Original Article

นิพนธ์ต้นฉบับ

Comparison of Four Office-based Procedures in Treatment of Inferior Turbinate Hypertrophy

Naruwat Kesornsukhon

Department of Otorhinolaryngology, Samut Sakhon Hospital, Thailand

Abstract A prospective clinical trial was carried out to compare the efficacy of submucosal non - temperatured controlled radiofrequency tissue volume reduction (RFTVR), temperatue controlled radiofrequency tissue volume reduction (TCRFTVR), submucosal resection with microdebrider (SMRM) and carbondioxide (CO_2) laser ablation in office - based treatment of chronic inferior turbinate hypertrophy. The study was done in Samut Sakhon Hospital between August 2004 and September 2008. In all, 120 symptomatic inferior turbinate hypertrophy patients were enrolled, randomized, and separated into 4 groups (30 for each groups). All patients in each groups were operated in both sides of inferior turbinate with the same instruments. Visual analogue scales (VASs), turbinate size, saccharin transport time (STT) were used to evaluate and compare the result at pre-operative, 12th week and 24th weeks post-operative periods. Significant improvement was achieved by VAS scores and turbinate size for all procedures at both post-operative evaluation periods in comparison to pre-operative finding, whereas there were no significantly different outcomes in comparison between each techniques. However, the CO_2 laser impaired STT in comparison between pre-operative and 12th, 24th weeks post-operative conditions, but no significant changing was found for the residual three submucosal procedures. The SMRM required more instruments and operation time than other techniques. In this 24 weeks period study, RFTVR and TCRFTVR reportedly yielded identical results of treatment to SMRM and CO_2 laser. The RFTVR procedure is cheaper and faster in operation than TCRFTVR whereas no different outcomes of treatment between both radiofrequency techniques. The study suspected RFTVR is appropiate for office - based treatment of inferior turbinate hypertrophy as it is easy to perform, less time consuming, with promising outcomes, yet without admission requirement and harmful complications.

Key words: **inferior turbinate hypertrophy, surgery, radiofrequency, microdebrider, CO_2 laser**

Introduction

Chronic nasal obstruction is one of the most common rhinologic problems and very frequent symptom in daily medical practice in Thailand[1,2] especially in chemical industrial area like Samut Sakhon province.[2-4] Hypertrophy of the inferior turbinates is the frequent cause and may be related to allergy, non-allergic rhinitis, and iatrogenic rhinopathy.[2] Unfor-

tunately, there is no official incidence report of inferior turbinate hypertrophy in Thailand.[2] Even though medical treatments are frequently effective to restore comfortable nasal breathing, nasal obstruction is sometimes slightly improved. Surgical reduction of inferior turbinates can be proposed for treatment of medical refractory cases.[2-7]

A number of surgical interventions with promising outcomes are available for treatment, including cryosurgery, electrocautery, outfracture, total and partial turbinectomy, turbinoploasty, submucosal resection, laser assisted turbinoplasty, radiofrequency tissure ablation and submucosal resection with microdebrider.[2-7]

The variety of surgical techniques available indicates the lack of consensus on the optimal surgical technique.[5-7] No technique is perfect and its effectiveness depends on selection criteria. Moreover, each is associated with known short - and long - term complications such as pain, bleeding, mucociliary function impairment and atrophic rhinitis.[5-8]

As many reports,[5-7] the previous study in Samut Sakhon Hospital about surgery of inferior turbinate demonstrated the significant effect of selection criteria of patients.[2-4] Those with mucosal swelling whose turbinate size reduced from topical decongestant application demonstrated more chance of improvement by using mucosal surgery such as radiofrequency.[2-4] The patient who didnot respond to decongestant test may possibly have bony part of turbinate abnormality such as air cell or bony hypertrophy and may need investigation and power instrument for bone reduction surgery.[4]

Nasal mucociliary function, an important defense mechanism that protect the respiratory system against bacteria and other foreign particles is impaired in the majority of surgical reductions of the inferior turbinate.[8] A wider nasal cavity does not necessarily mean that the nasal function is better.[8,9] For these reasons the goal of the surgical treatment of inferior turbinate hypertrophy should be to diminish perceptive symptoms resulting from optimal volume reduction while preserving mucociliary function.[8] As such, there are still debates about the best choice of inferior turbinate surgery.

