

## POST CABG SURGERY PAIN WITH THE USE OF SKELETONIZED VERSUS PEDICLED TECHNIQUE OF INTERNAL THORACIC ARTERY HARVESTING

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### Contribution

AK conceived the idea and designed the study. Data collection and manuscript writing was done by RT. AN did final review. All authors contributed equally to the submitted manuscript.

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### ABSTRACT

**Objective:** To document post coronary artery bypass graft (CABG) surgery pain with the use of skeletonized technique versus pedicled technique of internal thoracic artery (ITA) harvesting in our population.

**Methodology:** A cross sectional study was done from February 2014 to September 2017. Patients who underwent elective on-pump coronary artery bypass graft surgery were included in the study. Patients were subjected to two different techniques for CABG surgery. Postoperatively CABG surgery pain intensity was scored prior to discharge and at 01 month follow-up on a visual analogue scale (VAS) ranging from 0 to 10. Chi square statistical test was utilized ( $p \leq 0.05$ ).

**Results:** Total of 197 patients were included. In ninety nine patients the pedicled technique of left ITA conduit harvesting was utilized while in ninety eight patients skeletonized left ITA was harvested. The Visual Analogue Score pre-discharge (VAS 0-10) was  $2.61 \pm 0.23$  in the skeletonized left ITA group and  $2.58 \pm 0.31$  in the pedicled left ITA group. The Visual Analogue Score at 01 month after discharge (VAS 0-10) was  $0.57 \pm 0.14$  in the skeletonized left ITA group and  $1.21 \pm 0.18$  in the pedicled left ITA group. The difference in the pre-discharge VAS scores between the skeletonized and pedicled left ITA groups was not significant statistically ( $p > 0.05$ ), whereas the Visual Analogue Score was significantly lower in the skeletonized left ITA group ( $p \leq 0.05$ ) at one month follow up.

**Conclusion:** There is decreased post CABG surgery pain with the use of skeletonized technique of internal thoracic artery harvesting compared to pedicled technique.

**Key Words:** CABG surgery, Cardiac Surgery, Internal Thoracic Artery, Skeletonized, Harvesting Technique, Pain.

## INTRODUCTION

CABG surgery is the gold standard for management of multi-vessel diseases.<sup>1,2</sup> ITA has significant benefits to reduce the occurrence of adverse cardiac events but it can develop significant vasoconstriction with decreased blood flow and the patients complain of severe and continuous pain after operation.<sup>3,4</sup> Harvesting of ITA can alter the perfusion of the sternum which can cause pain after operation.<sup>2,5</sup> Pedicled and skeletonized methods are harvesting techniques of the internal mammary artery. Pedicled ITA has surrounding structures along with it but, skeletonized ITA does not contain surrounding tissues with it.<sup>6</sup> Randomized analyses documented the comparison of the two harvesting techniques based on different aspects.<sup>4</sup> After CABG surgery patients complain of chronic chest wall pain-post CABG surgery pain syndrome(PCP). The underlying cause of this is the direct damage to intercostal nerves that occurred during surgery.<sup>7</sup> During CABG surgery injury to the intercostal nerves can occur due to direct damage to nerves while harvesting the ITA.<sup>7</sup> During the pedicled harvesting technique the internal thoracic artery and vein, fat and endothoracic fascia are mobilized with the use of electrocautery while during the skeletonized harvesting the IMA is taken down with minimum damage to other tissues.<sup>7,8</sup> Compression or tension of intercostal nerves while retracting the chest wall may be another mechanism involved in causing PCP.<sup>7,8</sup>

Although the skeletonized technique of ITA harvesting is time consuming, it has the advantage that with this the collateral vascular supply of the sternum is protected during harvesting of the ITA from the chest wall and it reduces the occurrence of postoperative sternal wall pain compared to the pedicled technique of harvesting. Studies showed that skeletonized ITA compared to the pedicled technique significantly reduces the injury to vascular supply of retrosternal tissue with decreased incidence of pain after CABG surgery.<sup>9</sup>

We conducted this study to document post coronary artery bypass graft (CABG) surgery pain with the use of skeletonized technique versus pedicled technique of internal thoracic artery (ITA) harvesting in our population.

