

FULL ARTICLE

Elucidation of a Therapeutic Paradigm Shift Based on Kuhn's *Structure of Scientific Revolutions*: The Story of Canine External Ear Canal Surgery

Lysimachos G. Papazoglou, D.V.M., Ph.D., MRCVS

Department of Clinical Sciences, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

In 1962, Thomas Kuhn published his "The Structure of Scientific Revolutions," which became a cornerstone in the philosophy of science. Kuhn used theoretical physics to examine the evolution of scientific theories. According to Kuhn, scientific revolutions are delivered through paradigm shifts or breakdowns that happen when old ideas are unable to solve scientific problems. Kuhn's theory commences with prescience, where scientists concentrate on characterizing problematic areas. Over time, new and significant queries arise that the existing paradigm fails to address, leading to instability, anomaly, or crisis. The accumulation of a significant number of instabilities pushes the scientific community toward reaching a new consensus (paradigm) for solving the instabilities and move toward a stable era of science. Yet, replacement of the old paradigm is not complete, as the old paradigm is also functioning along with the new one. The purpose of this work is to elucidate how advances in canine external ear canal surgery are consistent with the mechanism of paradigm shift and scientific revolution suggested by Kuhn. It is proposed that an approach based on Kuhn's model can be adopted to underpin and understand the root causes for advances in other surgical fields.

Key words: Canine, Ear canal, Kuhn, Paradigm shift, Surgery

Submitted 3 May 2016; Revision received 23 June 2016;
Accepted for publication 25 August 2016; Published online
29 August 2016

INTRODUCTION

Principles of Scientific Revolutions

In 1962, Thomas Kuhn published "The Structure of Scientific Revolutions," which became a cornerstone in the philosophy

Address Correspondence to LG Papazoglou, Department of Clinical Sciences, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, 11 Voutyra street, 54627 Thessaloniki, Greece. Phone: 00302310994426. Fax: 00302310994449. E-mail: makdvm@vet.auth.gr

of science.¹ Kuhn used theoretical physics to examine the evolution of scientific theories. Before him, it was believed that scientific development, progress, and advances are found on evolution and accumulation of knowledge and new ideas over the centuries. According to Kuhn, this was not the case anymore, as scientific advances were associated with revolutions that occurred independently and delivered through paradigm shifts or breakdowns that happened when old ideas were unable to solve scientific problems.¹ Kuhn's theory commences with prescience, where scientists begin to concentrate on a problematic area to characterize and describe it with no intention of providing solid solutions to overcome that problem. Over time, new and significant queries arise that the existing paradigm fails to address, leading to an instability, anomaly, or crisis. The accumulation of a significant number of instabilities makes the scientific community infer that the existing paradigm is no more capable of resolving crises. Such instabilities foster major advances in an attempt to solve the problematic areas and move toward a stable period of structural activity that is controlled by a single paradigm, which is developed and extended uncritically by the majority of scientific community (i.e., normal science). Finally, scientists devise a new theoretical paradigm—totally different from the previous one(s)—that replaces the old paradigm, giving rise to a new era of normal science. Yet, replacement of the old paradigm is not complete, as the old paradigm is also functioning along with the new one. The purpose of the present work is to show how advances in canine external ear canal surgery are consistent with the mechanism of paradigm shift suggested by Kuhn in his "The Structure of Scientific Revolutions." The aim of external ear canal surgery is to treat otitis externa through lateral wall resection (LWR), vertical canal ablation (VCA), and total ear canal ablation and lateral bulla osteotomy (TECA-LBO).

Anatomy of the Canine Ear Canal and Pathophysiology of Otitis Externa

The canine external ear canal is formed by the pinna and the vertical and horizontal ear canals. The pinna and the vertical ear canal contain the auricular cartilage, whereas the horizontal ear canal is formed by the annular cartilage. These structures form a funnel that terminates at the tympanic membrane, separating the air-filled middle ear from the external ear canal. The external ear canal is a reverse L-shaped structure. The horizontal ear canal attaches to the petrous temporal bone through a short osseous component.

