

Incidence of Intercostobrachial Nerve Injury After Transaxillary Breast Augmentation

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Background: Although many studies on transaxillary breast augmentation (TBA) have been published, none has examined the incidence of intercostobrachial nerve (ICBN) injury after aesthetic surgery.

Objective: This study was designed to measure the incidence of ICBN injury after endoscopic and non-endoscopic TBA, and to determine anatomic guidelines for the avoidance of iatrogenic injury to the ICBN.

Methods: A questionnaire was distributed nationally to 1000 plastic surgeons selected randomly from the roster of the American Society of Plastic Surgeons. The questionnaire sought information on the surgeons' experience, technique, and complication rate with regard to TBA. Anatomic dissections of 6 unoperated axillae were also performed.

Results: Our survey response rate was 50%; of those responding, 26.8% of surgeons (134) performed TBA. Of the 134 surgeons performing TBA, 72 (53.7%) used an endoscope. The overall complication rate was 62.7%, which included upper-arm and shoulder pain, numbness, sensory loss, and tingling, and upper-arm fibrous banding. No significant differences were seen between the complication rates for the endoscopic (66.7%) and open (58.1%) TBA groups. With few exceptions, all symptoms resolved in 3 to 6 months. The dissection study confirmed the location of the ICBN as being immediately subcutaneous in the axilla.

Conclusions: TBA is associated with a high incidence of injury to the ICBN. Our findings indicate that the use of an endoscope with the transaxillary approach does not significantly affect the rate of injury to the ICBN. The dissection study performed helped to confirm that an immediately subcutaneous plane of dissection in the axilla is safest with regard to avoiding injury to the ICBN. (*Aesthetic Surg J* 2002;22:26-32.)

Transaxillary breast augmentation (TBA) was first described in the early 1970s by Hoehler¹ at the Klinik für Plastische und Wiederherstellungschirurgie in Frankfurt, Germany. Having experienced very few complications after 228 breast augmentations, Hoehler concluded that the transaxillary approach is preferable to the inframammary and periareolar approaches. He further argued that the transaxillary approach requires a simple technique, provides good cosmetic results, and is advantageous in that "no bleeding occurs during the operation and the scars are invisible."¹ More recent studies indicate that TBA also causes lactation deficiencies less often than periareolar breast augmentation.² A major advancement in TBA came in 1993 when Ho³ first reported the use of the endoscope as a means of improving visibility during dis-

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section of the implant pocket. Ho claimed that the endoscope affords a degree of precision and control that is unobtainable with the open procedure.

Since Ho's application of the endoscope in TBA, many articles have described various techniques to help improve outcomes with endoscopic transaxillary breast augmentation (ETBA), such as external traction elevation of the arm,⁴ submuscular⁵ and subfascial⁶ implant placement, and local infiltrative anesthesia.⁷ These as well as other reports published on both open transaxillary breast augmentation (OTBA) and ETBA describe complications such as hematoma, malpositioning of the implant, subclavian and lateral thoracic vein thrombosis, lymphangitis of the upper arm, capsular contracture, hypertrophic scarring, infection, subcutaneous fibrous banding,⁸ and injury to the long thoracic nerve in open TBA.^{9,10} Few studies specifically address the topic of sensation loss, and most reports restrict their discussion to the loss of nipple sensation.^{11,12} However, there are a multitude of reports on sensory changes after breast cancer surgery, and a few specifically address upper inner-arm sensory loss caused by intercostobrachial nerve injury after axillary dissection.¹³⁻¹⁷ This information could be applicable to OTBA and ETBA.

The benefits of preserving the ICBN in axillary dissection have been reported as early as 1985.¹⁸ More recently, a randomized controlled trial to evaluate preservation of the ICBN in axillary dissection has indicated that sectioning of the ICBN causes sensory deficits significantly more often than preservation of the ICBN.¹⁹ The authors recommended that the ICBN be preserved whenever possible. Conversely, a similar randomized controlled trial published the same year in the *European Journal of Surgical Oncology* found no significant difference in sensory deficit between the sectioned ICBN group and the preserved ICBN group.²⁰ The authors concluded that preservation of the ICBN is not necessary. Although the current evidence for or against preservation of the ICBN in oncologic procedures is inconclusive, careful attention must be paid to the incidence of injury to the ICBN in elective procedures, such as breast augmentation, in which even minor or transient complications can be a source of great distress for the patient and the surgeon.

