

Negative results - Cardiac general

Brachial plexus injury following median sternotomy[☆]

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Received 29 May 2006; received in revised form 11 December 2006; accepted 12 December 2006

Abstract

Objective: Brachial plexus injury is a rare complication after median sternotomy. We investigated that injury to the brachial plexus was retrospectively assessed in the results of three patients who underwent median sternotomy for open heart surgery. **Materials and methods:** All patients were placed in the hands-up position after right internal jugular vein cannulation, and the internal mammary artery was prepared for all of those. Nerve conduction measurements and electromyography were performed besides neurological examination. **Results:** Brachial plexus injury was detected in three cases (0.5%) of 575 patients who underwent coronary artery bypass grafting with median sternotomy. The main symptoms were continuous pain, and motor and sensory disturbances at the affected upper extremity (left arm in all cases). The common feature was that in all cases the left internal mammary artery was harvested. While the symptoms were relieved in two patients about six months after the operation, the other one had intractable pain and paresthesia. **Conclusion:** The most important measure is careful sternal retraction and use of the hands-up position for the low incidence and benign course of brachial plexus problems. Inappropriate sternal retraction during preparation of internal mammary artery should be avoided.

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Keywords: Brachial plexus injury; Complications; Nerve damage; Sternotomy

1. Introduction

Brachial plexus injury during median sternotomy is a rare complication. In several published series [1–15] prevalence varied between 2% and 38% (Table 1). The neurological problem that affects cervical 8 (C8) and thoracic 1 (T1) vertebra is mostly caused by mechanical trauma secondary to improperly applied sternal retractors, preparation of the internal mammary artery, cannulation of internal jugular vein, penetration of fractured rib and cold application [15–17]. Brachial plexus injuries have not any specific treatment. Recovery can be as long as six months, whereas in some cases the dysfunction can be intractable. We investigated three cases which had brachial plexus injury after a median sternotomy for open heart surgery and the results of them.

2. Patients and methods

Five hundred and seventy-five consecutive adult patients who were undergoing cardiac operations necessitating median sternotomy and extracorporeal circulation were evaluated before and after operation for symptoms and signs of neurologic deficits related to brachial plexus dysfunction. The neurologic examination consisted 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.

Right internal jugular vein cannulation was performed. All operations were performed with membrane oxygenators, aortic and bicaval cannulation, and moderate hypothermia (30–32 °C). All patients were placed in the hands-up position, and internal mammary artery was prepared for all of those.

Within the first three days after extubation of the trachea 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 three cases (0.5%) of 575 patients who underwent coronary artery bypass grafting with median sternotomy after investigation of the whole group of patients.

3. Case reports

3.1. Case 1

A 35-year-old man underwent coronary artery bypass grafting (CABG) (four-vessel bypass) for coronary artery

[☆] This Clinical article was presented at the XVth Annual Meeting, Mediterranean Association of Cardiology and Cardiac Surgery, Bodrum, Turkey, September 26–29, 2004.

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Table 1
Prevalence of brachial plexus lesions after cardiac operations

Reference	Mode	Patients	Complications	%
Baisden et al., 1984 [1]	P	36	3	8.3
Benecke et al., 1988 [2]	P	1583	22	1.4
Hanson et al., 1983 [3]	P	531	26	5.0
Lederman et al., 1982 [4]	P	421	23	5.4
Marganitt et al., 1986 [5]	P	15	0	0.0
Morin et al., 1982 [6]	R	958	54	6.0
Roy et al., 1988 [7]	P	162	16	10.0
Seyfer et al., 1985 [8]	P	53	20	38.0
Shaw et al., 1985 [9]	P	312	21	7.0
Sotaniemi, 1982 [10]	P	100	12	12.0
Tomlinson et al., 1987 [11]	P	335	16	4.8
Treasure et al., 1980 [12]	P	200	4	2.0
Vander Salm et al., 1980 [13]	P	180	33	18.3
Vander Salm et al., 1982 [14]	P	120	18	15.0
Vahl et al., 1991 [15]	P	1000	27	2.7

P, Prospective; R, Retrospective.

disease. The left internal mammary artery (LIMA) was harvested at the operation. Pain, motor and sensorial disturbances developed at the left upper extremity after the operation. The electromyography (EMG) revealed no significant findings. The patient was managed with palliative treatment and the symptoms relieved six months later.