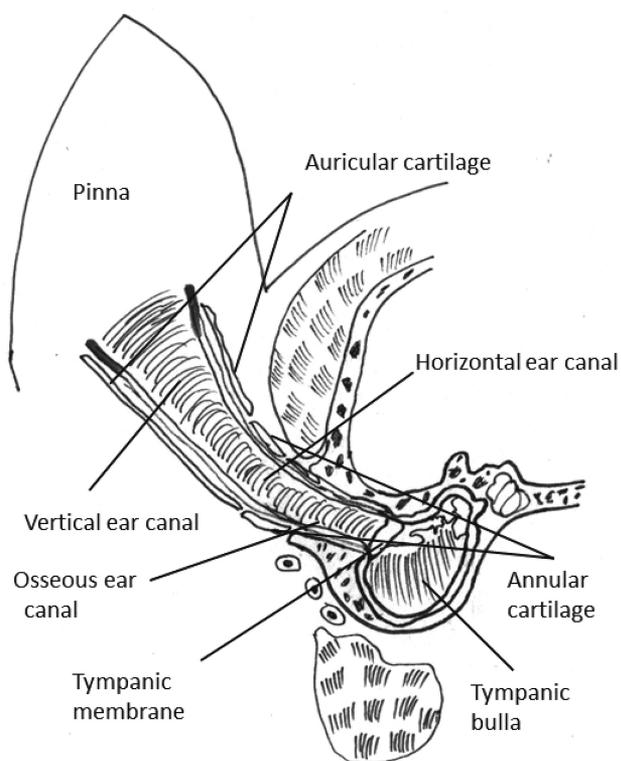


Figure 1: Schematic representation of the anatomy of canine external ear canal and middle ear.

The ventral portion of the middle ear is located within the tympanic bulla of the petrous temporal bone. The middle ear is connected to the nasopharynx through the auditory or Eustachian tube (Figure 1).

Otitis externa is a common inflammatory process that affects canine ear canals. Primary, predisposing, and perpetuating factors are involved in the development of otitis.² Primary factors such as atopic dermatitis and presence of parasites and foreign bodies play a role in the induction of the inflammatory process. Anatomic predispositions and maceration make the ear canal susceptible to inflammatory process, whereas bacteria and yeasts perpetuate the inflammatory process. Inflammation of the epidermis and dermis along with hyperplasia and hypertrophy of the sebaceous and ceruminous glands takes place, leading to excessive cerumen production, which, under certain microclimate conditions, results in secondary infection. Ear canal ulceration and erosion lead to purulent exudate and necrotic debris accumulation. Chronicity of otitis externa results in epidermal and dermal hyperplasia, stenosis, fibrosis, or ossification of the external ear canal, leading to total and permanent occlusion of the lumen.²

Scientific Revolutions in Canine Ear Canal Surgery

1. Prescience.

Ear canal surgery began a long time ago when veterinarians realized the need of treating inflammation and exudate formation in the ear canal by draining the external ear canal.³ Incision of the vertical ear canal and placement of tampons,

tubes, or bandages have been described in the middle of nineteenth century. All these techniques failed as granulation tissue formation resulted in premature healing of the incision of the ear canal. In 1931, Formston and McCune described a technique to treat chronic otorrhea in dogs.⁴ In 1936, Hinz reported the removal of a triangular section of the lateral wall of the vertical canal followed by suturing of the skin to the edges of the incision.³ These authors removed a triangular piece of the ear cartilage at the level of the vertical canal and sutured the skin flaps around the incision to the cartilage and ear epithelium. This technique was active until the middle of the twentieth century.³

2. Revolution I and Normal Science: LWR.

In 1949, Zepp reported a LWR that has been the standard for the last 50 years.⁵ This technique was not served as treatment of otitis externa *per se* but was regarded as an adjunct to medical management. The purpose of LWR is to provide aeration of the external ear canal, improving the microclimate, to allow drainage of the ear canal and for local application of medications. LWR entails removal of the skin over the vertical canal by incising along the cranial and caudal margins of the vertical canal to the level of the annular cartilage, creating a drain board that was reflected ventrally and sutured to the skin edges.

