World Journal of Otorhinolaryngology-Head and Neck Surgery (2017) 3, 136–141

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.keaipublishing.com/WJOHNS; www.wjent.org

Research Paper

Results of pediatric endoscopic and endoscopically assisted tympanoplasty

Glenn Isaacson [a,b,*], Jonathan A. Harounian [a]

[a] *Departments of Otolaryngology – Head and Neck Surgery, Lewis Katz School of Medicine, Temple University, Rydal, Pennsylvania, USA*
[b] *Departments of Pediatrics, Lewis Katz School of Medicine, Temple University, Rydal, Pennsylvania, USA*

Received 20 April 2017; received in revised form 18 June 2017; accepted 21 September 2017
Available online 3 November 2017

KEYWORDS
Cartilage graft;
Endoscopic ear surgery;
Minimally invasive surgery;
Otoendoscopy;
Pediatric tympanoplasty

Abstract *Objectives:* To evaluate the success of pediatric endoscopic and endoscopically assisted transcanal cartilage inlay tympanoplasty.
Methods: Retrospective review of single surgeon experience.
Results: During a 3 year period, 30 children underwent 31 endoscopic or endoscopically assisted transcanal tympanoplasties by the senior surgeon using tragal cartilage/perichondrial inlay grafts. There were 22 boys and 8 girls, ranging in age from 3.5 to 17 years (median 6 years). All tragal cartilage grafts (31/31; 100%) survived. Twenty-seven surgeries (27/31; 82%) resulted in an intact drum (17/31; 55%) or a microperforation (10/31; 32%). In four cases (4/31; 13%) significant perforations formed in previously unaffected portions of the drum.
Conclusion: Transcanal endoscopic cartilage inlay tympanoplasty offers a practical, minimally invasive approach to tympanoplasty for children of any age. It avoids postauricular or endaural incisions, tympanomeatal flap elevation, and canalplasty. Graft survival is uniform. Microperforation at the graft margins remained in 1/3 of children. Technical modifications may lead to higher rates of tympanic closure.

* Corresponding author. Department of Otolaryngology – Head and Neck Surgery, Lewis Katz School of Medicine at Temple University, 1077 Rydal Road, Suite 201, Rydal, PA 19046, USA.
E-mail address: glenn.isaacson@temple.edu (G. Isaacson).
Peer review under responsibility of Chinese Medical Association.

Production and Hosting by Elsevier on behalf of KeAi

https://doi.org/10.1016/j.wjorl.2017.09.002

Introduction

Pediatric tympanic membrane perforations commonly arise as sequelae of chronic middle ear infections and as a complication of the tympanostomy tubes use to treat otitis media.[1] While many perforations heal spontaneously or close after freshening the edges of the perforation, formal tympanoplasty is often needed. Repair of chronic perforations usually requires the placement of a mesothelial derived graft under, over, or into the perforation. In children with small ear canals, this classically required a postauricular incision, graft harvest, and elevation of the tympanic membrane for access. Success rates range from 60% to 90% in large series.[2]

The development of high-resolution, small diameter endoscopes allows a direct transcanal approach even in children with small ear canals. Transcanal cartilage inlay tympanoplasty has been popularized as a minimally invasive technique for repair of previously inaccessible anterior tympanic perforations.[3,4] It is performed through the ear canal without creating a tympanomeatal flap. Tragal cartilage is harvested with minimal donor site morbidity. Such surgery is more appealing to the families as it avoids a classic postauricular approach with its associated morbidities. Very high success rates (94%—96%) are claimed in small series.[5—7] Our experience confirmed the advantages of the endoscopic approach, but careful post-operative follow-up suggested a lower rate of permanent tympanic closure than claimed by endoscopic ear surgery enthusiasts.

In this paper, we review our experience with endoscopic and endoscopically assisted transcanal tympanoplasties in children using cartilage inlay grafts.

Methods

Data collection

After receiving approval from the Temple University Institution Review Board (protocol 24276), a computerized collection of patient office notes, photographs and operative reports was queried using the Microsoft Word "find" feature. The data collection was done in a manner that protects patient identity and privacy. All children who had undergone transcanal endoscopic and endoscopically assisted tympanic membrane tragal grafting were identified using the search term "tragal". Patient age and gender, perforation size, method of grafting, graft survival and extent of tympanic membrane closure were assessed for each.