## METHODOLOGY

A cross-sectional descriptive study was done from February 2014 to September 2017 at Dow University of Health Sciences, Civil Hospital, Karachi. After obtaining informed consent one hundred and ninety seven patients were included in the study according to the calculated sample size utilizing the technique of non-probability consecutive sampling. The inclusion criteria for our study were those patients who underwent elective on-pump coronary artery bypass graft surgery. Our exclusion criteria for this study were those patients who had, peripheral vascular disease, off-pump CABG surgery, combined surgeries, emergent and redo CABG surgery, ejection fraction less than forty percent, stroke and history of rib fractures. Those patients who were not able to return for follow up were also excluded from the study.

CABG surgery was performed with median sternotomy. In one group patients the pedicled technique of left ITA conduit harvesting included the ITA, the lateral and medial veins, fat, fascia and lymphatics. In other group patients skeletonized left

ITA was harvested by incising the endothoracic fascia between the ITA and the medial vein. Dissection was performed using low voltage electro-cautery avoiding thermal damage to the ITA to mobilize the entire length of the ITA proximally to the distal bifurcation.

Data was collected for preoperative, operative and postoperative patient characteristics. Frequencies and percentages were calculated for gender, diabetes mellitus, hypertension, hypercholesterolemia, left main disease, smoking and chronic pulmonary obstructive disease. Standard deviations and means were determined for time required for cardiopulmonary bypass and time period for aortic cross clamping. The mean lengths of hospitalization and intensive care unit stay were recorded. Frequencies and percentages were calculated for site of maximum pain at the time of discharge and analgesic use. Postoperatively CABG surgery pain intensity was scored prior to discharge and at 01 month follow-up on a visual analogue scale (VAS) ranging from 0 to 10. Chi square statistical test was utilized ( $p \leq 0.05$ ).

## RESULTS

The total number of patients in our study was one hundred and ninety seven. In ninety eight patients the left ITA was harvested utilizing the skeletonized technique where as in ninety nine patients the pedicled harvesting technique was utilized. The average age and percentage of male patients in the skeletonized and pedicled ITA groups was 61.49 years and 85.71% males and 59.83 years and 88.89% males respectively. In the skeletonized left ITA group 38.78% were diabetic, 78.57% were hypertensive, 67.35% had hypercholesterolemia, 21.43% had left main coronary artery disease, 30.61% were smokers. In the pedicled left ITA group 37.37% were diabetic, 75.76% were hypertensive, 63.64% had hypercholesterolemia, 17.17% had left main coronary artery disease, 27.27% were smokers (Table 1).

In the skeletonized left ITA group the cardiopulmonary bypass time was 81.3 minutes, the aortic cross clamp time was 63.4 minutes, and a mean of 3.4 distal anastomoses were performed. In the pedicled left ITA group the cardiopulmonary bypass time was 79.5 minutes, the aortic cross clamp time was 62.1 minutes, and the average number of distal anastomoses was 3.1 (Table 2).

The duration of stay in the intensive care unit and the hospital was 2.1 days and 6.4 days in the skeletonized left ITA group and 2.5 days and 7.1 days in the pedicled left ITA group respectively. In the pedicled left ITA group 2 patient required re-exploration for bleeding. The Visual Analogue Score pre-discharge (VAS 0-10) was  $2.61 \pm 0.23$  in the skeletonized left ITA group and  $2.58 \pm 0.31$  in the pedicled left ITA group. The Visual Analogue Score at 01 month after discharge (VAS 0-10) was  $0.57 \pm 0.14$  in the skeletonized left ITA group and  $1.21 \pm 0.18$  in the pedicled left ITA group. The difference in the pre-discharge VAS scores between the skeletonized and pedicled left ITA groups was not significant statistically ( $p > 0.05$ ), whereas the Visual Analogue Score was significantly lower in the skeletonized left ITA group ( $p \leq 0.05$ ) at one month follow up. The site of maximum pain at the time of discharge in the skeletonized and pedicled left ITA group was 65.31% and 68.69% in left chest, 7.14% and 4.04% in the right chest and 27.55% and 27.27% in the middle of the chest respectively. (Table 3)