3. Anomaly and Crisis: Complications of LWR.

Four retrospective studies were published to evaluate the results of LWR in dogs. In one study reviewing 281 dogs undergoing LWR, 35% of the dogs showed no improvement.⁶ Similar results were reported by Gregory and Vasseur in 26 dogs, where 47% of them had an unsuccessful outcome.⁷ Interestingly, the authors reported a favorable outcome in some dogs irrespective of the technical errors. Lane and Little reviewed the records of 135 dogs that had ear canal surgery and found poor outcomes associated with concurrent otitis media, irreversible changes in the medial wall, and stricture of the horizontal canal related to failed drainage.⁸ Finally, in 1998, Sylvestre documented 55% failures following a study of 60 dogs with LWR.⁹ In this study, the author found that the procedure failed in 86.55% of Cocker Spaniels and that Shar-Peis showed better outcomes, although they had stenotic vertical ear canals compared with other breeds.⁹ Mineralization and ossification of the external ear cartilage may be seen in chronic cases, and creation of a drain board is usually puzzling. Elkins et al. reported the creation of a drain board by removing the mineralized cartilage from the epithelium of the lateral ear canal and suturing the epithelium to the ventral skin.¹⁰ However, this technique is rarely performed, as chronic changes in the vertical canal also usually affect the horizontal canal. Over the years, veterinary surgeons changed their approach to treating canine otitis externa from recommending LWR with recurrent otitis to avoiding this technique.¹¹

4. Revolution II and Normal Science: VCA.

The disappointing results of the LWR to treat otitis externa prompted veterinary surgeons to move toward a new surgical approach involving removal of the vertical ear canal. VCA was first described by Fraser et al.¹² This procedure

combines the advantages of LWR with total removal of the severely inflamed vertical ear canal; the horizontal ear canal is sutured to the surrounding skin following a vertical transection of the vertical ear canal at the level of the annular cartilage. Indications for performing VCA include apart from otitis externa, tumors confined to the vertical canal, and traumatic lacerations of the external ear cartilage. The outcome of VCA was reviewed by Siemering, who performed this procedure in 75 dogs; 72 dogs showed no symptoms of otitis externa after a follow-up of 12 weeks.¹³ Lane modified the technique by using a ventral flap similar to LWR to improve drainage and avoid stricture of the horizontal canal.¹⁴

5. Anomaly and Crisis: Complications of VCA.

Lane and Little reported postoperative complications of VCA including ear canal stenosis or stricture.⁸ Targari and Pinniger modified the original procedure by describing a pull-through technique and compared this procedure with VCA; by performing the pull-through technique, no vertical transection of the vertical canal is performed and better cosmesis is achieved.¹⁵ Targari reviewed the long-term results of the pull-through technique and reported encouraging results.¹⁶ However, McCarthy and Caywood—by retrospectively reviewing the long-term results of VCA in 36 dogs—reported complete resolution of clinical signs in only 23% of the dogs.¹⁷ Vertical ear canal is seldom the only location of severe inflammatory changes associated with otitis externa or tumors. Thus, recurrence of these two diseases following VCA is not uncommon.²

6. Revolution III and Normal Science: TECA.

Failures of LWR and VCA to treat otitis externa, obstruction of ear canal with proliferative tissue, mineralization of the external ear canal, or neoplasms of the ear canal and generally chronic end-stage otitis externa in dogs received much attention from veterinary surgeons as early as 1958–1959 when Seward et al and Singh and Rao described TECA by removing of the vertical and horizontal ear canals from the ligamentous attachment to the osseous external ear canal. In this approach, the tympanic membrane is left intact and the wound is closed with sutures.^{18,19} This technique was reviewed by Grono (1962) and Fraser et al. (1970), who reported a high incidence of postoperative fistula formation.^{20,21}

7. Anomaly and Crisis: Complications of TECA.

Extension of otitis externa to the middle ear is a common occurrence. Many surgeons questioned the use of TECA for the management of otitis media, as by ablation of the ear canal, no drainage from the infected middle ear occurred, resulting in septic lesions around the incision line.^{21,22} These concerns were documented later on by Smeak and Dehoff in their retrospective study of 39 TECAs in 28 dogs, where a significant number of chronic wound drainage and fistula formations were recorded in 33% of surgeries. Inadequate drainage of the middle ear and incomplete removal of the secretory epithelium lining the tympanic bulla or debris within the ear canal or tympanic cavity were responsible for these complications.²³

