

นิพนธ์ต้นฉบับ

## Intracordal injection with autogenous fat : preliminary study of 9 cases

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*Paralytic or atrophic vocal cords will cause hoarseness, aspiration or airway obstruction due to types and positions of the involved cords. The authors used autogenous fat injection into the vocal cords in nine patients for relief of hoarseness and/or aspiration resulted from unilateral vocal paralysis (7 cases), bilateral vocal cord paralysis (1 case) and atrophy of vocal cords (1 case).*

*The results of the study reveal excellent voice in two patients, moderate voice improvement in two patients and slight voice improvement in two patients. The aspiration was adequately controlled in two cases, and the other one case was inadequate because of multiple cranial nerves paralysis. The authors believe that this procedure is easy, and safe and obtain the good results.*

**Key words :** Cord medialization, Vocal cord paralysis free fat graft.

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การฉีดหุ่นสายเสียงด้วยเนื้อเยื่อไขมัน : การศึกษาเบื้องต้นในผู้ป่วย 9 ราย. จุฬาลงกรณ์เวชสาร  
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ผู้ป่วยที่มีอัมพาตของสายเสียง หรือสายเสียงฝ่อมีขนาดเล็ก จะทำให้เกิดอาการเสียงแหบ สำลักใน  
ขณะกลืนอาหาร และหายใจลำบาก ขึ้นอยู่กับชนิดของอัมพาต และตำแหน่งของสายเสียง ผู้วิจัยได้ทดลอง  
ใช้เนื้อเยื่อไขมันของผู้ป่วยเองฉีดเข้าไปหุ่นสายเสียงจากทางด้านข้างในผู้ป่วย 9 รายที่มีอาการเสียงแหบ  
และ/หรือสำลักในขณะกลืนอาหาร ซึ่งเกิดจากมีอัมพาตของสายเสียงข้างเดียว 7 ราย อัมพาตของสายเสียง  
ทั้ง 2 ข้าง 1 ราย และสายเสียงฝ่อมีขนาดเล็กจากการบาดเจ็บ 1 ราย ผลการศึกษาในส่วนของคุณภาพเสียง  
พบว่าเสียงดีขึ้นมาก 2 ราย ดีขึ้นปานกลาง 2 ราย และดีขึ้นเล็กน้อย 2 ราย (รวม 6 ราย) และในส่วนของ  
ความพยายามลดการสำลักในขณะกลืน ได้ผลดีน่าพอใจ 2 ราย อีก 1 รายไม่ได้ผล เนื่องจากมีการสูญเสีย  
เส้นประสาทสมองอื่น ๆ ร่วมด้วย คณะผู้วิจัยเห็นว่าวิธีการทำผ่าตัดนี้ทำได้ง่าย ปลอดภัย เนื้อเยื่อไขมันก็  
หาได้จากตัวผู้ป่วยเอง และที่สำคัญคือได้ผลดี

Vocal cord paralysis or loss of vocal cord mass results in abnormal glottic closure. The patient with this condition will have a hoarse, breathy and weak voice which becomes easily fatigued with continued use. The other group of patients will complain of aspiration and cough that sometimes is severe enough to cause difficulties in their lives.

In order to solve this problem, the paralytic cord is thrust into the midline, it can then be touched by the active compensated contralateral cord.<sup>(1-6)</sup> This is also true for the hypo-plastic cord or loss of vocal cord tissue.

To achieve this, augmentation with various kinds of material were used,<sup>(1-6)</sup> among them Teflon paste is the most widely accepted substance<sup>(3)</sup> but collagen has also been used as an alternative.<sup>(1,7)</sup> Teflon has foreign body properties, so it will cause inflammatory process in the injected tissue, resulting in a granuloma formation and migration of it.<sup>(8,9)</sup> The drawbacks of collagen are similar to Teflon, and it is also absorbed by the tissue over a period of time.<sup>(10)</sup> Laryngoplastic phonosurgery designed and popularized by Isshiki, using the silicone block augmented from the external approach into the hole made in the

thyroid ala is still being investigated by many authors.<sup>(4-5)</sup>

Fatty tissue transplantations were used successfully in many areas to correct the body contour such as in facial hypotrophy. We tried the use of autogenous fatty tissue obtained from the abdominal wall and injecting it into the paracordal tissue to push the cord medially.<sup>(11-13)</sup> This article is a report of the preliminary study to observe the outcome, advantages and disadvantages of the intracordal lipo-injection procedure.

