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A Comparison of Different Anastomotic Techniques After Two Different Degrees of Tracheal Resection in the Dog

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Abstract

Tracheal resection and end to end anastomosis is a practical procedure for the correction of tracheal stenosis. In this study three techniques of tracheal anastomosis (simple interrupted pericartilaginous sutures, averting anastomosis and telescoping anastomosis) at two different degrees of tracheal resection (4 and 8 rings) were compared. The averting anastomotic technique proved better in terms of tracheal apposition, narrowing of lumen and healing. The degree of resection as such seems to be having no effect on tracheal healing.

Introduction

Stenosis of trachea, a frequent aftermath of both injury and disease presents a formidable challenge to the surgeon. The causes of tracheal stenosis include: foreign bodies (Beitzel and Brinker, 1956), vascular anomalies (Linton, 1956), stricture following tracheostomy (Andrews and Pearson, 1971), collapsed tracheal rings (Leonard, 1971), granulomas resulting from intubation with cuffed endotracheal tubes (Dorbin and Canfield, 1977), neoplasm (Brayan *et al.*, 1981), congenital tracheal stenosis (White and Kellagher, 1986), rupture of trachea due to penetrating neck injury (Kellagher and White, 1987), peritracheal lesions (Salisbury *et al.*, 1990) and after surgical repair of trachea (Smith *et al.*, 1990). Once stenosis is established the logical approach is resection of stenotic segment and re-establishment of an adequate airway by primary anastomosis (Webb *et al.*, 1974).

Since the first attempt of tracheal anastomosis reported by Colley (1895), several other techniques have also been reported in literature (Ferguson *et al.*, 1950; Maisel and Dingwall, 1950; Som and Klein, 1958; Withrow *et al.*, 1978; Whitfield *et al.*, 1989; Fingland *et al.*, 1995). These techniques have been used with variable success. In this study different anastomotic techniques after two degrees of tracheal resection i.e. 4 and 8 rings have been evaluated macroscopically, microscopically and radiographically, so as to find a suitable technique with an edge over the other techniques.

Materials and Methods

This study was carried out on 21 clinically healthy mongrel dogs between 10-15 kg body weight. Out of 21 dogs, 18 were divided into two equal groups and marked as group I and II, while group III (n = 3) acted as control. In group I resection of 4 tracheal rings was performed, while in group II, 8 rings were resected. Group I and group II were further subdivided into three subgroups as Ia, Ib, Ic, IIa, IIb and IIc, each comprising of 3 dogs on the basis of three techniques of tracheal anastomosis to be tested.

Surgical Procedure: The animals were prepared, anesthetized and the proposed portion of the trachea was excised. For each subgroup a different suturing technique was applied. In subgroups Ia and IIa, the anastomosis was performed by simple interrupted pericartilaginous sutures, which encompassed one tracheal ring on each side of the anastomosis (Ferguson *et al.*, 1950). In subgroups Ib and IIb, an averted anastomosis was performed. Horizontal mattress sutures were passed through the annular ligaments on both sides of the anastomosis (Som and Klein, 1958). These sutures did not include the tracheal ring. In subgroups Ic and IIc, a telescoping anastomosis was performed. The caudal segment of the trachea was telescoped into the cranial segment (Withrow *et al.*, 1978). Horizontal mattress sutures with monofilament nylon (Prolene 4-0) were passed through the overlapped tracheal cartilages.

In the control group, two tracheal rings were incised longitudinally on the ventral midline of the trachea. No sutures were applied as to study the natural healing process.

