CO₂ Laser Stapedotomy—Our Experience—A Preliminary Report

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Abstract

Laser Stapedotomy is now the routine surgical procedure performed for otosclerosis in numerous centres in the world. The authors describe their preliminary experiences with the use of the CO₂ laser for stapedotomy. 10 patients operated in a period of 3 months in 1996 have been included in this study. The surgical technique is simple and easy to perform. Preliminary results seem to indicate lesser post op morbidity, and better hearing results in these patients as compared to those cases operated by conventional techniques.

The standard surgery for Otosclerosis i.e. stapedectomy or more recently stapedotomy, involves direct contact and subsequently movement of the stapes footplate and consequently of the inner ear fluids. It is a well documented fact that excess instrumentation in the area is fraught with danger and complications especially in the hands of the occasional or inexperienced stapes surgeon is common (1). The use of lasers in Stapes surgery has emerged as the best technique as it minimizes the movement and gives excellent results in the hand of the experienced and inexperienced alike. However the laser has not come into regular use especially in a country like India due partly to the financial constraints, lack of knowledge of the properties of the various lasers and the persistent misconception that the lasers were somehow harmful to the inner ear. The authors in this article describe their preliminary experience with the use of the CO₂ lasers in stapes surgery.

Materials & Methods

During 1996 in a 3 month period between September and December, 10 of our patients

underwent stapedotomy with the CO₂ laser. The laser machine was a Carl Zeiss 30 Watt Carbon Dioxide laser with a micro manipulator mounted on the microscope. All the patients were seen in the outpatient department of the K. K. R. ENT Hospital & Research Institute, Madras. All the cases were clinically diagnosed as Otosclerosis and the diagnosis was subsequently confirmed by audiometry and impedance audiometry. There were 6 male patients and 4 female patients in the study and their age ranged from 19 to 58. Preoperative investigations included routine blood and urine tests, audiometry, impedance audiometry and speech discrimination scores.

Surgical Technique

In our hospital, the preparation of the patient for undergoing a Laser Stapedotomy is identical to that done by the conventional method. The patient is admitted the previous night before surgery. Preoperative sedation is given 1 hour before surgery intra muscularly. All surgeries are performed under local anesthesia and general anesthesia is seldom required. unless contraindicated the local anesthetic used is freshly prepared 2% Lignocaine with 1:80,000

Fig. 1 : The Carl Zeiss CO₂ Laser

Adrenaline. About 2ml of this mixture is injected into the posterior and postero superior canal wall. This infiltration provides adequate anesthesia and haemostasis in the operative field. The skin incisions are given with hand held instruments and a tympanomeatal flap is created. The flap is then elevated and the middle ear is entered under the annulus. The chorda tympani nerve is identified and carefully preserved while curettage of the posterior canal wall is done. Good visualization of the long process of the incus is required since the laser energy is delivered in a straight line and therefore curettage is continued till the facial nerve is well visualised superiorly and the pyramid is clearly seen posteriorly.

The laser machine is then switched on from the standby mode to the ready mode. The parameters of laser energy required are calculated and programmed into the laser. Three parameters are important and strictly adhered to. They are 1. Power measured in watts / cm² to be delivered to the tissue and especially to the oval window. 2. The second parameter is the time interval for which the laser energy is present. and 3. The last parameter is the spot

size. For the laser stapedotomy, the parameters that were followed in our institute were a power of 1.2 watts/cm² used while working in the round window. The time the energy was present was 0.1 sec and was repeated every few seconds. The spot size was adjusted to be 200nm, the smallest possible in our laser. As the surgery proceeds the laser is used to vaporise any connective tissue strands and adhesions around the incus and the stapes. When the area of the oval window is clear, the stapedotomy procedure begins. The stapedial tendon is vaporised first. The laser energy is then focussed on the posterior crus and a series of laser blasts are used to remove as much of the posterior crus as possible. The smoke produced as a result of the vaporisation is evacuated with a fine suction. The anterior crus is rarely seen in the surgical position and therefore cannot be vaporised. However, this does not present a problem and the slightest pressure with an angled probe fractures the anterior crus. Once the crura are separated from the footplate the incudostapedial joint is separated and the surprastructure is removed. The footplate is now completely visible and a series of laser

Fig. 2 The rosette of laser blasts on the footplate of stapes

blasts are laid down in a rosette pattern on the footplate and then the fine layer of char which is formed is removed with a fine suction. The size of the fenestra is controlled precisely and a teflon piston of 0.5mm diameter & appropriate length as measured from the undersurface of the incus to the fenestra is used. Small bits of gelfoam are placed around the fenestra to form a seal of the oval window.