### Materials and methods

From March 1991 to January 1993, nine patients were treated with autogenous fat injection into the paracordal tissue in order to augment and medialize the cord. The fat was harvested from the abdomen through the incision in the umbilicus.

Seven patients had unilateral cord paralysis, one had bilateral cord paralysis and the other had trauma-induced hypotrophic cord with impaired movement.

There were 3 men and 6 women, the ages ranged from 20 to 48 years. (Table 1)

**Table 1.** Clinical summary of a patients treated with lipo-injection into paracordal tissue.

Case	Sex	Age (yr)	History	Diagnosis	Fat inject <sup>m</sup>	Follow up (month)	Result
1	F	27	History of toxic goiter since age 16, euthyroid after treatment for 7 years. Hoarseness for 2 years. No thyroid surgery	Left cord paralysis in paramedian position, poor compensation of the right cord	0.75 ml	10	Excellent voice, good glottic closure Excellent patient's satisfaction
2	F	31	Subtotal thyroidectomy for thyrotoxicosis for 2 years previously. Hoarseness and breathiness immediately after surgery	Left cord paralysis in intermediate position, large posterior gap. poor right cord compensation	1.0 ml	6	Moderate voice improvement, nearly complete glottic closure
3	M	28	Car accident with neck trauma 10 years previously	Left cord paralysis in paramedian position, poor compensation of the right cord	0.5 ml	1/2	Slight voice improvement, edema of arytenoid

4	M	25	Fracture of the larynx for one month, Laryngofissure repairing, stenting	Moderately impaired movement of both cords with bowing of the left one and large posterior gap granulation tissue at anterior commissure	0.75 ml	1	Slight voice improvement. Wide posterior gap
5	F	42	Non-Hodgkin lymphoma of left ovary, treated with chemotherapy and radiotherapy. Aspiration began after surgery	Left cord paralysis in paramedian position with large rima glottidis	1.25 ml	1	Aspiration subsides, effective closure of rima glottidis
6	M	48	Underlying of chronic renal failure, Diabetes mellitus, congestive heart failure and recurrent pneumonitis. Left cord paralysis with severe aspiration. Tracheostomy was done	Left cord paralysis with atrophy of cordal mass, wide rima glottidis	1.0 ml	2	No aspiration. Be able to extubate. The patient died of uremia 2 months after lipo-injection
7	F	20	Gun shot wound of face and neck 3 months previously. Fracture of right side of mandible. Bilateral CN X, right CN IX, XI, XII palsies. Severe aspiration, hoarseness, breathiness with tracheostomy	Bilateral vocal cord paralysis. Both were in intermediate positions. Rima glottidis 5 mm.	Lt. 0.75 ml Rt. 0.87 ml	1	No impairment. Cricopharyngeal myotomy was performed later

8	F	40	Follicular adenoma with occult papillary adenocarcinoma treated by total thyroidectomy combined with radioactive iodine therapy. Immediate hoarseness postoperatively. voice	Right cord paralysis with hypoplastic cordal tissue. Bowing in the middle and posterior parts. No compensation from the left side	0.87 ml	4	Moderate improvement of voice but still some degree of hoarse. Posterior gap about 1 mm. Fair patient's satisfaction
9	F	21	Hoarse and breathy voice for 1 year. No cause identified	Left cord paralysis in paramedian position. Inadequate compensation from the right cord	0.75 ml	3	Excellent improvement of voice

### Voice assessment

Patients who complained of hoarse, breathy voice should have their voice function assessed by a speech pathologist. Unfortunately, the voice clinic had not been completely established, so the videostroboscopic recordings were not available.