Surgical method

An operating microscope and 3 mm, 0° and 30° rigid endoscopes (7220 AA, BA, Karl Storz™ Tuttlingen, Germany) were available in each case. Images were recorded with a Karl Storz high-definition camera and AIDA™ recording system. The operating microscope was used for canal injection with local anesthetic, for tragal graft harvest, and during fashioning of the graft. Freshening of the margins of the perforation, placement of Gelfoam in the middle ear and graft positioning were done exclusively with endoscopic visualization for anterior perforation with narrow ear canals (most cases). These cases would be classified as Class 2b (more than 50% of procedure done endoscopically) under the American Academy of Otolaryngology — Head and Neck Surgery Foundation Endoscopic Ear Surgery working group system as well as the International Working Group on Endoscopic Ear Surgery system.[8,9]

Similar technique was used for central and marginal perforations. The perforations were freshened by creating tiny holes 1 mm from the margin with a curved pick, then sweeping the pick to join the holes. This created a rim of fresh tissue that was removed with cup forceps. Adjacent tympanosclerotic plaques were not removed. The tympanic annulus was left intact and not elevated when the perforation extended to the margin.

The entire tragal cartilage was harvested with investing perichondrium on both surfaces (Fig. 1). The cartilage component of the graft was carved to match the tympanic perforation, leaving large perichondrial flaps for placement medial and lateral to the perforation (Fig. 2). The graft was positioned with the medial perichondrium resting on a bed of saline soaked Gelfoam. The lateral perichondrial flap supported the graft and was secured with a layer of Gelfoam (Fig. 3). Bacitracin ointment filled the ear canal. The tragal donor site was closed with absorbable sutures.

Follow-up

Children were seen at 1 week, 4 weeks and 3 months after surgery. Status of the graft and tympanic closure were assessed at each visit and confirmed by tympanometry at the 3 month visit. Children with residual perforations were followed at 6 month intervals and were offered revision surgery if the residual perforation had not closed by 1 year following the original tympanoplasty.

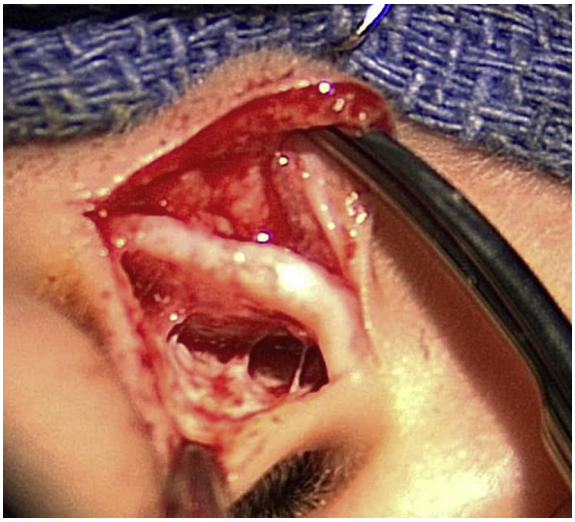

Fig. 1 Tragal cartilage harvest.

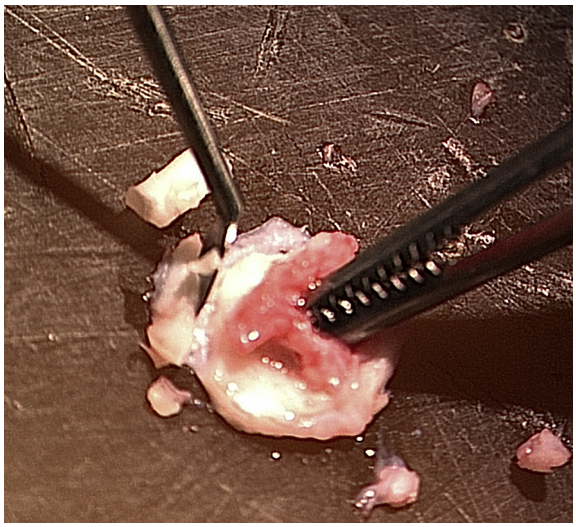

Fig. 2 The tragal graft is carved to fit the perforation with large perichondrial flaps preserved on both surfaces.