The objective of this study was to compare four effective mucosal sparing surgical instruments available in Samut Sakhon hospital for treatment of non-allergic nasal obstruction from chronic inferior turbinate hypertrophy : submucosal non - temperature - controlled radiofrequency tissue volume reduction (RFTVR)[2], temperatue-controlled radiofrequency tissue volume reduction (TCRFTVR)[2-4], submucosal resection with microdebrider (SMRM)[3,4,] and carbondioxide (CO_2) laser ablation.[6] As a result, the most appropiate for treatment in office -based setting that is easy to perform, less time consuming, with promising outcomes, yet without admission requirement and harmful complications is identified.

Methods

A prospective, randomized, clinical trial was carried out between August 2004 and September 2008. In all, 120 symptomatic non-allergic nasal obstruction patients with inferior turbinate hypertrophy refractory to medical treatment in Samut Sakhon Hospital were randomized and equally separated into four groups (30 for each procedure). The age ranged from 15 to 60 years with the mean of 39.4, SD 6.7 years. Patients, previously treated with antihistamines, decongestants, and nasal corticosteroids without any success were enrolled. None of the patients had scientific evidence of allergy demonstrated with negative results of skin prick test for specific aeroallergens. Furthermore, all patients should have responded to topical nasal vasoconstrictive agents, (decongestant test - positive).

Patients with previous turbinate surgery, septal

deformities, nasal polyps or tumor, nasal radiotherapy, or recurrent sinusitis were excluded.

The size of inferior turbinates were graded at the anterior end into 1-4, comparing to the nasal width at nasal valve area (between septum and lateral nasal wall).[2-4,10] A score of 1 represented 0-25 percent, 2 for 25-50 percent, 3 for 50-75 percent, 4 for 75-100 percent of occupation of the reference area.[2-4,10] Visual analogue scale (VAS), saccharine transport time (STT) and complications were evaluated preoperatively, and postoperatively at 12th week, and 24th week.

Surgical Procedure

Radiofrequency tissue volume reduction (RFTVR and TCRFTVR)

A cotton pledget soaked with 2% xylocain was placed in the anterior portion of the inferior turbinate for 5 minutes, followed by the injection of 1ml. of 2% xylocain without adrenaline solution in each turbinates to obtain local anesthetic effect. The temperature and power were set preoperatively to level 6, coagulation mode, 5 seconds for RFTVR and 75ºC, 350 Joules respectively for TCRFTVR.[2-4,11] The radiofrequency energy was delivered via the Ellman® for RFTVR and the Somnus® S1 radiofrequency generator for TCRFTVR was conveyed successively to three different sites of each turbinate (to the upper and lower area of the anterior portion and to the middle portion). Nasal endoscope was not needed in all operative steps.

Submucosal resection with microdebrider (SMRM)

After the application of local anesthesia as described in the RFTVR section, small incision was made with a number 15 blade in the anterior aspect of the inferior turbinate. A submucosal pocket was created with sharp dissection on the medial surface of the bony

Table 1 Demographic data

n	RFTVR 30	TCRFTVR 30	SMRM 30	CO_2 laser 30
Age (year)*				
Mean, SD	39.4, 6.7	38.9, 8.1	36.1, 7.5	38.1, 6.3
Range	15-60	17-58	18-56	15-58
Sex*				
Male / Female	15 / 15	16/14	13/17	14/16
Inferior turbinate	14 grade 3	10 grade 3	12 grade 3	18 grade 3
Average Size	16 grade 4	20 grade 4	18 grade 4	12 grade 4
score*	total 106	total 110	total 108	total 102
Model	Ellman®	Somnus®	Medtronic®	Lumenis®
Setting	Coagulation	75°C, 350 J	3000-cps	30 Watts
	Leve l6/5 sec.	3 sites /each		5-7 J
				Superpulse
Operation time				
Mean, SD (sec./side)	20, 3.2	65, 3.2	600, 145.1	70, 15.2
Instrument cost (bath)	120,000	600,000	900,000	2,800,000
Probe Cost (bath/case)	2,500	6,000	12,000	None disposable