The assessments were based on clinical findings, which included the quality of voice, intensity, and ability to raise voice; together with the patient's and physician's satisfactions were evaluated. The phonation times were measured. After a three-month course of voice therapy, there were no improvements in all parameters measured, so 6 patients underwent the surgery for voice improvement. The other indication for fat injection was to control aspiration, three patients were included in this category, their pre-operative and post-operative clinical findings were evaluated.

### Operative technique

The surgeries were performed under general endotracheal anesthesia using a small endotracheal tube except for patients 5 and 6 in whom the jet ventilation system were used and in patient 7 who had anesthesia through her tracheostomy. The abdominal wall was prepared and draped in the usual sterile manner. A short periumbilical incision was made and 3-4 cc of fatty tissue was obtained. The fat was separated from the fibrous tissue component and cut into small pieces of about 2x2 mm. with sterile precaution. The pure fat was then placed into the barrel of a Bruning vocal cord injection device to which an

18-gauge needle on a straight shaft had been attached.

The Dedo-type rigid laryngoscope was used to expose the larynx. After having been suspended, an operating microscope with 400 mm. objective lens was used to improve the magnification, and the fat was injected under visualization. Two injections were made into the lateral aspect of the vocal cord, one in the middle third, and the other in the anterior third. Sometimes an additional injection into the posterior third of paracordal tissue was required especially in the cases with large posterior gaping. The injected fat was observed to readily diffuse into the muscle bulk increasing the cordal mass which resulted in a medialization of the vocal cord. The injection should result in a 50% over correction or a convex bowing of the involved vocal cord to beyond the midline. At this time any leakage of fat from the injected site was also searched for and prevented by sealing it off using the electrocautery.

The laryngoscope was then removed, the patient extubated and observed post-operatively for laryngeal stridor and airway obstruction. Fortunately no patients had laryngeal obstruction from this procedure.

### Results

We divided the patients into two groups-the hoarse voice group and the aspiration group.

For the hoarse voice group, the indications for surgery were to improve the voice quality, increase the intensity and pitch range as well as to reduce the leakage of air during phonation. There were two men and four women (total=6) in this group, with the ages ranged from

20 to 40 years (mean=27 years old). Two-thirds (4/6) of the patients had left vocal cord paralysis except one case who had a right cord paralysis, and the other case only had restriction of the left cord mobility with loss of its volume. The causes of vocal cord paralysis included thyroid surgery(2), neck trauma(1) and idiopathic cause(2) and in which one case may be due to a thyroid related disease (thyrotoxicosis). The patient whose vocal cord volume was low was associated with a blunt trauma of the neck resulting in fractures of the laryngeal framework. He had previously undergone laryngofissure, repair and stenting for 3 weeks from another hospital.

The results of surgery were interpreted as "slight voice improvement", "moderate voice improvement" and "excellent voice" using all the parameters described above. Two cases yielded excellent voice improvement, two had moderate voice improvement, and the remaining two cases had only slight improvement of voice and glottic closure. Interestingly these latter two cases were noted to have the wide posterior glottic gaps which were caused by trauma of the larynx resulting in the left cord paralysis in one case and the left cord bowing and volume deficit in the other.

In the second (aspiration) group, there were three patients aged 20, 42 and 48 years. The first case (number

5) suffered from left cord paralysis secondary to non Hodgkin lymphoma involving the mediastinal node. The second case (number 6) had an underlying chronic renal failure with diabetes mellitus, congestive heart failure, recurrent pneumonitis and paralysis of left true vocal cord. The third case was a young female (number 7) who was injured by a gun shot wound in the neck which caused trauma to the both vagus nerves and glossopharyngeal, spinal accessory and hypoglossal nerves in the right side. She had severe problems with aspiration and dysphagia. A wide rima glottidis of 4 mm, and paralysis of both vocal cords were noted.