Results

Patient characteristic

From March 2014—September 2016, 30 children underwent 31 endoscopic or endoscopically assisted transcanal tympanoplasties by the senior surgeon (GI). All returned for scheduled follow-up and are included in the analysis. There were 22 boys and 8 girls in the series ranging in age from 3.5 to 17 years (median 6 years). All perforations were clean and dry at the time of surgery. Their size ranged from 15% to 70% of the normal drum surface area. Three children had some squamous ingrowth at the perforation edge, but none had a retraction pocket or cholesteatoma.

Healing

All tragal cartilage grafts (31/31; 100%) survived. Twenty-seven surgeries (27/31; 82%) resulted in an intact drum (17/31; 55%) (Fig. 4 A and B), or a microperforation (10/31; 32%) (Fig. 5). In four cases (4/31; 13%) significant perforations formed in previously unaffected portions of the drum. In two cases, this was larger than the original perforation (Fig. 6). None of the residual or recurrent perforations noted at 3 month follow-up healed spontaneously. Two children have undergone minor revision procedures with lobular fat or cartilage, resulting in complete closure.

Discussion

Transcanal approaches

Since its introduction by Eavey[10] several authors have advocated transcanal cartilage inlay tympanoplasty for the repair of pediatric tympanic membrane perforations. The surgery is minimally invasive, avoiding postauricular or endaural incisions, tympanomeatal flap elevation and

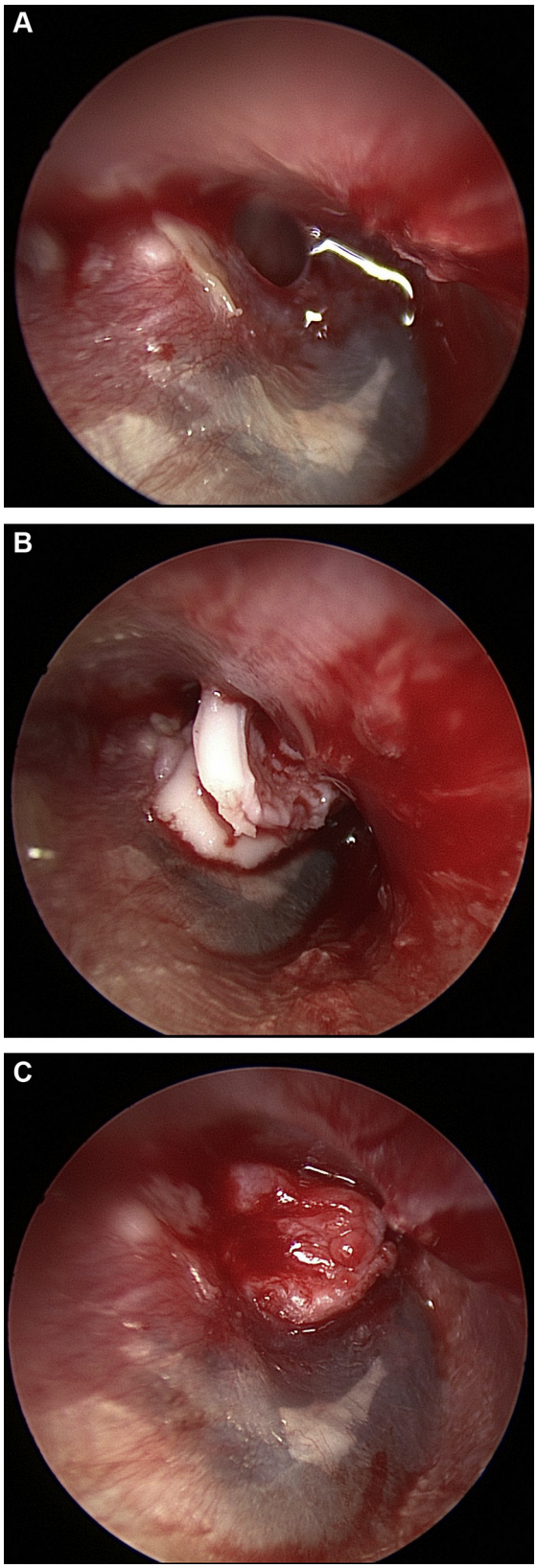

Fig. 3 A: Endoscopic view of freshened perforation; B: Insetting of graft; C: Completed graft placement.