**No statistically difference of age, sex, and pre-operative turbinate size between each groups by using t-test. (p> 0.05)*

turbinate. The Medtronic® straight microdebrider with 4-mm tip and tricutting blade was applied through the incision. Submucosal tissue was debrided at 3,000-cycle per second oscillating mode.[3,4,13] Hemostasis was almost achieved with suction electrocautery. All procedures were performed under nasal endoscope guidance. The incision was not closed. Gel foam or Ivalon® packing was used for 48 hours in case of minor bleeding.

CO_2 laser

After the application of local anesthesia as described in the RFTVR procedures. The laser energy was delivered via Lumenis®. The power were set at 30 Watts, superpulse, delivered via nasal probe kit.[6]

Symptom Evaluation

Each patient was informed to use a 10-cm Visual analogue scale (VAS) to grade general nasal obstruction preoperatively (day 0), at 12th week, and 24th week after surgery. A score of 0 represented no obstruction and no episodes of nasal obstruction and a score of 10 indicated a constant complete and unremitting nasal obstruction.

Nasal Ciliary Function

Nasal ciliary function was evaluated preoperatively (day 0), at 12th week and 24th week after surgery by the Saccharin-charcoal transport time (STT). The test performed by depositing 15 mg of saccharin mix with charcoal on the inferior turbinate. Then patient was asked to swallow every 30 seconds; immediately after the patients tasted the saccharin the test was stopped and the transfer was confirmed by direct viewing of the black color of charcoal on the pharyngeal wall.[8,14] Time was measured in minutes from beginning of saccharin deposit.

Data analysis and statistical test

Statistical analysis was performed by using software package SPSS for window version 13.0. Data of the inferior turbinates size, VASs of symptom, and nasociliary function were shown as mean, SD. Paired t -test was used to compare between preoperatively and at 12th week, 24th week postoperatively within each group. One - Way ANOVA test was used to compare the outcomes between different groups of treatment at the same evaluation periods.

A p - value less than 0.05 was considered to be statistically significant.

Results

The demographic data of each group of all 120 patients were demonstrated in Table 1. There were 14 of grade 3 and 16 of grade 4 size of inferior turbinates were enrolled in RFTVR group (total score 106), 10 of grade 3 and 20 of grade 4 size of inferior turbinates for TCRFTVR group (total score 110), 12 of grade 3 and 18 of grade 4 for SMRM group (total score 108) and 18 of grade 3 and 12 of grade 4 for CO_2 group (total score 102). There were no statistically differences of age, sex, and pre-operative turbinate size between each group by using t-test ($p > 0.05$).

Subjective Change of Symptoms

The severity of nasal obstructions after RFTVR and TCRFTVR began to lessen from the third day after the treatment. Statistically significant improvements in the VAS scores was observed at 12th week ($p < 0.001$) and persisted at 24th week postoperatively ($p < 0.001$). In SMRM and CO_2 groups, the subjective symptoms slightly worsened during the first 3 or 4 days and began to improve in the first postoperative week. Statistically significant improvements in VAS scores were observed at 12th week ($p < 0.001$) and persisted at 24th week postoperatively ($p < 0.001$) (Table 2). Treatments comparison by using ANOVA test between four groups showed no significant difference in the measurements at 12th week and 24th weeks postoperatively ($p > 0.05$) (Fig. 1).