**Table 1: Preoperative Patient Characteristics (n = 197)**

	<b>Skeletonized Left Internal Thoracic Artery</b>	<b>Pedicled Left Internal Thoracic Artery</b>
Number of patients	98	99
Age (mean)	61.49 years	59.83 years
Male	84 (85.71%),	88 (88.89%) ,
Female	14 (14.29%)	11 (11.11%)
Diabetes mellitus	38 (38.78%)	37 (37.37%)
Hypertension	77 (78.57%)	75 (75.76%)
Hypercholesterolemia	66 (67.35%)	63 (63.64%)
Body mass index (mean)	27±0.6 kg/m <sup>2</sup>	26±0.5 kg/m <sup>2</sup>
Left main coronary artery disease	21 (21.43%)	17 (17.17%)
Smoking	30 (30.61%)	27 (27.27%)
Chronic obstructive pulmonary disease	7 (7.14%)	6 (6.06%)

**Table 2: Operative Patient Characteristics (n = 197)**

	<b>Skeletonized Left Internal Thoracic Artery</b>	<b>Pedicled Left Internal Thoracic Artery</b>
Left ITA harvesting technique	n = 98	n = 99
Cardiopulmonary bypass time (Mean ± SD) minutes	81.3 ± 8.7	79.5 ± 9.3
Aortic cross clamp time (Mean ± SD) minutes	63.4 ± 4.8	62.1 ± 5.1
Number of distal anastomoses (mean)	3.4	3.1

**Table 3: Postoperative Patient Characteristics (n = 197)**

	<b>Skeletonized Left Internal Thoracic Artery</b>	<b>Pedicled Left Internal Thoracic Artery</b>	<b>P Value</b>
Intensive care unit length of stay (days)	2.1	2.5	
Hospital length of stay (days)	6.4	7.1	
Re-exploration for bleeding (number of patients)	0	2	
Visual Analogue Score pre-discharge (VAS 0-10)	2.61 ± 0.23	2.58 ± 0.31	> 0.05
Visual Analogue Score at 01 month after discharge (VAS 0-10)	0.57 ± 0.14	1.21 ± 0.18	≤ 0.05
Site of maximum pain at time of discharge			
Left chest pain	64 (65.31%)	68 (68.69%)	
Right chest pain	7 (7.14%)	4 (4.04%)	
Midline chest pain	27 (27.55%)	27 (27.27%)	

## DISCUSSION

CABG surgery is the gold standard for management of multi-vessel diseases and ITA is the conduit of choice. ITA has a vasovascularum (its own blood source), well-developed elastic lamina, nerve supply and tunica media that contain less myocytes. After CABG surgery, chronic chest wall pain is a common problem. The responsible mechanism of PCP is still not clear, although it is the result of nerve injury that occurred during ITA dissection.<sup>1,2,10,11</sup> Studies suggested that direct injury to intercostal nerves during operation is responsible for this pain. After CABG surgery for up to two years after operation, around the median sternotomy scar discomfort and chronic chest wall pain occurs and that is not anginal and has an incidence of 28-56%.<sup>12</sup>

During CABG surgery, injury to the intercostal nerve can occur due to direct damage to nerves while harvesting the ITA. Compression or tension of intercostal nerves while retracting the chest wall may be other mechanisms involved in PCP.

