

## BRACHIAL PLEXUS INJURY DUE TO MEDIAN STERNOTOMY AND LIMA HARVESTING

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### ABSTRACT

**Objective:** Brachial plexus injury is an unusual and under-recognised complication of coronary artery bypass grafting especially when internal mammary artery harvesting takes place. It is believed to be due to sternal retraction resulting in compression of the brachial plexus. Although the majority of cases are transient, there are cases where the injury is permanent and may have severe implications as illustrated in the accompanying case history. We investigated that injury to the brachial plexus was retrospectively assessed in the results of eight patients who underwent median sternotomy for open heart surgery.

**Methodology:** Between March 2006 and October 2008, 455 patients underwent cardiac surgery with median sternotomy. In post operative period peripheral neuropathy symptoms were observed in eight (1.7%) patients. All patients were placed in the hands up position after right internal jugular vein cannulation, and internal mammary artery was prepared for all those patients. The symptoms were classified as pain, sensory impairment and motor impairment.

**Results:** Brachial plexus injury was detected postoperatively in these eight patients. The patients with injured nerves were older and had undergone longer operation times. There were no differences between the patients with injured nerves and the others with respect to mammary artery harvesting or other operative variables. Full recovery occurred in seven of eight (87%) patients after six months, one (13%) patient suffered from disesthesia.

**Conclusion:** It is known that heart surgery sometimes causes partial brachial plexus injury, especially in the lower trunk. However, these peripheral nerve problems are usually not considered clinically important and are not investigated. Patients undergoing open heart surgery must be closely followed up for peripheral nerve injury during the postoperative period.

**KEY WORDS:** Brachial Plexus Injury, LIMA Harvesting.

Pak J Med Sci April - June 2009 (Part-II) Vol. 25 No. 3 424-427

### How to cite this article:

Basel H, Aydin U, Hazar A, Dostbil A, Tekin O, Kapan S. Brachial plexus injury due to median sternotomy and lima harvesting. Pak J Med Sci 2009;25(3): 424-427.

### INTRODUCTION

Brachial plexus injuries have been recognised for many years as a complication of cardiothoracic surgery. A prospective analy-

sis of 455 patients undergoing coronary artery bypass graft (CABG) surgery as the sole cardiac procedure was carried out to assess the frequency of brachial plexus injury complications. In all, 455 variables were assessed in each patient. In several published retrospective series prevalence varied between 2% and 38%, but previously reported prospective studies prevalence varied between 0.5% and 9.6%.<sup>1</sup> The neurological problem that affects cervical eight and thoracic one vertebra is mostly caused by mechanical trauma secondary to

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- \* Received for Publication: March 17, 2009
- \* Revision Received: April 11, 2009
- \* Revision Accepted: May 7, 2009

improperly applied sternal retractors, preparation of the internal mammary artery, cannulation of internal jugular vein.<sup>2</sup>

Our objective is to report our experience by describing the clinical details of eight patients, since the condition may not always be recognised in cardiac surgical units.

## METHODOLOGY

A prospective study is reported of the prevalence, the clinical picture and the course of plexus brachialis lesions following median sternotomy during heart operations. The study comprises 455 patients operated in two years. In 8 patients (1.7%) a lesion of the lower plexus brachialis was found postoperatively. The neurological examination considered of a detailed history regarding upper extremity pain, paresthesia, numbness, and weakness and of a thorough examination of all motor and sensory functions supplied by the brachial plexus (Table-I). In two patients the plexus lesion was combined with an ipsilateral Horner syndrome. The present study suggests that in spite of cautious use of the sternal retractor, the appearance of a postoperative plexus lesion cannot be completely avoided. The Horner syndromes, however, may remain for a longer time period.<sup>3</sup> It is advisable that patients who have to undergo a heart operation with median sternotomy should be informed before hand about the possible side-effects described here.

Right internal jugular vein cannulation was performed. All operations were performed with membrane oxygenators, aortic and bicaval

cannulation, and moderate hypothermia (30 C). All patients were placed in the hands-up position, and internal mammary artery was prepared for all these patients. Within the first three days each patient was reexamined. Whenever a difference between the preoperative and the postoperative state was found, the patients were reviewed with a consulting neurologist to examine the relationship of the assumed neurologic deficits to the brachial plexus. Nerve conduction measurements and electromyography were performed besides neurological examination. These examinations were performed seven days after the operation and were repeated about four weeks and six months postoperatively. Brachial plexus injury was detected in 8 cases (1.7%) of 455 patients who had undergone coronary artery bypass grafting with median sternotomy after investigation of the whole group of patients.

## RESULTS

Brachial plexus injury was detected in eight cases (1.7%) of 455 patients who had undergone median sternotomy for open heart operation in our clinic. There were two female and six male patients, and the mean age was 58.12 years. Diabetes mellitus was assessed in two patients as a multisystemic disorder. In all these cases the initial symptoms were pain, motor and sensorial disturbances at the affected upper limb (in the left arm in all cases).