With the exception of such studies on axillary dissection in the treatment of breast cancer, the incidence of injury to the ICBN has not been the focus of any published

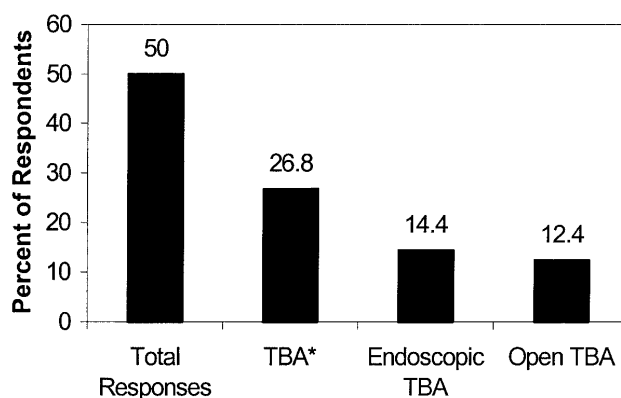


Figure 1. Response rates for survey questionnaire. TBA, Transaxillary breast augmentation.

report on transaxillary breast augmentation. Although axillary dissection for the treatment of breast cancer requires more extensive dissection of the axilla and, indeed, the removal of tissue, OTBA and ETBA require incisions in the axillary region that put the ICBN at risk and may result in sensory deficits in the upper arms of women undergoing elective augmentation mammoplasty. Because upper-arm numbness, tingling, or sensation loss associated with injury to the ICBN is an undesirable sequelae of an elective procedure such as TBA, it is important to know how often it occurs. This study was designed to survey the incidence of injury to the ICBN during transaxillary breast augmentation and to evaluate whether certain adjuncts to the procedure, such as endoscopic access, prevent or contribute to these injuries.

Materials and Methods

Survey study

A questionnaire was developed to seek the incidence of injury to the ICBN by recording the frequency of occurrence of such symptoms as postoperative pain, numbness, tingling, and sensation loss in the upper arm and shoulder (Table 1). These symptoms were selected on the basis of the likelihood that they result from injury to the ICBN. Such symptoms have been found to closely correlate with damage to the ICBN in randomized controlled trials.^{19,20} The 1000 recipients of this questionnaire were selected at random from the names listed in the combined American Society of Plastic Surgeons and Plastic Surgery Educational Foundation roster for the year 2000. Any name that corresponded to a member who was retired, not active, or living outside the United States was replaced by another randomly selected name.

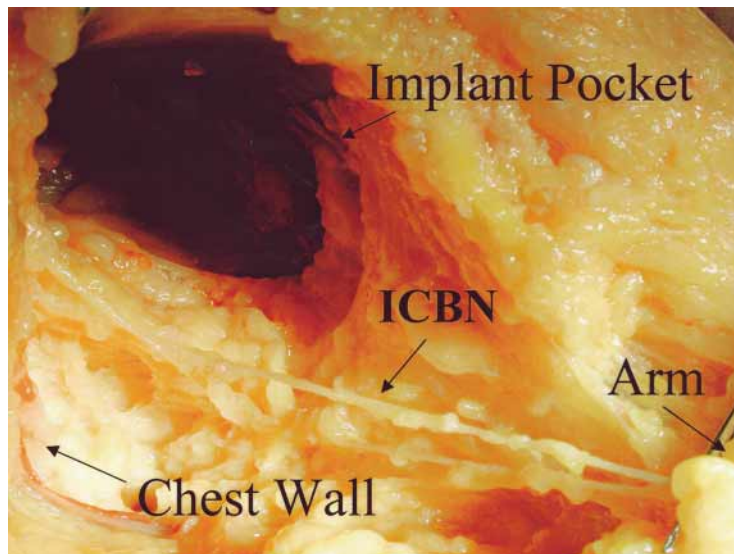


Figure 2. Location of the intercostobrachial nerve (ICBN) in relation to the arm, chest wall, and implant pocket.