Inferior Turbinate Size

The total scores of inferior turbinate size at pre-

Table 2 Outcomes of RFTVR, TCRFTVR, SMRM and CO_2 laser groups at pre-operatve and 12th, 24th weeks post-operative in terms of nasal obstruction

	Mean Visual Analog Scale (VASs) Score, SD		
	Preoperative	**12 week**	**24 week**
RFTVR	6.79, 1.78	2.50, 2.47*	3.55, 1.77*
TCRFTVR	6.19, 1.69	2.65, 2.08*	3.65, 1.97*
SMRM	6.54, 1.89	2.78, 2.21*	3.78, 2.15*
CO_2 laser	6.25, 1.71	2.57, 2.10*	3.48, 2.75*

**paired t-test, in comparison between pre-operative and 12th weeks, 24th weeks post-operative VASs within each group show significant differences (p<.001)*

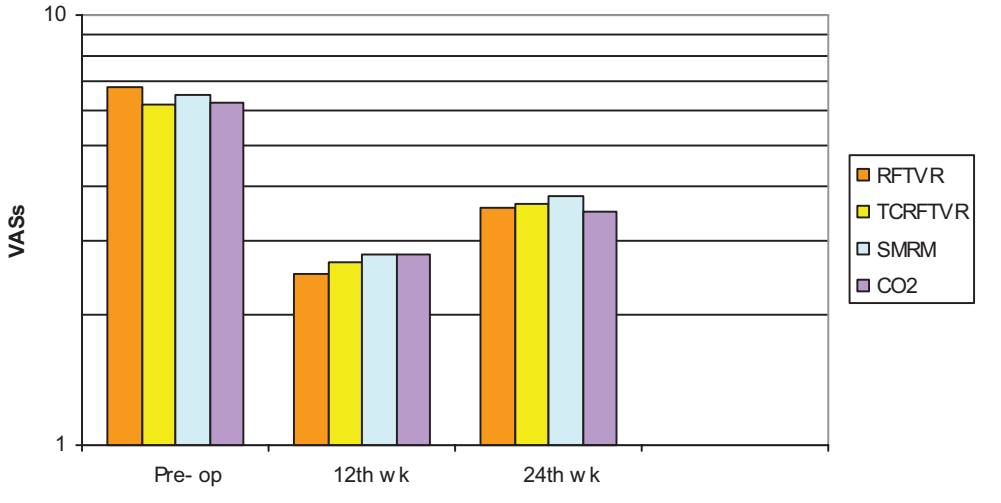

Fig. 1 Comparisons of mean VASs of the nasal obstructions at pre- and at 12-week, 24-week post- operative periods compared between RFTVR, TCRFTVR, SMRM and CO_2 laser groups.

operative and 12 -week and 24 - week postoperative periods were significantly reduced from 106 to 39 (67%), and 42 (60.37%) for RFTVR group, from 110 to 42 (61.81%), and 45 (59.1%) for TCRFTVR group, from 108 to 45 (58.33%), and 48 (55.6%) for SMRM group and from 102 to 38 (62.74%), and 44 (56.86%) for CO_2 group. It showed a significant reduction ($p<0.001$) of inferior turbinate size within any group which correlated well to nasal obstruction VAS reduction at 12th week and 24th week. No significant changes were obtained when a comparison was made between 12th week and 24th week postoperatively (Table 3). Treatments comparison between all groups showed no significant differences in inferior turbinate size score at 12th week and 24th weeks postoperatively by using ANOVA test ($p >0.05$) (Fig. 2).

Nasal Ciliary Function

The outcomes showed no significant variations between those of STT at preoperative and 12th week, 24th week postoperative period ($p <0.05$) in RFTVR, TCRFTVR, and SMRM group. The different outcomes showed significant increase STT in CO_2 group

Table 3 Outcomes of RFTVR, TCRFTVR, SMRM and CO_2 laser groups at pre-operatve and 12th, 24th weeks post-operative in terms of total inferior turbinates size score.