The results of fat implants into the true vocal cord were analysed. Chronic aspiration was much improved in the first two cases. In the last patient, although two attempts of lipoinjection were made in both vocal cords, the procedure failed to prevent aspiration owing to severe dysphagia from multiple cranial nerves injury in the neck, so crico-pharyngeal myotomy was done in order to improve swallowing.

Pre-operative and post-operative evaluations and measurements of phonation time, intensity improvement, ability to raise the voice and patient's and doctor's satisfactions were noted. [Fig. 1-2]

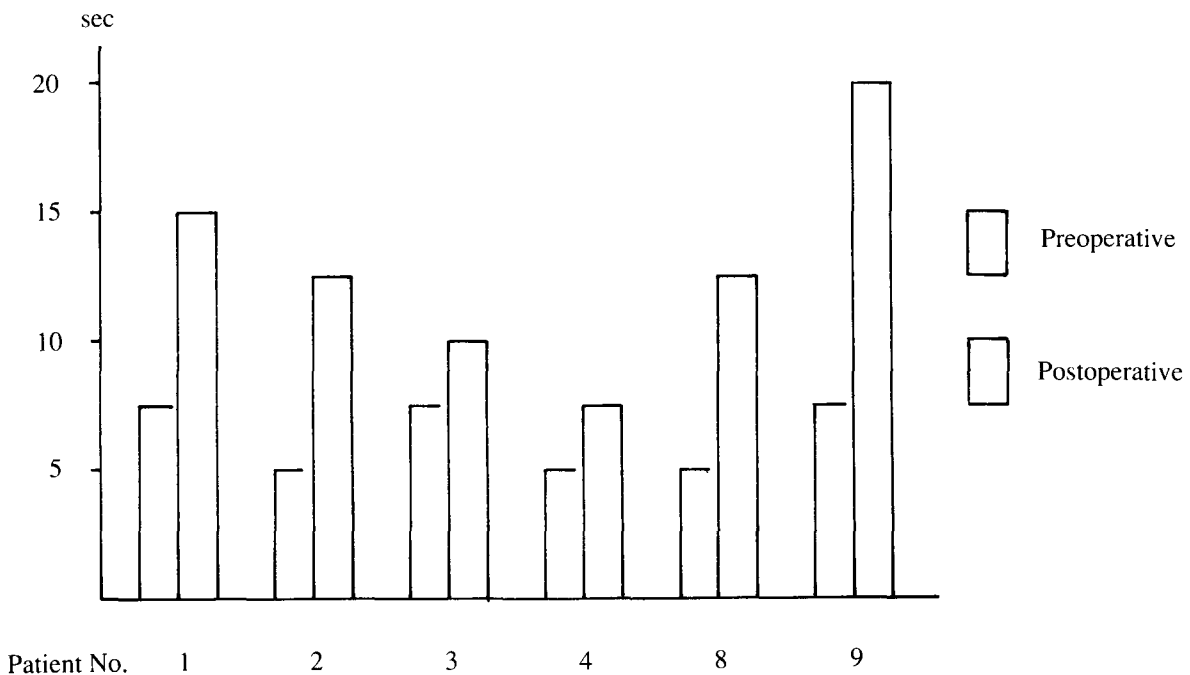
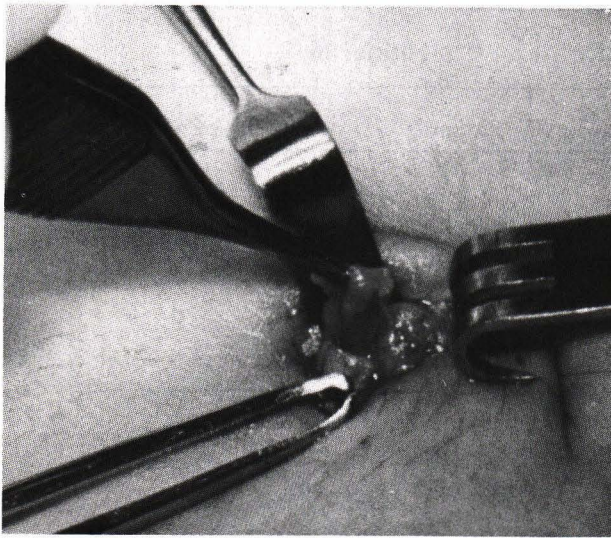
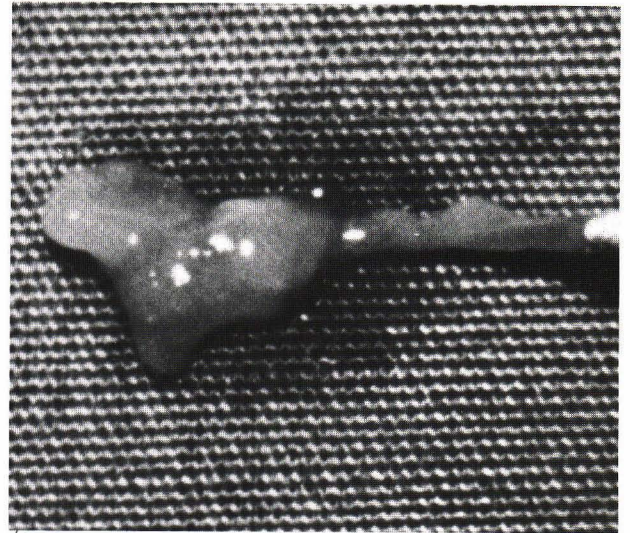