3.2. Case 2

A 65-year-old man underwent CABG (four-vessel bypass) for coronary artery disease. The LIMA was harvested at the operation. Pain, motor and sensorial disturbances developed at the left upper extremity after the operation. The EMG revealed incomplete lesion with severe axonal degeneration at the inferior trunk of the left brachial plexus. The patient received palliative treatment but the paresthesia and pain continued in the left arm.

3.3. Case 3

A 50-year-old man underwent CABG (four-vessel bypass) for coronary artery disease. This patient had diabetes mellitus (DM) for seven years. The LIMA was harvested at the operation. Pain, motor and sensorial disturbances developed at the left upper extremity after the operation. The EMG was normal. The patient received palliative treatment and the symptoms relieved after six months.

4. Discussion

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 [1–11, 15].

Injury to the brachial plexus was retrospectively assessed in results of three patients who underwent median sternotomy for open heart operation in our clinic. Brachial plexus injury was detected in three cases (0.5%) of 575 patients. 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. In two cases the symptoms regressed after six

months whereas one patient had intractable paresthesia and pain. One patient had DM for the past seven years.

Several factors have been associated with brachial plexus injury, including concomitant patient disease, anatomical variations, positioning of the patient, surgical and physiological factors (Table 2) [18]. 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. 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 three cases.

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 [18]. In one of our cases the inferior roots were affected and there was completely no improvement.

Table 2
Factors associated with intraoperative brachial plexus injury

<i>I. Concomitant disease</i>
• Diabetes mellitus
• Hypothyroidism
• Pernicious anaemia
• Alcoholism
• Pre-existing neuropathy
• Herpes zoster
• Polyarteritis nodosa
• Peripheral vascular disease
• Coagulopathy
<i>II. Concomitant anatomical predisposition</i>
• Cervical rib
• Scalene muscle hypertrophy
• Deformity (e.g. post-traumatic) of shoulder region
• Anomalous derivation of plexus
<i>III. Positioning</i>
• Steep Trendelenburg
• Steep Trendelenburg + shoulder braces
• Steep Trendelenburg + wrist suspension
• Excessive abduction of arm (>90°)
• Dorsal extension at shoulder
• Posterior shoulder displacement
• External rotation of arm
• Excessive rotation of head
<i>IV. Surgical</i>
• Prolonged operative time
• Median sternotomy
<i>V. Physiological</i>
• Hypothermia
• Hypotension

From Ben-David B [18].

To avoid these serious complications there are some preventive measures; (1) Exact median sternotomy should be performed. (2) Caudal localization of the retractor should be attempted. (3) Constant traction on the sternal halves should be reduced. (4) Asymmetric traction should be avoided when possible. (5) 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 [11, 15, 18].

In 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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ICVTS on-line discussion A

Title: Brachial plexus injury following median sternotomy

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doi:10.1510/icvts.2006.137380A

eComment: Congratulations to Unlu et al. for their excellent work [1]. Post-sternotomy brachial plexus injuries are annoying, common complications, whose incidence has always been underestimated. The symptoms often manifest as a variety of upper extremity neuropathies, such as pain, numbness, dysesthesia, or loss of motor function in the hand, forearm, or arm. And, in the vast majority of these patients, the neurological symptoms are transient and usually resolved within six months.

We experienced several patients who presented with transient brachial plexus neuropathies with full recovery in our practices. And, we had one reported patient on whom we performed coronary artery bypass surgery with left internal mammary artery harvesting also who experienced persistent, unrecovered brachial plexus injury [2]. One recent experienced permanent brachial plexus injury patient who received aortic graft transposition operation for his acute aortic dissection was concluded to be related to nerve injury during brachial cannulation procedure.

We are interested in the mechanism of brachial plexus injury related to surgical procedures. The constituent nerve roots of the plexus are fixed proximally at their points of exit from the vertebral canal, and distally the nerves are tethered to the axillary fascia. Excessively spreading the sternal retractor will increase the distance between these fixation points and thus stretch the brachial plexus. A downward-pushed clavicle with an upward-rotating first rib by asymmetrical sternal retractor will also compress the distal part of the plexus. Both of them might more often affect upper trunk (C5–C7) rib fractures near costotransverse articulation or punctures for the internal jugular vein. Where the lower trunk (C8–T1) of the plexus lies immediately medial to them, they might often affect the lower trunk.

We agree with the preventive measures proposed by Unlu et al., we cautiously use the asymmetric sternal retractor, put a lower position and the smallest possible opening for sternal retractor, and prevent the prolong traction on the sternal halves to minimize the brachial plexus injury following median sternotomy.

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