The common characteristic was that LIMA was grafted to the left anterior descending artery in all cases. A significant difference in

Table-I: Cases postoperative brachial plexus injury following sternotomy

Patient No.	Sex	Age (yr)	Onset of sx post op.	Possible contributory preexisting condition	Initial presentation			Injury to roots	Time to max. recovery (week)	Degree of recovery
					motor	sensory	pain			
1	M	58	2 days	Diabetes	2	1	3	C8-T1	10	full
2	M	55	1 days	Cervical rib	3	1	2	C8-T1	4	full
3	M	41	Immediate	Diabetes	2	2	2	C8-T1	7	full
4	F	68	1 days	-	1	3	2	C8-T1	6	full
5	M	74	1 days	-	3	1	1	C7-T1	5	
6	F	48	2 days	Carpal tunnel sendr	2	2	2	C8-T1	11	Residüel tingling
7	M	53	2 days	-	3	1	2	C8-T1	18	
8	M	68	1 days	-	2	3	1	C7-T1	22	Residüel tingling

surgical procedure wasn't determined in any of the patient. Age wasn't determined as an influencing factor for brachial plexopathy. Predisposing factors were diabetes and carpal tunnel syndrome in the group, however a meaningful relationship between predisposing factors and pathology couldn't be concluded because of small number of patients. Seven of eight patients (87%) achieved full recovery at the mean time of 8.2 (range 1-24) weeks. One patient persisted suffering from disesthesia in the affected upper limb, and still full recovery couldn't be achieved. It was observed that recovery of sensory disorders were the first and fast when compared to the other disorders.

## DISCUSSION

Brachial plexus injury during median sternotomy is a rare complication. The 1.7% incidence of upper extremity brachial plexus injury in this study is similar to that in several previously reported prospective studies (Table-II). Several factors have been associated with brachial plexus injury, including concomitant patient disease, anatomical variations, positioning of the patient, surgical and physiological factors.<sup>4,5</sup> These pathogenetic concepts are supported by the most striking result of our study: the coincidence between LIMA preparation as graft for CABG and the subsequent prevalence of brachial plexus lesions. Internal mammary artery (IMA) preparation requires both a wide opening of the retractor and asymmetric traction to allow visualization of the costosternal junctions. The Favaloro retractor fulfills this requirement by constant traction of the left sternal half during the IMA preparation. However, this period of constant traction may lead to brachial plexus lesions.<sup>6,7</sup> In addition, in our patients positioning of the arm did correlate with the prevalence of brachial plexus lesions. The causes of brachial plexus injury may have been asymmetric traction of the retractor for good exposure in our eight cases. It was reported that placement of an internal jugular cannula had been implicated as a cause of brachial plexus injury.<sup>8</sup> In our series internal jugular cannula was performed to the pa-

Table-II: Incidence of upper extremity brachial nerve injury after sternotomy in prospective study

Source	No. of cases	No. with never injury (%)
Keates et al.,	529	10(1.9)
Benecke et al., 1988	1583	22(1.4)
Hanson et al., 1983	531	32(6.1)
Lederman et al., 1982	421	23(5.4)
Vahl et al., 1991	1000	27(1.2)
Shaw et al., 1985	312	30(9.6)
Tomlinson et al., 1987	335	16(4.8)
Morin et al., 1982	958	54(6.0)
Ünlü et al., 2007	575	3(0.5)

tients from the right side and symptoms were determined at the left side of the patients. Therefore we believe that there were no brachial plexus injury related to internal jugular vein cannulation in this series.

Vander Salm et al. have documented that median sternotomy can cause first rib fractures and the fractured ribs can cause brachial plexus pathologies.<sup>7,8</sup> In our series chest X-rays were detected and first rib fracture or another musculoskeletal injury wasn't observed. Brachial plexus injuries can be seen in two various forms. The former is characterized by a predominance of sensory complaint in the lower roots of the plexus and the latter by a predominance of motor deficit in the upper and middle roots. The former is far more frequent than the latter, with an excellent prognosis for recovery.<sup>9,10</sup> In one of our eight cases the inferior roots were affected and there was completely no improvement.

To avoid these serious complications there are some preventive measures; Exact median sternotomy should be performed. Caudal localization of the retractor should be attempted.<sup>11,12</sup> Constant traction on the sternal halves should be reduced. Asymmetric traction should be avoided when possible. Retractors designed for asymmetric traction should be used with extreme caution. Postoperative neurologic assessment should be performed in every patient to allow early detection and therapy of nerve lesions.<sup>13,14</sup>

There are no reports in the literature of routine preoperative and postoperative electro-

physiological studies in large patient groups to evaluate brachial plexus injury during open heart surgery.<sup>15,16</sup> It is known that heart surgery sometimes causes partial brachial plexus injury, especially in the lower trunk.<sup>17,18</sup> However, these peripheral nerve problems are usually not considered clinically important and are not investigated.<sup>19</sup> Patients undergoing open heart surgery must be closely followed up for peripheral nerve injury during the postoperative period. Plexus injury after median sternotomy differs in that it is common, with an estimated incidence of 2%–38% despite care to avoid malposition of the arms and typically involves the lower plexus roots .

### CONCLUSION

Increasing use of internal mammary artery grafts in coronary artery bypass demands measures to protect the brachial plexus. The most important measure for the low incidence and benign course of brachial plexus problems in these patients resulted from careful sternal retraction and use of the hands-up positions. Inappropriate sternal retraction during preparation of internal mammary artery should be avoided.

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