Diagram 1. Maximum phonation times in 6 patients.



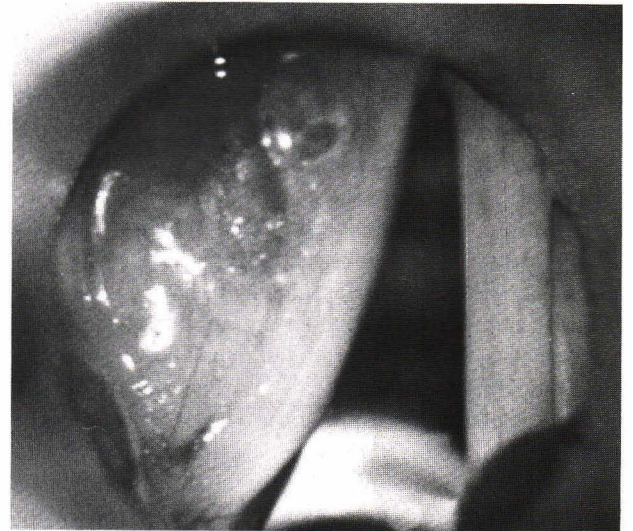
**Figure 1.** Taking fatty tissue from periumbilical incision.



**Figure 2.** Fatty tissue injected from vocal cord injector (Bruning gun).

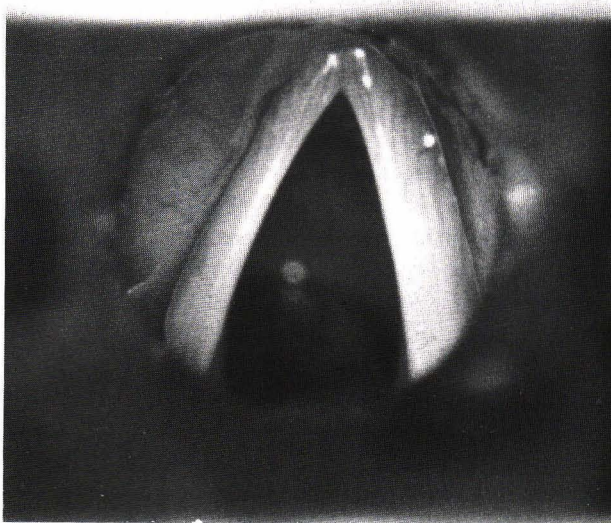


(a)