Post Operative Care: All the animals were provided with antibiotic cover and were injected Farmox 15 per cent (Amoxycillin Trihydrate) at a dose rate of 1 ml per 20 kg body weight intramuscular for seven days. Pred 2.5 per cent (Steroid) injection was given 1 ml (25 mg Prednisolone Acetate) per dog intramuscular on first day after operation followed by 0.5 ml (12.5 mg Prednisolone Acetate) for the next two days. Local dressing of the wound was done daily with Geokorton spray. All the animals were fed on normal diet from 2nd day onward till the end of the experiment. The skin sutures were removed 10th day postoperatively. The radiographs of all the animals were taken at the end of their prescribed experimental period and per cent dorsoventral luminal stenosis was measured. Postmortem

examination of all the animals was performed after the end of prescribed experimental period and per cent luminal stenosis was measured planimetrically. Moreover, sections of the trachea were cut from the anastomotic site and processed for the observation of histomorphological changes.

Results

The general health of all the animals was good. Signs of obstruction such as stridor were not observed in any animal even after exercise. There was a rise in temperature in all the dogs varying from 1°F-1.5°F during the 1st 24 hours after surgery, which was considered a normal body response to surgical insult. The limitation of neck extension for first few days was observed in almost all the dogs. The limitation was more marked in animals of group II but full extension was possible by 3-7 days after surgery.

Post operatively, all wounds of trachea and surrounding structures healed by primary intention. There was no infection locally or in the mediastinum in any of the animals. No tissue crepitus suggestive of leak was noted in any dog nor was there any evidence of obstructed trachea or impaired airway.

On radiograph the normal tracheal walls appeared as thin parallel soft tissue densities. At the anastomotic site the tracheal walls were seen to be thickened and deviated inward narrowing the effective tracheal lumen. The per cent dorsoventral luminal stenosis was also measured radiographically before the dogs were killed. This narrowing was more prominent in subgroups Ic and IIc as compared to other subgroups (Table V).

The shape of trachea at the anastomotic site was round as compared to the normal elliptical shape. Anastomosis in all the cases was secure and found to be airtight. No gap was seen between tracheal segments. As prolene (nonabsorbable monofilament nylon suture) was used, the sutures were present in there original place and status. No disruption was observed. It was evident that the sternothyrohyoideous muscles were fixed intimately to the trachea in all the animals.

The inner diameter of the trachea at the anastomotic site (per cent luminal stenosis) was measured and compared with diameter of normal trachea in the same specimen. These measurements are given in the tables I to V.

In microscopic examination, marked fibroblastic proliferation and mononuclear cell infiltration was observed with greater deposition of collagen fibers.

All the control animals were euthanised on 8th day postoperation. After postmortem tracheae were exposed and it was observed that the incision in tracheal walls had completely closed and tracheal walls were airtight.

Discussion

The results of healing of tracheal anastomosis are in conformity with the observations of other workers (Maisel and Dingwall, 1950., Varshney and Kumar, 1984., Kinjavdekar *et al.*, 1992), who also observed that healing of anastomosis in the absence of infection took approximately 3 weeks.

To avoid excess of tension on anastomoses during the operations, trachea was mobilized completely from cricoid cartilage of larynx to reaching the mediastinum. This surgical manipulation did not affect healing in any animal. This confirmed the observation that division of all extrinsic vessels of trachea did not affect healing of surgical lesions of the trachea (Cantrell and Folse, 1961), because extensive collateral circulation exists between the segmental arteries that enter the submucosa between the tracheal hyaline cartilages (Sobin *et al.*, 1963).

During this study 4 and 8 tracheal rings were resected which corresponded to 10 per cent and 20 per cent of tracheal length, respectively (a normal dog's trachea comprises of 35-45 cartilaginous rings). It was observed that the resection of upto 20 per cent of tracheal length did not affect tracheal healing. This confirmed the observations of Fingland *et al.*, (1995) who removed 8 tracheal rings and got success. This has also been reported by Cantrell and Folse, 1961, who measured the limit of tension on an anastomosis in order to obtain predictable primary healing. They noted that after complete mobilization 8-23 cartilages (about 20 to 60 per cent) of the trachea could be excised in an adult dog. It was also noted that after resection dogs experienced limitation in their neck extension for first few days but full extension was possible by 3-7 days after surgery (Cantrell and Folse, 1961).