Table 1. Parameters surveyed

Parameter	Units and increments				
	1-10	11-50	51-100	>100	
No. breast augmentations/y	1-10	11-50	51-100	>100	
% TBA	0%	1%-24%	25%-49%	50%-74%	75%-100%
% ETBA	0%	1%-24%	25%-49%	50%-74%	75%-100%
% Rate of symptom occurrence*	0%	1%-24%	25%-49%	50%-74%	75%-100%
Duration of symptom occurrence*	3 mo	6 mo	12 mo	Unresolved	Other
Location of incisions (relative to axillary hairline)	At	Above	Below		
Length of incisions (cm)	<2 cm	3-4 cm	>4 cm		

ETBA, Endoscopic transaxillary breast augmentation; TBA, transaxillary breast augmentation.

*Symptoms surveyed included upper-arm pain, numbness, tingling, sensation loss, and fibrous banding; and shoulder pain, numbness, tingling, and sensation loss.

Questions pertaining to the technique of TBA procedures that may affect the incidence of injury to the ICBN were also asked, such as location and length of incisions.

The returned questionnaires were separated according to whether the respondent performed TBA, and those from physicians who did perform TBA were separated according to whether the procedure was performed endoscopically (ETBA) or nonendoscopically (OTBA). The respondents who performed ETBA were instructed to fill out the questionnaire with regard to their endoscopic procedures. Therefore all the data con-

tained in the questionnaires were grouped as either ETBA or OTBA.

The data were then entered into a computer and cross-tabulations were run with the use of SPSS software (Statistical Package for Social Sciences Inc, Chicago, IL). The cross-tabulations compared each of the parameters listed in Table 1 to each other, giving chi-square values to evaluate significant differences.

Dissection study

A total of 6 axillary dissections were performed on 3 dif-

Table 2. Comparisons

Parameter	%	P
Complications reported*		
For all TBA	62.7	
For ETBA	66.7	.166
For OTBA	58.1	.166
Location of incision		
Above axillary hairline	23.6	.665
At axillary hairline	21.2	.665
Below axillary hairline	16.7	.665
Length of incision		
≤2 cm	21.4	.669
3-4 cm	22.6	.669
≥6 cm	19.1	.669
Tingling in shoulder		
For surgeons performing ETBA >50% of the time	21.1	.004 [†]
For surgeons performing ETBA <50% of the time	0	.004 [†]
Sensation loss in shoulder		
For surgeons performing ETBA >50% of the time	5.3	.011 [†]
For surgeons performing ETBA <50% of the time	0	.011 [†]

ETBA, Endoscopic transaxillary breast augmentation; OTBA, open transaxillary breast augmentation; TBA, transaxillary breast augmentation.

*Complication = any symptom measured, as listed in Table 1.

[†]P reflects significantly different data.

ferent unpreserved female postmortem subjects. All dissections were performed with the arms in abduction.

Results

Survey study

Of the 1000 questionnaires mailed, 500 were returned, yielding a 50% response rate. The response frequencies are listed in Figure 1. Among the 500 respondents, 134 (26.8%) performed TBA. Most (59.7%) of these surgeons performed breast augmentations fewer than 50 times per year and used the axillary approach for breast augmentation in fewer than 50% of their breast augmentation cases. Of the 134 surgeons who used the transaxillary approach for breast augmentation, more than half used an endoscope (53.7%); most (70.6%) of these surgeons used an endoscope in more than 50% of their TBA patients. The total complication rate was 62.7%. The surgeons performing ETBA reported a complication rate of 66.7%, whereas surgeons performing OTBA reported a complication rate of 58.1% ($P = .166$).

The results of the cross-tabulations performed with the SPSS software are listed in Table 2. Surprisingly, the frequency with which the responding surgeons performed breast augmentations with the transaxillary approach had no effect on the complication rate. Likewise, neither the location nor the length of incisions had an effect on the complication rate. However, though not statistically significant, a trend existed between the incision location and the complications reported, especially for symptoms involving the upper arm. For all symptoms involving the upper arm, incisions located above the axillary hairline correlated with the greatest number of complications. Most of the surgeons made incisions at the axillary hairline for both endoscopic and open TBA groups (56.5% and 58.9%, respectively).