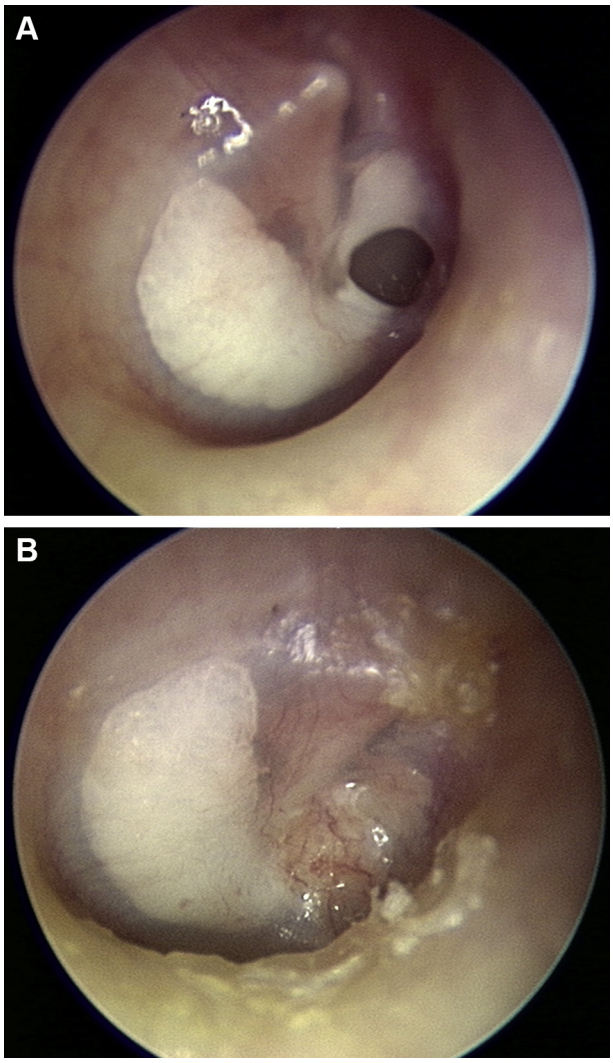

Fig. 4 A: Central perforation with surrounding tympanosclerosis; B: Healed, grafted perforation.

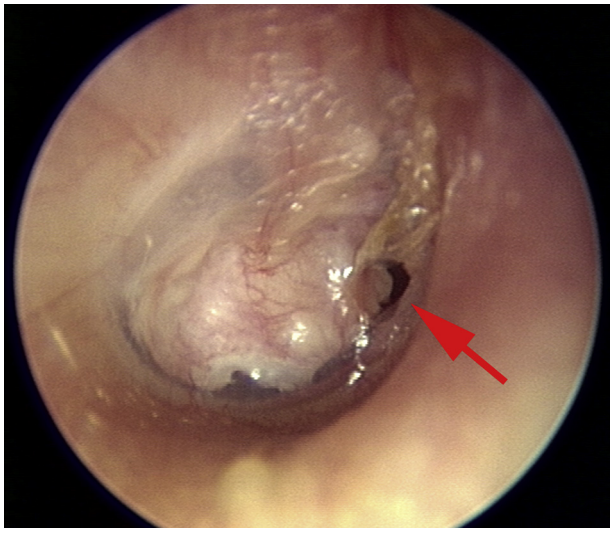

Fig. 5 Microperforation (arrow) at graft margin.

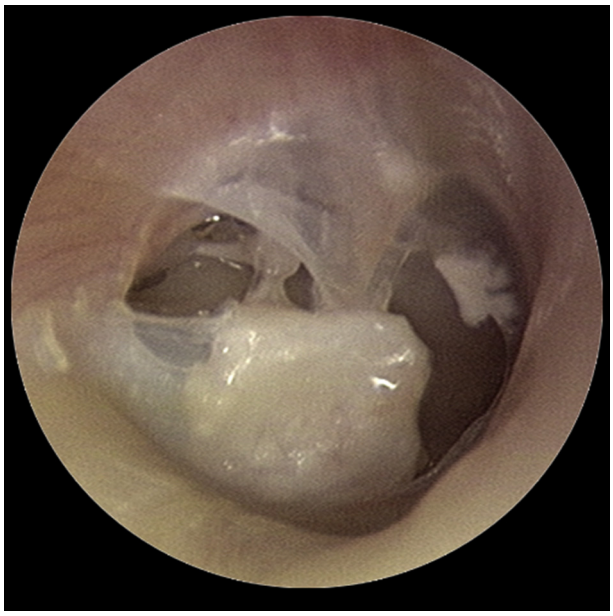

Fig. 6 Six months after graft placement. New, large perforations surrounding viable graft.