	Total inferior turbinate size score		
	Preoperative	**12th week**	**24th week**
RFTVR	106	39*	42*
TCRFTVR	110	42*	45*
SMRM	108	45*	48*
CO_2 laser	102	38*	44*

**paired t-test, in comparison between pre-operative and 12th weeks, 24th weeks post-operative scores within each group showed significant differences (p<.001)*

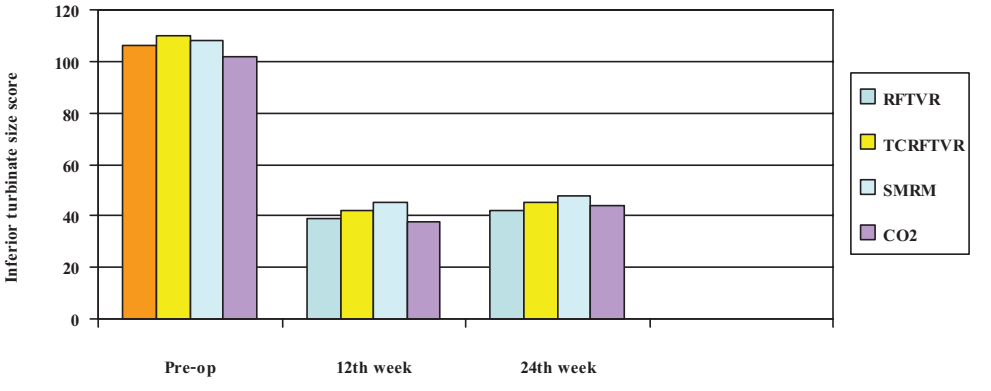

Fig. 2 Inferior turbinates size score at pre- and at 12-week, 24-week post-operative periods were compared between RFTVR, TCRFTVR, SMRM and CO_2 laser groups

Table 4 Outcomes of RFTVR, TCRFTVR, SMRM and CO_2 laser groups at pre-operatve and 12th, 24th weeks post-operative in term of mean saccharin - charcoal transport time (STT).

	STT Preoperative (min)	**STT 12 week (min)**	**p-value***	**STT 24week (min)**	**p-value***
RFTVR	10.10,1.50	10.40,1.70	0.12	11.35,1.78	0.12
TCRFTVR	10.20,1.80	12.10,1.74	0.11	11.85,1.22	0.15
SMRM	10.41,2.03	11.89,2.03	0.13	11.35,1.78	0.12
CO_2 laser	10.51,1.50	16.89,2.03	0.015	14.85,1.22	0.04

**paired t-test, in comparison between pre-operative and 12th weeks, 24th weeks post-operative within each group.*

between preoperative and at 12th week (p-value 0.015), 24th week (p-value 0.04) postoperative (Table 4).

In comparison of STT between CO_2 group and the others at 12th week and 24th week postoperative period, it resulted in statistically significant differences by using ANOVA test ($p< 0.05$ at 12th week and at 24th week). No difference was found in the other groups ($p> 0.05$) (Fig. 3).

Complications

Most patients tolerated all types of procedures

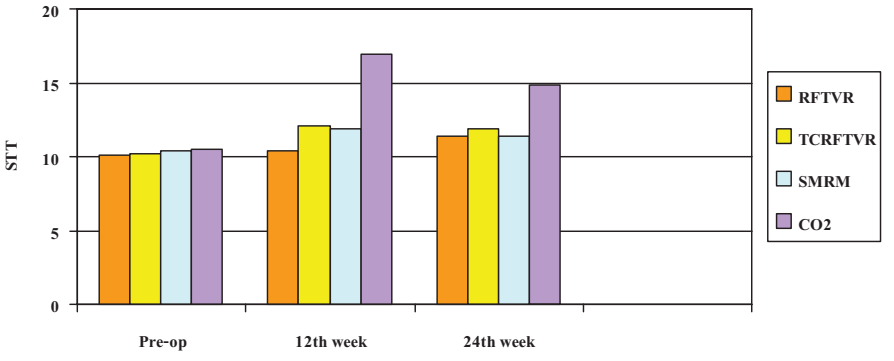

Fig. 3 The mean saccharin - charcoal transport time (STT) : comparison between RFTVR, TCRFTVR, SMRM and CO_2 laser groups

well. In RFTVR and TCRFTVR group, no mucosal erosion, bleeding, nor adherent crust formation was observed. The most common complaints were pain and nasal discharge immediately after the treatment, which gradually decreased within 2-3 days.