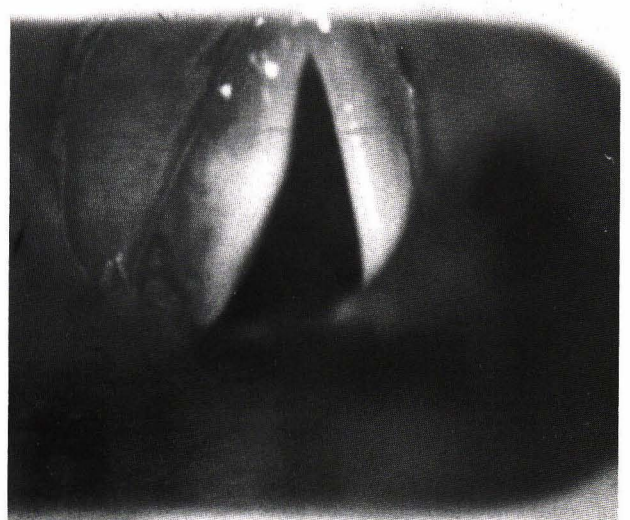


(b)

**Figure 3.** Patient No. 1. Preoperative (a) and postoperative (b) appearances of the left vocal cord.  
Note : The convexity of the true vocal cord resulting from laterally injected fatty tissue.



(a)



(b)

**Figure 4.** Patient No.9. Preoperative (a) and postoperative (b) views of the larynx.

Case	Intensity		Ability to raise voice		Satisfaction	
	Preop	Postop	Preop	Postop	Patient's	Patient's
1	1	4	1	3	4	3
2	1	3	1	3	3	2
3	0	2	1	2	2	2
4	1	2	1	2	1	2
8	1	3	1	2	2	3
9	1	4	1	4	4	4

0 = very poor  
 1 = poor  
 2 = fair  
 3 = good  
 4 = excellent

Dr. impression-using the symptomatic and laryngoscopic improvement

## Discussion

Vocal cord paralysis and impaired movement of the vocal cords usually results in hoarseness, aspiration and airway obstruction in various degrees due to types of the paralysis and the contour of true vocal cords themselves. Unilateral vocal cord paralysis may cause either hoarseness or aspiration or both; while bilateral cord paralysis usually causes airway obstruction except for the high lesions of both vagus nerves which will have a wide rima glottidis caused by simultaneous injuries to both the external branches of the superior laryngeal nerves and the recurrent laryngeal nerves.(14-15) We have noted this type in the last patient of the aspiration group (patient number 7) who also had paralysis of other cranial nerves. Severe dysphagia and aspiration were the main problems, two lipo-injections into both true vocal cords were tried without improvement of either symptoms. Barium swallowing was performed with an injection of 1% xylocaine into the cricopharyngeus muscle in order to relax the esopharyngeal inlet. This resulted in the improvement of the swallowing function and aspiration was reduced. Cricopharyngeus myotomy was done a week later, significant improvement in swallowing function and reduction of aspiration were noted.

The main treatment for vocal cord paralysis and/or volume deficit is by the augmentation of the true vocal cord in order to increase the mass of the true cord and medialization will follow.(1-7,11-13)

The first attempt to medialize the paralysed cord was perform by using hard paraffin,(12) but later the procedure was abandoned because of complications due to a tendency to develop paraffinoma. The interest in intracordal injection was renewed after Arnold (1963) used homogenous cartilage particles(16) and gained more popularity after Lewy's introduction of the Teflon paste as the ideal material because of its low tissue responses and

the high success rate.(17)