Pedicled and skeletonized are harvesting techniques of internal thoracic artery.<sup>13</sup> Pedicled ITA has surrounding structures along with it. Pedicled technique includes the artery along with surrounding tissue (1-2cm). In the pedicled technique the ITA is dissected away with fascia, lymphatics, adipose tissue and accompanying veins so a pedicle is developed.<sup>6,14-16</sup> During pedicled harvesting technique the ITA and vein, fat and endothoracic fascia are mobilized with use of electro-cautery while during skeletonized harvesting the ITA is taken down along with minimum damage to other tissues.<sup>8</sup> Skeletonized technique was described by Keely in 1987 that take down only the artery.<sup>8</sup> Although the skeletonized technique is time consuming but it has the advantage that the collateral vascular supply of the sternum and integrity of the endothelium is protected during harvesting so there is less occurrence of pain after operation.<sup>9,17</sup> In our study, in ninety nine patients the pedicled technique of left ITA conduit harvesting included the ITA, the lateral and medial veins, fat, fascia and lymphatics. In ninety-eight patients skeletonized left ITA was harvested by incising the endothoracic fascia between the ITA and the medial vein. Dissection was performed using low voltage electrocautery avoiding thermal damage to the ITA to mobilize the length of the ITA proximally to the distal bifurcation. Postoperatively CABG surgery pain intensity was scored prior to discharge and at 01 month follow-up on a visual analogue scale (VAS) ranging from 0 to 10. Chi square statistical test was utilized ( $p < 0.05$ ).

Studies documented the decreased ischemia of sternum after skeletonized technique but still there is risk of minimum tissue injury with use of electrocautery during skeletonized harvesting technique that could be enough to injure the surrounding intercostal nerves that will cause development of PCP. The studies documented neuropathic injury, mechanical compression or tension and also ischemic injury are different mechanisms involved in development of PCP.<sup>9,17</sup>

Gaudino and Deja et al in their studies documented that with skeletonized technique endothelium is preserved and maintain better blood supply when comparing the pedicle technique.<sup>6</sup> Skeletonized technique reduces the occurrence of pain after operation. The results of recent studies showed that skeletonized left ITA can decrease the occurrence of postoperative pain.<sup>8</sup>

Skeletonized ITA harvesting technique has the advantage that it preserves the vascular supply of sternum, cause less trauma to chest wall so it reduces the occurrence of sternal wall pain.<sup>13</sup> Different studies showed that skeletonized ITA is associated with decreased incidence of pain after CABG surgery. The decreased occurrence of post CABG pain with skeletonized ITA is because the skeletonized technique protects the anterior branch of the intercostal nerve.<sup>12,17</sup>

In our study the duration of stay in the intensive care unit and the hospital was 2.1 days and 6.4 days in the skeletonized left ITA group and 2.5 days and 7.1 days in the pedicled left ITA group. In the pedicled left ITA group 2 patient required re-exploration for bleeding. The Visual Analogue Score pre-discharge (VAS 0-10) was  $2.61 \pm 0.23$  in the skeletonized left ITA group and  $2.58 \pm 0.31$  in the pedicled left ITA group. The Visual Analogue Score at 01 month after discharge (VAS 0-10) was  $0.57 \pm 0.14$  in the skeletonized left ITA group and  $1.21 \pm 0.18$  in the pedicled left ITA group. The difference in the pre-discharge VAS scores between the skeletonized and pedicled left ITA groups was not significant statistically ( $p > 0.05$ ), whereas the Visual Analogue Score was significantly lower in the skeletonized left ITA group ( $p \leq 0.05$ ) at one month follow up.

Studies showed the incidence of PCP being 28-56%. Studies showed that after pedicled harvesting technique chest wall pain was present at 7 months in 45% while in 5% of those where skeletonized technique was utilized, and they concluded that skeletonized harvesting technique is superior to decrease the nerve injury and PCP incidence.<sup>13</sup> Further studies are required utilizing various operative techniques, or different techniques of neuroprotection and perioperative analgesia aimed to decrease the occurrence of PCP.<sup>13</sup>

## CONCLUSION

There is decreased post CABG surgery pain with the use of skeletonized technique of internal thoracic artery harvesting compared to pedicled technique.

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