In CO_2 group, there was minimal pain, crust formation in initial two weeks. No major complication was found.

In SMRM group, uncontrolled bleeding was observed during the operation and electrocautery was performed in five patients under endoscopic guidance. Mucosal tears were common in 14 (46.7%) of the 30 patients, but there was no loss of mucosa. Synechia was observed in four (13.4%) patients, all from mucosal tears group. Minor bleeding in early postoperative period was seen in two (6.7%) patients and managed with gel foam or ivalon® packing for 1 day. The data showed SMRM was more complicated surgery process and resulted in minor complications. No significant variations between the major complication rates of each procedure ($p > 0.05$) were reported.

In conclusion, there were minimal major complications by using all kinds of instrument but SMRM encountered more minor complications such as bleeding, mucosal tear and synechia.

Discussion

Hypertrophy of the inferior turbinates is the frequent causes of chronic nasal obstruction. Surgery may become necessary in some patients refractory to medical treatment. Not only the variety of surgical techniques and instruments available indicates the lack of consensus on the optimal technique[5-7] but also the comfortable and instrument available in different hospitals. The objective of this study was to compare four effective mucosal sparing surgical techniques in treatment of non-allergic nasal obstruction from chronic inferior turbinate hypertrophy : RFTVR[2], TCRFTVR[2-4], SMRM[3,4] and CO_2 laser ablation.[6]

The goal of the surgical treatment of inferior turbinate hypertrophy should be to diminish perceptive symptoms resulting from optimal volume reduction while preserving mucociliary function.[8] The results of this study demonstrated significant improvements of VAS scores ($p< 0.001$) and turbinate size ($p<0.001$) at 12th week, 24th week postoperative period by using all kinds of surgical instruments (Table 2,3). The outcomes are comparable to other previous studies on outcomes of each equipments[2-9,11-13] and demonstrated promising results of all these treatments. The previous three studies in Samut Sakhon Hospital[2-4] about surgical treatment of inferior turbinate hypertrophy also demonstrated significant improvements resulted from using TCRFTVR[2-4], RFTVR[4] and SMRM[4].

A wider nasal cavity does not necessarily mean

that the nasal function is improved.[8,9] Nasal mucociliary function, an important defense mechanism that protects the respiratory system against bacteria and other foreign particles was evaluated in this study by using STT.[8] As also shown in other previous studies[2-9,11], the STT similarly showed no significant post-treatment differences in comparison between pre and post- operative periods of three submucosal methods (Table 4) and withouth significant differences between each other (Fig 3). In contrast, the CO_2 laser impaired STT more than other methods (p 0.015 at 12 th week, p 0.04 at 24th week) as demonstrated in table 4 with significant difference impairments in comparison to other three methods ($p < 0.05$). These STT impairments resulting from mucosal scar from laser ablation disturb mucociliary clearance.[2-4,6] Based on this impairment result, although using less harmful instruments as the CO_2 laser, the mucosal ablation operations that causing scar may not be the first choice of treatment of nasal mucosal hypertrophy. SMRM needs more operation time, endoscope assistance, and electrocautery (Table 1). In that connection, it dictates the need of an operation room other than OPD. There are some studies demonstrated less long term recurrence of nasal obstruction by using SMRM than RFTVR and TCRFTVR[4,12] yet unable to be demonstrated within the 24th week follow up in this study (Fig. 1,2). The researcher suspected RFTVR and TCRFTVR are 10-30 times less time consuming than SMRM (Table 1); identical results in objective and subjective parameters were observed from both techniques. RFTVR is three times less time consuming operated than TCRFTVR ($p<0.05$) with identical improving result in comparison to pre-opeative finding ($p<0.001$) (Table 1).

Consequently, RFTVR emerges as the most appropiate for treatment in an office -based setting that dictates simplicity, less time consuming, promising outcomes, no hospital admission requirement and no harmful complications.