With an obliterated footplate, the laser has to be used with the conventional techniques, and its use is rather limited. The laser is used only to achieve perfect haemostasis while the actual drilling on the footplate and fenestration is done using a fine diamond burr. The patient is confined to bed for 24 hours after surgery and is discharged on the second post operative day.

Results

All our patients observed no vertigo in the immediate postoperative period. The absence of postoperative symptoms allows better patient co-operation and overall satisfaction. The authors now aim to perform laser stapedotomy as an outpatient procedure.

All the patients in our series have had a successful outcome, a closure of the airborne gap to less than 10db at 0.5, 1, 2 & 4Khz. as measured one month after surgery.

Discussion

For use of lasers in Otosclerosis surgery, the major tissue effects which must be considered are :

1. Vaporisation of the stapes footplate.
2. The thermal effects on the inner ear including the perilymph, utricle and, saccule.

Two kinds of lasers visible lasers (Argon & KTP - 532) and the invisible CO2 laser have been successfully used in Otosclerosis surgery. These two kinds of lasers differ markedly in their optical & tissue properties. The visible lasers possess ideal optical properties but less than ideal tissue properties

and the CO2 laser possesses ideal tissue properties but less than ideal optical properties (4), Coker (5) was first to recommend the use of the CO2 laser in humans on the basis of extensive experiments on cats and Lesinski was the first to report the use of the CO2 laser in humans.

The advantages of the CO2 laser in stapes surgery are many, The CO2 laser energy is rapidly absorbed by tissue or fluid regardless of color and is less penetrant and has less energy scatter than any of the medical lasers. Therefore with the correct energy settings, the laser energy is completely absorbed by the stapes footplate when performing a stapedotomy and the laser energy will not penetrate more than 0.1 mm in the vestibule and will not cause any damage to the inner ear structures (6,7).

The disadvantages of the CO2 laser which have mainly pertained to the accuracy of the aiming beam, have now been overcome and the only remaining disadvantage is that the laser is mounted on the microscope and requires the use of a micromanipulator. In stapes surgery, the inability to reach the anterior crus is a problem but as explained earlier is hardly significant.

All the 10 patients in our study had minimal or no postoperative symptoms and the hearing result was an airborne gap closure of less than 10db. Lesinski (7) in his pioneering work, has also reported excellent results in 87% (less than 10db) and 94% (less than 15db). Also significant is the fact that 0% of our patients and only 4.6% of the cases in Lesinski's study showed a drop in bone conduction at 4 KHz. Neither of the series showed any loss of bone conduction at the speech frequencies of 0.5, 1 & 2 KHz.

Conclusion

The results of the study although preliminary, are very encouraging. The CO2 laser has provided the surgeon with a safe and very precise tool for stapedotomy. When the proper

guidelines are followed, and the energy settings are carefully monitored, the laser has proved to be very safe and no untoward complications have occurred.

The immediate post operative vestibular symptoms have been minimised and the hearing

results especially in the higher frequencies is better due to the minimal instrumentation and trauma to the hair cells at the basal turn of the cochlea. The authors would like to conclude that the CO2 laser stapedotomy is safe, and is definitely a superior procedure when compared to conventional surgical techniques.

References

1. J. B. Causse : The twenty five points of otosclerosis surgery (1989) *Am. J. Otol*, vol 10, No. 1, Jan 1979, 75-77.
2. Palva T. (1979) Argon laser in otosclerosis surgery. *Acta Otolaryngol (Stockh)* 104 : 153-157,
3. Perkins RC (1980) : Laser stapedotomy for otosclerosis. *Laryngoscope* 90 : 228 : 240.
4. Manford TM (1990) *Lasers in Ossicular Surgery OCNA* vol 23, Nol. 7-18.
5. Coker, N.J. (1986) Carbon Dioxide Laser Stapedotomy : A Histopathologic Study. *Am. J. Otolaryngo.*, 4:253-257.
6. Lesinski S. G, Stein. J. A; (1989) CO2 laser Stapedotomy. *Laryngoscope*; 99(suppl): 20-24.
7. Gardner, G (1984) Co2 Laser Stapedotomy. Is It Practical ? *Am. J. Otolaryngol.*, 5:108 - 117,

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