canalplasty with their associated technical demands and possible complications. While originally advocated for small to medium-sized central perforations, indications for the inlay technique have expanded to include marginal and subtotal perforations.[11] Higher failure rates in these situations led Eavey et al to modify their technique to include custom contouring and the addition of a split thickness skin graft lateral to the cartilage-perichondrial graft.[12] The recent addition of endoscopic visualization has expanded the potential patient population to include children under the age of 5 years and those with prominent anterior canal bulges, who were not candidates for transcanal microscopic surgery. Several authors report equivalent or superior outcomes with transcanal endoscopic tympanoplasty compared with underlay fascia or cartilage tympanoplasty done under the operating microscope using either a transcanal or postauricular approach.[3,4,6,7] Most of these series include only short periods of follow-up. "Success" is defined differently from report to report.

Types of failure

Our experience and that of colleagues suggested that the near perfect initial results reported by enthusiasts might be optimistic. Large reviews of pediatric tympanoplasty, regardless of surgical technique report significant rates of graft failure months to years after surgery, persistent small perforations near the annulus, myringitis, and recurrence of middle ear disease after initial tympanic closure.[13–17] Continuing eustachian tube dysfunction, immunologic immaturity and less than optimal cooperation with postoperative care have been cited as potential reasons for imperfect results in pediatric tympanoplasty.[18–20] Some otologists argue that persistent middle ear or mastoid inflammation from biofilm disease not addressed by

tympanic membrane repair alone may lead to surgical failure.[21]

Technical modifications

Our results confirm that tragal cartilage-perichondrial grafts are durable — all grafts survived in this series. Cartilage has modest metabolic needs and resists resorption even in the presence of active middle ear disease or cholesteatoma.[22,23] Several authors describe maneuvers attempting to minimize microperforations at the margins of cartilage inlay graft. Eavey[10] advocates both precise contouring of the graft to fit the shape of the perforation and a 1 mm overlap of cartilage with native tympanic membrane or the annulus. He accomplishes this by cutting a deep groove into the cartilage graft, so that split cartilage lies medial and lateral to the native ear drum (Fig. 3 B and C). We have lately increased the size and overlap of the cartilage component of our grafts, depending less on the medial and lateral perichondrial flaps to seal the perforation.

Distant failures

We are perplexed by the delayed appearance of perforations in portions of the tympanic membrane not involved in the surgery in a few patients. We do not routinely lift tympanomeatal flaps that might cause devascularization of other parts of the drum. We have been using ciprofloxacin/dexamethasone drops during the month after surgery to dissolve residual Gelfoam and prevent granulation formation. Recent reports of negative effects of fluoroquinolone drops on tympanic membrane healing have led us to discontinue this adjuvant treatment.[24]

Conclusion

There is a strong trend in surgical practice toward less invasive approaches. The transcanal endoscopic approach to tympanoplasty has great appeal for surgeons and their patients. Endoscopic approaches to the pediatric ear continue to evolve with greater experience among surgeons and improving instrumentation. Endoscopic and endoscopically assisted tympanoplasty will likely become the preferred approach to repair of tympanic perforations in children. It is hoped that our experience — good and bad, will contribute to improvements in technique and outcomes.

Funding

None.

Financial disclosures

None.

Conflicts of interest

None.