Furthermore, no significant difference was found between the complications reported for endoscopic versus open TBA. However, the frequency with which the surgeons used an endoscope did affect the complications rate reported for the symptoms of shoulder tin-

Table 3. Time necessary for symptom resolution

Procedure	Symptoms								
	uaP	uaN	uaT	uaFB	uaSL	sP	sN	sT	sSL
ETBA									
Average time for symptom resolution (mo)	3.0	3.5	3.0	4.0	5.25	2.5	6.0	3.0	6.0
SD (wk)	5.8	4.4	5.0	8.5	16.7	4.5	20.8	0	20.8
OTBA									
Average time for symptom resolution (mo)	4	4.5	4	4.5	4.5	4.25	5.5	5	5.5
SD (wk)	9.3	11.8	11.6	11.4	11.7	13.6	15.6	14.5	15.6

ETBA, Endoscopic transaxillary breast augmentation; OTBA, open transaxillary breast augmentation; SD, standard deviation, uaP, upper-arm pain; uaN, upper-arm numbness; uaT, upper-arm tingling; uaFB, upper-arm fibrous banding; uaSL, upper-arm sensation loss; sP, shoulder pain; sN, shoulder numbness; sT, shoulder tingling; sSL, shoulder sensation loss.

gling and shoulder sensation loss. Surgeons who performed ETBA less frequently than 50% of the time had patients who reported tingling in their shoulder 21.1% of the time and sensation loss 5.3% of the time, whereas surgeons who performed ETBA more than 50% of the time had no patients who reported tingling ($P = .004$) or sensation loss ($P = .011$) in their shoulder.

The average time for resolution of shoulder tingling was 3 months for ETBA and 5 months for OTBA; the average time for resolution of shoulder sensation loss was 6 months for ETBA and 5.5 months for OTBA (Table 3). For all the symptoms surveyed, the average time for resolution was 4 months, with a standard deviation of 2 months. The longest time for resolution of any symptom was 12 months, which occurred for all symptoms surveyed at least once. Upper-arm numbness, sensation loss, and fibrous banding were each reported unresolved on one occasion, and all were reported by the OTBA group but not the ETBA group.

Dissection study

The ICBN was consistently present in every dissection. However, the course of the nerve from the chest wall to the upper inner arm varied, even from one axilla to the other on the same subject. Sometimes it was a single nerve, and sometimes 2 or more nerves crossed the axilla as a result of early branching. The lateral thoracic vein was intimately involved with the ICBN as it traversed the axilla. The nerve became more superficial as it crossed

the axilla into the upper inner arm, where it was located subcutaneously (Figure 2).

Discussion

Augmentation mammoplasty has evolved greatly since Cronin and Gerow's²¹ introduction of the gel implants procedure in 1963. Approaches for implantation of breast prostheses have progressed from inframammary to periareolar,²² transareolar,²³ axillary,¹ and, most recently, transumbilical.²⁴ The main advantage of the axillary route has been placement of the incision in the apex of the axilla, well away from the breast. There have been disadvantages as well. The inability to accurately dissect the inferior and medial areas of the submuscular pocket has sometimes led to aesthetic results that are less than optimal, and many have abandoned the procedure.⁵ The application of the endoscopic technique reportedly has allowed more control over implant pocket dissection with improved hemostasis, accurate prosthesis positioning, and improved overall results.³

Injury to the ICBN has been noted as a potential complication of the endoscopic as well as the open approach to TBA.^{8,12,25} Some studies mention that patients complained of symptoms related to the distribution of the ICBN, but none reports the incidence of such complaints, and some studies did not even refer to the nerve.^{1,3,5} Tebbetts²⁵ specifically addresses this issue in a segment of the report on OTBA published in 1984. He states that the dissection in the axilla should be "immediately subcutaneous (super-

ficial to axillary fat)” to avoid injury to the ICBN. Before adapting this dissection technique, he noted that 4 of 20 patients had paresthesia or anesthesia in the distribution of ICBN. After he began using it, he saw no further symptoms relating to possible damage to the ICBN.²⁴ In Ho’s³ original description of ETBA, no specific description is provided of the dissection plane in the axilla for port placement, and the ICBN is never mentioned. All other published articles to date recommend a subcutaneous dissection in the axilla en route to the lateral border of the pectoralis major muscle and make no comment on how often patients complain of symptoms such as tingling, numbness, sensation loss, or pain in the upper arm.^{1,5}