8. Revolution IV and Normal Science: TECA and LBO.

Because of the high rate of complications following TECA, surgeons abandoned the technique and consider performing TECA combined with some type of tympanic cavity drainage. TECA and LBO were described to address these issues.^{24–28} This technique involves an incision around the auricular cartilage and a skin incision over the vertical ear canal. The vertical and horizontal ear canals are dissected free of their muscular attachments, and the ear canal is amputated at the level of the tympanic bulla followed by an LBO. Sharp (1990) described drainage of the tympanic bulla by TECA and ventral bulla osteotomy; however, there was no advantage over LBO for the treatment of otitis externa and media and this modification was not adopted by the surgical community.²⁹ Overall, very careful and precise dissection and familiarity with the technique led to the resolution of clinical signs of otitis externa and media, and favorable results as high as 93% have been achieved.^{27,28} Change in the ear carriage is a complication for dogs with erect ears undergoing TECA-LBO. Subtotal ear canal ablation LBO was devised to address this ear carriage alteration.³⁰ In this procedure, after transection of the distal vertical ear canal, the proximal vertical and horizontal canals are removed by a standard TECA-LBO. The distal vertical canal is closed with sutures, and the procedure is routinely completed. Subtotal ear canal ablation may also be used in dogs with tumors and abnormalities of the horizontal ear canal.³⁰

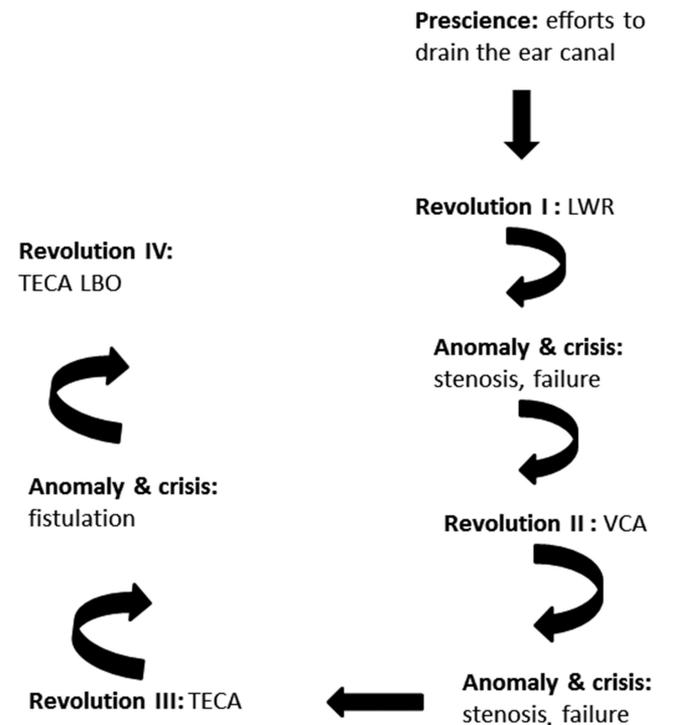


Figure 2: Ear canal surgery cycle based on Kuhn's structure of scientific revolutions. LWR: Lateral wall resection, VCA: Vertical canal ablation, TECA: Total ear canal ablation, TECA-LBO: Total ear canal ablation and lateral bulla osteotomy.

CONCLUSION

In the present article, canine external ear canal surgery served as an example of scientific development and advance based on Kuhn's model of scientific revolution (Figure 2). It is evident that scientific developments in this surgery was not because of knowledge accumulation or evolution during the years but rather the result of revolutionary shifts that resulted from "anomaly" or "crisis" and gave birth to surgical procedures that can be performed independently based on specific indications. Kuhn's scientific revolution model may explain successfully how scientific development and improvement in veterinary surgical procedures occurred. It is proposed that an approach based on Kuhn's model—as exemplified in this paper in canine external ear canal procedures—can be adopted to underpin and understand the root causes for advances in other surgical fields.

CONFLICT OF INTEREST STATEMENT

The author has no conflicts of interest to disclose.

SOURCE OF SUPPORT

There is no funding source to report for this manuscript.