References

1. Isaacson G, Rosenfeld RM. Care of the child with tympanostomy tubes. *Pediatr Clin North Am*. 1996;43:1183—1193.
2. James AL, Papsin BC. Ten top considerations in pediatric tympanoplasty. *Otolaryngol Head Neck Surg*. 2012;147:992—998.
3. Marchioni D, Soloperto D, Rubini A, et al. Endoscopic exclusive transcanal approach to the tympanic cavity cholesteatoma in pediatric patients: our experience. *Int J Pediatr Otorhinolaryngol*. 2015;79:316—322.
4. Nassif N, Berlucchi M, Redaelli de Zinis LO. Tympanic membrane perforation in children: endoscopic type I tympanoplasty, a newly technique, is it worthwhile. *Int J Pediatr Otorhinolaryngol*. 2015;79:1860—1864.
5. Daneshi A, Jahandideh H, Daneshvar A, Safdarian M. Bilateral same-day endoscopic transcanal cartilage tympanoplasty: initial results. *Braz J Otorhinolaryngol*. 2017;83:411—415.
6. Dündar R, Kulduk E, Soy FK, et al. Endoscopic versus microscopic approach to type 1 tympanoplasty in children. *Int J Pediatr Otorhinolaryngol*. 2014;78:1084—1089.
7. Lade H, Choudhary SR, Vashishth A. Endoscopic vs microscopic myringoplasty: a different perspective. *Eur Arch Otorhinolaryngol*. 2014;271:1897—1902.
8. Cohen MS, Landegger LD, Kozin ED, Lee DJ. Pediatric endoscopic ear surgery in clinical practice: lessons learned and early outcomes. *Laryngoscope*. 2016;126:732—738.
9. http://www.sinuscentro.com.br/iwgees/index.htm.
10. Eavey RD. Inlay tympanoplasty: cartilage butterfly technique. *Laryngoscope*. 1998;108:657—661.
11. Alain H, Esmat NH, Ohad H, Yona V, Nageris BI. Butterfly myringoplasty for total, subtotal, and annular perforations. *Laryngoscope*. 2016;126:2565—2568.
12. Ghanem MA, Monroy A, Alizade FS, Nicolau Y, Eavey RD. Butterfly cartilage graft inlay tympanoplasty for large perforations. *Laryngoscope*. 2006;116:1813—1816.
13. Tos M, Orntoft S, Stangerup SE. Results of tympanoplasty in children after 15 to 27 years. *Ann Otol Rhinol Laryngol*. 2000;109:17—23.
14. Suzuki H, Koizumi H, Kitamura T, Tabata T, Kise Y, Hashida K. Revision Myringoplasty using thin-sliced cartilage for postoperative reperforation in patients with chronic otitis media. *J UOEH*. 2016;38:237—242.
15. Harris JP, Wong YT, Yang TH, Miller M. How I do it: anterior pull-through tympanoplasty for anterior eardrum perforations. *Acta Otolaryngol*. 2016;136:414—419.
16. Manning SC, Cantekin EI, Kenna MA, Bluestone CD. Prognostic value of eustachian tube function in pediatric tympanoplasty. *Laryngoscope*. 1987;97:1012—1016.
17. Hardman J, Muzaffar J, Nankivell P, Coulson C. Tympanoplasty for chronic tympanic membrane perforation in children: systematic review and meta-analysis. *Otol Neurotol*. 2015;36:796—804.
18. Isaacson G. Tympanoplasty in children. *Otolaryngol Clin North Am*. 1994;27:593—605.
19. Sarkar S, Roychoudhury A, Roychaudhuri BK. Tympanoplasty in children. *Eur Arch Otorhinolaryngol*. 2009;266:627—633.
20. Yegin Y, Çelik M, Altintaş A, Çolak C, Kayhan FT. Do the angle and length of the eustachian tube affect the success rate of pediatric cartilage type 1 tympanoplasty. *J Craniofac Surg*. 2017;28:e227—e231.

21. Redleaf MI. Air space reduction tympanomastoidectomy repairs difficult perforations more reliably than tympanoplasty. *Laryngoscope*. 2014;124(Suppl 3):S1—S13.
22. Vashishth A, Mathur NN, Choudhary SR, Bhardwaj A. Clinical advantages of cartilage palisades over temporalis fascia in type I tympanoplasty. *Auris Nasus Larynx*. 2014;41:422—427.
23. Dornhoffer J. Cartilage tympanoplasty: indications, techniques, and outcomes in a 1,000-patient series. *Laryngoscope*. 2003;113:1844—1856.
24. Alrwisan A, Antonelli PJ, Winterstein AG. Quinolone ear drops after tympanostomy tubes and the risk of eardrum perforation: a retrospective cohort study. *Clin Infect Dis*. 2017;64:1052—1058.

Edited by Xin Jin