In our study, we found that a majority of those surveyed (62.7%) reported that their patients have some sequelae of injury to the ICBN. Whether or not an open or endoscopic approach was used did not make a statistically significant difference (58.1% versus 66.7%, respectively, $P = .166$). One criticism of this high incidence of complications is the inclusion of fibrous banding in the symptom group surveyed. Many explanations have been cited for the cause of upper-arm fibrous banding. In a letter published in *Plastic and Reconstructive Surgery*, Laufer²⁶ states that this is a result of “sclerosed lymphatic channels.” Dowden²⁷ argues that the cause is consistent with Mondor’s thrombophlebitis. In the same issue, Young²⁸ reports an incidence of approximately 15% in more than 2000 patients, and relates the cause of upper-arm fibrous banding to “local inflammation and swelling with tension on ICBN or medial cutaneous nerve of the arm.” Because no consensus has been reached on the cause of upper-arm fibrous banding and the possibility that it could be the result of injury to the ICBN, we decided to include it in our symptom group. Even if that parameter is removed, the percentage of complications noted by the respondents still remains high (47.2% for ETBA, 37.7% for OTBA, and 44.8% overall).

Most surgeons noted our symptoms in only 1% to 24% of their patients (9 noted symptoms in 25% to 49% of their patients). The true incidence is difficult to measure because of cross-innervations with the medial cutaneous nerve of the arm and occasional contributions from a lateral branch of the third intercostal nerve.¹⁸ This is further supported by a recent study detailing the anatomy of the ICBN. O’Rourke and co-workers²⁹ demonstrated that in 28

cadaver dissections, the size of the ICBN was inversely proportional to the size of the medial cutaneous nerve of the arm, suggesting some overlap in sensory innervation of the upper arm. Thus the incidence of injury may actually be higher but simply not observed. A study regarding axillary dissection for breast cancer, where the ICBN is either transected or presumed to be transected, has shown that only a small percentage of patients have chronic symptoms.³⁰ However, in one prospective randomized trial of preservation of ICBN during axillary node clearance for breast cancer, symptoms were a cause for concern in the majority of patients, despite warnings and reassurances before surgery about potential sensory loss.¹⁹ Therefore, sensory deficits would be especially distressing in an elective procedure such as augmentation mammoplasty, even if it occurred in a small percentage of patients.

Neither the location nor the length of incision affected the incidence of complications. This again confirms that the plane of dissection in the axilla may be the key to avoiding injury to the ICBN. One statistically significant result was the percentage of shoulder tingling and sensation loss, which correlated with the frequency with which the surgeon used the endoscopic technique. If the surgeon used ETBA in more than 50% of TBA cases, no shoulder tingling or sensation loss was noted in any patient. On the basis of the current knowledge of ICBN anatomy, no sound explanation exists for the above observance. However, these findings suggest that perhaps the ETBA technique requires continued and consistent practice beyond the initial learning curve.

Most of the reported symptoms resolved within 3 to 6 months, but a few surgeons noted unresolved sensory deficits in the upper arm. One respondent even stated that he or she had abandoned TBA, given the complications listed in our survey. One surgeon reported a radial nerve palsy, which resolved in 6 to 8 weeks.

We do understand that our survey has limitations. Every respondent has a different surgical technique and skill, and patients were not directly questioned about our parameters. Our main intent was to determine the incidence of injury to the ICBN observed by surgeons performing either OTBA or ETBA because the procedure has become more widespread since the publication of Tebbett’s²⁵ article regarding OTBA in 1984. The sig-

nificance of our study results is that most surgeons have noted some upper-arm and shoulder symptoms in their patients after TBA, and the use of an endoscope does not make a difference in the prevention of such injury. This study highlights the incidence of injury to the ICBN with TBA and indicates that with meticulous axillary dissection, the incidence may decrease. Our anatomic dissections reinforced the “immediately subcutaneous plane” of dissections that Tebbetts stressed in his publication. ■

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