($p < 0.001$) and remained below preoperative values for the duration of the study ($p < 0.001$). The reduction was more pronounced in the patients receiving an internal mammary artery graft (fig). On the second postoperative day mean (SEM) vital capacity was reduced to 36% (1·2%) and

Table 2 *Preoperative lung function and blood gas tensions (means with ranges)*

	Group 1 (IMA: n = 77)	*Group 2 (no IMA: n = 33)*
Age (y)	54·0 (38–71)	57·7* (44–67)
Height (m)	1·74 (1·61–1·99)	1·72 (1·58–1·85)
Weight (kg)	81·3 (61–121)	79·5 (60–96)
FEV_1 (l)	3·04 (1·82–4·92)	2·90 (2·05–4·52)
% predicted	88·5	89·7
FVC (l)	3·95 (2·43–5·89)	3·83 (2·88–5·94)
% predicted	91·9	93·6
VC (l)	4·28 (2·70–6·40)	4·16 (3·08–6·15)
% predicted	100·3	101·0
FRC (l)	3·15 (1·50–4·86)	3·15 (1·76–4·54)
% predicted	90·2	90·6
TLC (l)	6·63 (4·54–8·81)	6·51 (4·30–9·00)
% predicted	96·8	97·0
IC (l)	3·47 (1·83–4·80)	3·35 (1·75–4·79)
PEF (l/min)	470 (278–687)	445 (237–707)
% predicted	91·6	90·0
FER (%)	77·1 (61–90)	75·9 (61–89)
Pao_2 (kPa)	10·54 (8·50–13·21)	10·61 (8·81–13·44)
$Paco_2$ (kPa)	5·12 (3·61–5·82)	5·04 (4·25–5·78)

*$p < 0.05$.
FEV_1—forced expiratory volume in one second; FVC—forced vital capacity; VC—vital capacity; FRC—functional residual capacity; TLC—total lung capacity; IC—inspiratory capacity; PEF—peak expiratory flow; FER—forced expiratory ratio; Pao_2—arterial oxygen tension; $Paco_2$—arterial carbon dioxide tension; IMA—internal mammary artery graft.



*Lung volumes (means with SEM) before and after operation in group 1 (IMA graft: ●——●) and group 2 (no IMA graft: ●---●). *$p < 0.05$.*

	Before operation	*Postoperative day:*		
Numbers of patients: group 1	*77*	*54*	*74*	*75*
group 2	*33*	*28*	*33*	*33*

45% (2·0%) of the preoperative value in groups 1 and 2 (1·56 (0·07) and 1·85 (0·1) l), the difference between the groups being significant ($p < 0.02$). On day 4 the differences persisted, values for VC being 56% (1·2%) and 63% (2·1%) of preoperative values in groups 1 and 2 ($p < 0.05$). Mean (SEM) Pao_2 on day 2 was 7·34 (0·13) and 7·46 (0·20) kPa (difference non-significant) in groups 1 and 2, increasing by day 4 but to a lesser extent in group 1 (8·39 (0·13 kPa) than in group 2 (9·01 (0·23 kPa; $p < 0.05$). Corresponding $Paco_2$ values were 4·57 (0·07) and 4·51 (0·08) kPa (NS) for groups 1 and 2 on day 2 and 4·41 (0·07) and 4·33 (0·08) kPa (NS) on day 4.

A chest infection was diagnosed in 10 patients in

group 1 and in one patient in group 2 ($\chi^2 = 1{\cdot}56$, NS). Patients with infection had a lower FRC and were more hypoxaemic on day 4 ($p < 0{\cdot}05$) but there was no difference in VC, total lung capacity, or inspiratory capacity.

Patients in group 1 received more analgesia than those in group 2 ($p < 0{\cdot}05$). The mean (SD) total score was 50·9 (17·6) in group 1 and 42·2 (12·3) in group 2.

Discussion

A severe restrictive ventilatory defect and arterial hypoxaemia occurred after coronary artery surgery. The reduction in VC, TLC, and IC was more severe when internal mammary artery grafting was performed.

Use of the internal mammary artery graft is known to be associated with a lower Pao_2 immediately after cardiopulmonary bypass[7] but the effects of coronary artery surgery using the internal mammary artery and saphenous vein on lung function in the days after operation have not been compared. The increase in respiratory abnormalities after internal mammary grafting may be attributed to the high incidence of pleurotomy, the placing of a pleural drain, and possible additional trauma to the chest wall during dissection. Shoulder girdle pain is significantly greater when the internal mammary artery is used,[8] and in the present study increased surgical trauma may account for the greater analgesic requirements of patients in group 1.

Knowledge that internal mammary artery grafting produces a greater impairment of lung function than saphenous vein grafting may help in the management of patients after coronary artery surgery.

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