Although useful in intracordal injections Teflon was found to have some potential problems.(8-9) Ford and Bless reported misplaced Teflon in the supraglottic and subglottic areas, deep in the cervical soft tissues and the contra-lateral vocal cord. They also noted vocal cord stiffness and irregular surface of the injected vocal cord resulting in incomplete closure of rima glottidis.(1) The techniques of Teflon injections were discussed by Rubin, with injections either too superficial or too deep could cause the upper surface of the vocal cord to balloon and subsequently to become stiff. Foreign body granulomas can also develop resulting in an even poorer quality of voice than in the pre-injection period.(18)

The search for other materials to replace Teflon for vocal cord injection, included gelfoam and soluble bovine collagen injections but although successfully used, some limitations still occurred. Both of these were used on a temporary basis for vocal cord rehabilitation, because the substances would be absorbed within 6-12 months.(1,10,18) Another method for augmentation and medialization of the vocal cord was by using a silastic block and this was first described by Isshiki and followed by other workers,(2,4-5,19) but it required external skin incision and hence, poor patient acceptability.

Fat transplantation has been used to reconstruct body defects for centuries, but a successful report of 32 cases was only made in 1916 by Kanaval. He commented that fat could be transplanted into any ordinary field where it survived, and it become part of the structure into which it had been placed, and that it did not act as a foreign body.(20) The fate of transplanted fat in both animals and humans were investigated,(21,22) Johnson found 75 to 85% of the original volume of previously injected fat was still present with the formation of microcyst and without evidence of liquefaction.(23) Asken noted that fat cells



obtained by liposuction are 90% viable if not traumatized by either excessive handling or high suction pressure.(24) We used an excisional method for obtaining fat, so trauma to the fat cells was minimized. The needle diameter used to harvest and inject the fat was studied, the degree of injury to the adipocytes was inversely related to the diameter of the needle.(25) The survival of the fat was proportion to the vascularity of the recipient site. Small volume of fat injected into the muscle with blood supply gave the best chance for survival.(26)

Injection of fat into the muscle of the vocal cord (thyro-arytenoid) was first performed in 1987(12) for augmentation of the paralysed cord which resulted in significant improvement of voice. Our experience with this procedure began in March 1991 when we planned to inject the vocal cord with Teflon, but at that time Teflon paste was out of stock and it also had a high price, so we switched to fat obtained from the abdominal incision. Our initial impression was good so we continued to use fat as a primary treatment for unilateral vocal cord paralysis as an alternative to Teflon injection and type I-Isshiki's thyroplasty. We also used this procedure to increase the volume of the hypotrophic bowing vocal cord in an attempt to improve voice (case 4) but the result was not as good as expected. Another indication besides voice improvement is to prevent aspiration during swallowing. Three patients were operated, two cases had the moderate success, the unsuccessful one had multiple cranial nerves injury from a gunshot wound in the neck resulting in severe dysphagia and aspiration. This patient was then improved by cricopharyngeus myotomy.

To date, our voice analysis is based on clinical evaluations including symptoms, signs, and degree of patients and doctor's satisfactions.

The outcome of this preliminary study is quite impressive, the surgical procedure is very easy and does not require extra instruments. Furthermore, surgery can improve voice quality and also prevent subsequent aspiration as well. The fat itself is an autogenous material, so it will not react as a foreign body and will survive in the injected vocal cord. The two major disadvantages are; the leakage of fat will leak from the punctured sites and volume loss. Prevention of this phenomenon could be very using jet ventilation anesthesia instead of using ordinary or small endotracheal tubes which would laterally compress the injected vocal cord. The other drawback is that the procedure will not completely close the posterior gaping especially in cases where endotracheal tubes are used in post-traumatic fibrosis of the vocal cord.

## Conclusion

Using the lipoinjection of the true vocal cord, we treated eight patients with paralysis of the vocal cord and one hypotrophic bowing vocal cord (from laryngeal trauma).

The results of the injection are impressive; the improvement of voice quality and cessation of laryngeal aspiration are noted. We recommend this surgery as an alternative procedure in treating the paralytic and atrophic cords.

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