Conclusion

From this study, all four instruments can be used in treatment of nasal obstruction from inferior turbinate hypertrophy with promising results and may have difference outcomes in some aspects. Three submucosal techniques causing less impairments of mucociliary transportation than mucosal ablation surgery. SMRM needs more operation time and instruments than the others. The 24th week follow up in this study could not demonstrate less long term recurrence of nasal obstruction by using SMRM than RFTVR and TCRFTVR[4,12]. The author recommend RFTVR to be considered as first initial office - based procedure in treatment for inferior turbinate hypertrophy with identical results to the other three procedures as well as cost effectiveness, limited operation time without serious complications.

Acknowledgement

This paper was presented by the author at Rhinology World 2009 Congress, Philadelphia, USA. and out of license of congress now with copyright permission for publishing.

References

1. Bunnag C, Jareoncharsri P, Siriporn V, Supornchai K. Epidemiology of rhinitis in Thais : characteristics and risk factors. Asian Pacific J Allergy Immonol 2000; 18:1-7.
2. Kesornsukhon N. Radiofrequency volumetic tissue reduction for treatment of inferior turbinate hypertrophy. Region 6-7 Medical Journal 2007; 26(2):197-204.
3. Kesornsukhon N. Comparison of RFTVR and SMRM in treatment of inferior turbinate hypertrophy. Chachoengsao Hospital J 2008; 96:97-104.
4. Kesornsukhon N. Comparison of outcome of treatment for inferior turbinate hypertrophy : RFTVR and SMRM. Bull Dept Med Serv 2009; 34:81-7.
5. Passali D, Lauriello M, Anselmi M, Bellussi L. Treatment of hypertrophy of the inferior turbinate: long-term results in 382 patients randomly assigned to

therapy. Ann Otol Rhinol Laryngol 1999; 108:569-75.
6. Sapci T, Sahin B, Karavus A, Akbulut UG. Comparison of the effects of radiofrequency tissue ablation, CO2 laser ablation, and partial turbinectomy applications on nasal mucociliary functions. Laryngoscope 2003; 103:514-9.
7. Lee KC, Hwang PH, Kingdom TT. Surgical management of inferior turbinate hypertrophy in the office: three mucosal sparing techniques. Operative Techniques in Otolaryngol Head Neck Surg 2001; 12:107-11.
8. Nuutinen J. Asymmetry in the nasal mucociliary transport rate. Laryngoscope 1996; 106:1424-8.
9. Hol MKS, Huising EH. Treatment of inferior turbinate pathology: a review and critical evaluation of the different techniques. Rhinology 2003; 38:157-66.
10. Bunnag C, Jareoncharsri P, Dachpunpour P, Vitavasiri A. Nasal airway resistance in asymptomatic Thai population. Siriraj Hosp Gaz 1995; 47:721-5.
11. Smith TL, Correa AJ, Kuo T, Reinisch L. Radiofrequency tissue ablation of the Inferior turbinates using a thermocouple feedback electrode. Laryngoscope 1999; 109:1760-75.
12. Hackman TG, Ferguson BJ. Powered instrumentaion and tissue effects in the nose and paranasal sinuses. Curr Opin Otolaryngol Head Neck Surg 2005; 13:22-6.
13. Rhee CS, Kim DY, Won TB, Lee HJ, Park SW, Kwon TY et al. Changes of nasal function after temperature-controlled radiofrequency tissue volume reduction for the turbinate. Laryngoscope 2001; 111:153-8.

บทคัดย่อ **การรักษาเทอร์บิเนตอันล่างของจมูกบวมโตแบบผู้ป่วยนอก : เปรียบเทียบวิธีการผ่าตัดรักษาโดยใช้เครื่องมือ 4 ชนิด**