The adhesion of surrounding muscles and fascia to the anastomotic site was observed in all the animals at the time of postmortem. This might be due to reaction of the tissues to the catgut used to suture the muscles and the fascia. The adhesion of anastomosed trachea to the surrounding structures has also been reported by Maisel and Dingwall, 1950 and is thought to aid in affording a good vascular supply to the suture line.

The technique of suturing the apposed segments by pericartilaginous sutures resulted in precise anastomosis and was found easy to be performed. The averting anastomosis technique in which the mattress sutures were applied through the apposed annular ligaments resulted in less narrowing of tracheal lumen as compared to the other techniques. The telescoping technique resulted in a marked narrowing of tracheal lumen, because the caudal segment was invaginated into cranial. However, it is claimed that later technique prevents interference with mucociliary clearance (Withrow *et al.*, 1978). These findings correspond to that of other workers (Hedlund, 1984., Varshney and Kumar, 1984).

On radiography, the tracheal lumen was found to be narrow at the site of anastomosis. The radiography has been considered the best test to judge the continuity of tracheal lumen (Lau *et al.*, 1980., Varshney and Kumar, 1984). It was observed that the narrowing of tracheal lumen occurred upto a variable extent after resection and

Table 1: Metric changes at anastomotic site in group I animals (Degree of Resection 4 rings)

Dog No.	Sub-group	Technique of anastomosis	Inner diameter of Normal site (cm)	Inner diameter of anastomotic site (cm)	%Narrowing
		Group I (Degree of Resection 4 rings)			
1	Ia	Pericartilaginous sutures	1.9	1.5	23
2			1.4	1.1	21
3			1.1	0.9	18
4	Ib	Averting Technique	1.8	1.5	17
5			1.5	1.2	20
6			1.6	1.4	12
7	Ic	Telescoping Technique	1.9	1.4	26
8			1.7	1.2	29
9			1.7	1.1	35
		Group II (Degree of Resection 8 rings)			
10	IIa	Pericartilaginous sultures	1.6	1.3	19
11			1.8	1.4	22
12			2.0	1.7	15
13	IIb	Averting Technique	2.1	1.8	14
14			1.6	1.4	12
15			1.8	1.5	17
16	IIc	Telescoping Technique	1.8	1.4	23
17			1.7	1.1	35
18			2.0	1.5	25

Table 2: Narrowing percentage (average) in three different techniques

		Narrowing Percentage in		
Dog No.	Degree of Resection	Pericartilaginous suturing	Averting anastomosis	Telescoping anastomosis
7	4 rings	23	17	26
8	4 rings	21	20	29
9	4 rings	18	12	35
16	8 rings	19	14	23
17	8 rings	22	12	35
18	8 rings	15	17	25
Average		19.66	15.50	28.83

anastomosis in all the cases. The narrowing of tracheal lumen after resection and anastomosis is a usual finding (Lau *et al.*, 1980, Hedlund, 1984, Fingland *et al.*, 1995) which occurs as a result of normal process of healing. The shape of tracheal section at anastomosis was round as compared to elliptical shape of section from normal site. This was due to the infolding of fibrous tissue at the anastomotic site (Maeda and Grillo, 1973).

Histologically, the anastomotic site was found to be covered with fibrous tissue in all the dogs. Healing progressed satisfactorily in all the cases with the exception of animals in which telescoping technique of anastomosis was used, where it was somewhat slower. These findings are in conformity with the observations of Varshney and Kumar, 1984 and Kinjavdekar *et al.*, 1992.

This study has clearly indicated that averting anastomosis performed by apposing annular ligaments with horizontal mattress suture has an edge over other techniques in terms of tracheal apposition, narrowing of the lumen and healing. Moreover, it has also been proved that the degree o resection had no effect on the healing of anastomosis. Th effects of steroids on healing of tracheal anastomosis need further exploration.

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