References

- Kuhn TS. *The Structure of Scientific Revolutions*. 1st ed. Chicago, University of Chicago Press, 1962: pp. 1–210.
- Radlinsky MG, Mason DE. *Diseases of the ear*. In: SJ Ettinger, EC Feldman (Eds.). *Textbook of Veterinary Internal Medicine. Diseases of the Dog and Cat*. St Louis, Saunders, Elsevier, 2010: pp. 1011–1030.
- Harvey CE. A history of the surgical management of otitis externa in the dog. *Vet Surg* 1980; 9: 150–152.
- Formston C, McCunn J. A surgical treatment for chronic otorrhea in the dog. *Vet J* 1931; 87: 112–115.
- Zepp CP. Surgical techniques to establish drainage of the external ear canal and corrections of hematoma of the dog and cat. *J Am Vet Med Assoc* 1949; 115: 91–92.
- Tufvesson G. Operation for otitis externa in dogs according to Zepp's method. *Am J Vet Res* 1955; 16: 565–570.
- Gregory CR, Vasseur PB. Clinical results of lateral ear resection in dogs. *J Am Vet Med Assoc* 1983; 182: 1087–1090.
- Lane JG, Little CJL. Surgery of the canine external auditory meatus: a review of failures. *J Small Anim Pract* 1986; 27: 247–254.
- Sylvestre AM. Potential factors affecting the outcome of dogs with a resection of the lateral wall of the vertical ear canal. *Can Vet J* 1998; 39: 157–160.
- Elkins AD, Hedlund CS, Hobson HP. Surgical management of ossified ear canals in the canine. *Vet Surg* 1981; 10: 163–168.
- Bellah JR. *Ear*. In: MJ Bojrab, E Monnet (Eds.). *Mechanisms of Disease in Small Animal Surgery*. Jackson, Teton New Media, 2010: pp. 334–349.
- Fraser G, Withers AR, Spreull JSA. Otitis externa in the dog. *J Small Anim Pract* 1961; 2: 32–47.
- Siemering GH. Resection of the vertical ear canal for treatment of chronic otitis externa. *J Am Anim Hosp Assoc* 1980; 16: 753–758.
- Lane G. Canine aural surgery. *In Practice* 1979; 1: 5–15.
- Tirgari M, Pinniger RS. Pull-through technique for vertical canal ablation for the treatment of otitis externa in dogs and cats. *J Small Anim Pract* 1986; 27: 123–131.
- Tirgari M. Long-term evaluation of the pull-through technique for vertical canal ablation for the treatment of otitis externa in dogs and cats. *J Small Anim Pract* 1988; 29: 165–175.
- McCarthy RJ, Caywood DD. Vertical ear canal resection for end-stage otitis externa in dogs. *J Am Anim Hosp Assoc* 1992; 28: 545–552.
- Seward CO, Blackmore WM, Ott RL. Treatment of chronic canine otitis externa by ablation of the ear canal. *J Am Vet Med Assoc* 1958; 133: 417–419.
- Singh GB, Rao MM. Otitis externa in canines—Its medical and surgical treatment. *Indian Vet J* 1959; 36: 236–242.
- Grono LR. The surgical treatment of canine otitis externa. *Australian Vet J* 1962; 38: 235–238.
- Fraser G, Gregor WW, MacKenzie CF, Spreull JSA, Withers AR. Canine ear disease. *J Small Anim Pract* 1970; 10: 725–754.
- Spreull JSA. *Ablation of the ear canal*. In: MJ Bojrab, (Ed.). *Current Techniques in Small Animal Surgery*. Philadelphia, Lea and Febiger, 1975: pp. 68–71.
- Smeak DD, Dehoff WD. Total ear canal ablation. Clinical results in the dog and cat. *Vet Surg* 1986; 15: 161–170.
- Mason LK, Harvey CE, Orsher RJ. Total ear canal ablation combined with lateral bulla osteotomy for end-stage otitis in dogs. Results in thirty dogs. *Vet Surg* 1988; 17: 263–268.
- Beckman SL, Henry WB, Cechner P. Total ear canal ablation combining bulla osteotomy and curettage in dogs with chronic otitis externa and media. *J Am Vet Med Assoc* 1990; 196: 84–90.
- Matthiesen DT, Scavelli T. Total ear canal ablation and lateral bulla osteotomy in 38 dogs. *J Am Anim Hosp Assoc* 1990; 26: 257–267.
- White RAS, Pomeroy CJ. Total ear canal ablation and lateral bulla osteotomy in the dog. *J Small Anim Pract* 1990; 31: 547–553.
- Doyle RS, Skelly C, Bellenger CR. Surgical management of 43 cases of chronic otitis externa in the dog. *Irish Vet J* 2004; 57: 22–30.
- Sharp NJH. Chronic otitis externa and otitis media treated by total ear canal ablation and ventral bulla osteotomy in thirteen dogs. *Vet Surg* 1990; 19: 162–166.
- Mathews KG, Hardie EM, Murphy KM. Subtotal ear canal ablation in 18 dogs and one cat with minimal distal ear canal pathology. *J Am Anim Hosp Assoc* 2006; 43: 371–380.