นฤวัต เกสรสุคนธ์

กลุ่มงานโสต ศอ นาสิก โรงพยาบาลสมุทรสาคร

วารสารวิชาการสาธารณสุข **2553; 19:855-64.**

การวิจัยเชิงศึกษาไปข้างหน้าเปรียบเทียบประสิทธิภาพของการรักษาเทอร์บิเนตอันล่างของจมูกบวมโตแบบผู้ป่วยนอก โดยการใช้การผ่าตัดด้วยเครื่องมือ 4 ชนิด คือ คลื่นวิทยุแบบไม่ควบคุมอุณหภูมิ คลื่นวิทยุแบบควบคุมอุณหภูมิ เครื่องตัดปั่นดูด ตัดเนื้อเยื่อใต้เยื่อบุจมูก และคาร์บอนไดออกไซด์เลเซอร์ระเหิดเยื่อบุจมูก ศึกษาในผู้ป่วยของโรงพยาบาลสมุทรสาคร ระหว่างสิงหาคม 2547 ถึง กันยายน 2551 จับฉลากแบ่งผู้ป่วย 120 ราย เป็น 4 กลุ่ม (กลุ่มละ 30 ราย) ผู้ป่วยแต่ละกลุ่มได้รับการผ่าตัดรักษาเทอร์บิเนตอันล่างของจมูกบวมโตในจมูกทั้งสองข้างโดยเครื่องมือชนิดเดียวกัน ประเมินผลการรักษาโดยใช้อาการเชิงประจักษ์ และ การทดสอบการทำงานของขนกวัดของเยื่อบุจมูกโดยขัณฑสกร ที่เวลา 12 สัปดาห์ และ 24 สัปดาห์ หลังรับการรักษา ผลการศึกษาแสดงว่าผู้ป่วยที่ได้รับการรักษามีอาการดีขึ้น และขนาดเทอร์บิเนตอันล่างเล็กลงโดยการรักษาทั้ง 4 วิธี อีกทั้งไม่พบความแตกต่างจากการประเมินอาการเชิงประจักษ์ และขนาดเทอร์บิเนตอันล่าง โดยการรักษาทั้ง 4 วิธี เมื่อประเมินผล 12 สัปดาห์ และ 24 สัปดาห์ หลังจากรับการรักษา การทำงานของขนกวัดของเยื่อบุจมูกโดยขัณฑสกรช้าลง ในผู้ป่วยรับการผ่าตัดโดยใช้คาร์บอนไดออกไซด์เลเซอร์ แต่ไม่พบความผิดปรกติการทำงานของขนกวัดของในการผ่าตัดอีก 3 วิธีที่เหลือ การใช้เครื่องตัดปั่นดูด ตัดเนื้อเยื่อใต้เยื่อบุจมูกใช้เวลาการผ่าตัดนานกว่าวิธีอื่นและต้องใช้เครื่องมือประกอบการผ่าตัดมากกว่า ผลการศึกษานี้พบว่าการผ่าตัดรักษาเทอร์บิเนตอันล่างของจมูกบวมโต โดยการใช้คลื่นวิทยุทั้งสองแบบ ทั้งแบบไม่ควบคุมอุณหภูมิ และควบคุมอุณหภูมิ ให้ผลการรักษาไม่แตกต่างจากการใช้ เครื่องตัดปั่นดูด ตัดเนื้อเยื่อใต้เยื่อบุจมูก และคาร์บอนไดออกไซด์เลเซอร์ระเหิดเยื่อบุจมูกในการติดตามผู้ป่วย 24 สัปดาห์ เมื่อเปรียบเทียบการผ่าตัดโดยคลื่นวิทยุทั้งสองแบบพบว่าคลื่นวิทยุแบบไม่ควบคุมอุณหภูมิ ประหยัดเวลาและค่าใช้จ่ายในการผ่าตัดกว่าแบบควบคุมอุณหภูมิ การผ่าตัดด้วยคลื่นวิทยุแบบไม่ควบคุมอุณหภูมิจึงมีคุณสมบัติเหมาะสมจะใช้เป็นการผ่าตัดขั้นต้นในการรักษาเทอร์บิเนตอันล่างของจมูกบวมโตแบบผู้ป่วยนอกมากกว่าการผ่าตัดแบบอื่น

คำสำคัญ: **เทอร์บิเนตของจมูกบวมโต, ผ่าตัด, คลื่นวิทยุ, เครื่องตัด ปั่น ดูด, คาร์บอนไดออกไซด์เลเซอร์**