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UNEXPECTED, DIFFICULT LARYNGOSCOPY: A PROSPECTIVE SURVEY IN ROUTINE GENERAL SURGERY

K. N. WILLIAMS, F. CARLI AND R. S. CORMACK

SUMMARY

A prospective study of unexpected, difficult laryngoscopy was carried out. During a 7-month period, all general surgery patients in whom the trachea was intubated were assessed; only those with obvious neck pathology were excluded. Ease or difficulty of laryngoscopy was graded by a standard method. There were no grade 4 cases and no failed intubations in a total of 1387 cases. There were significant differences in the results recorded by different individuals; this did not correlate with seniority or with the type of surgery. Four factors have been identified which help to explain these discrepancies. These findings are analysed in relation to the training of junior staff, with particular reference to obstetric anaesthesia.

KEY WORDS

Intubation, tracheal: complications, technique, training.

Difficulty in tracheal intubation is known to be the main factor in deaths associated with anaesthesia in young patients. It has been the subject of many studies, but a puzzling feature of this work is the enormous variation in the reported frequency of difficult laryngoscopy, ranging from 1 in 8 [1] at one extreme, to 1 in 300 [2] at the other. Our initial aim was to identify the reasons for these discrepancies.

Diseases which are notorious for causing difficulty with tracheal intubation, such as Still's disease and ankylosing spondylitis, do occur in obstetric patients, but in general they do not cause disaster. Only once have these diseases been implicated in the 30 years covered by the Confidential Enquiries. Such patients are easy to identify in advance and appropriate measures are taken to avoid trouble; it is the unexpected difficulty in a patient with no neck pathology that causes disaster. Because of this, patients with obvious neck pathology were excluded from this study.

PATIENTS AND METHODS

Anaesthetists were asked to rate difficulty of laryngoscopy into one of four grades, using the method we described previously [3]. A copy of this scheme was displayed in each anaesthetic room (fig. 1). The grade was entered in the theatre records and for most patients that was the only information noted. However, if there was any difficulty with laryngoscopy, full details were recorded. The data were transferred to a microcomputer for analysis.

The compliance rate was mostly about 90%, but this decreased to 77% during busy periods, when there was a tendency for easy cases to go unrecorded. Thus the total for grade 1 are about 15% too low, but this does not materially affect our conclusions.

RESULTS

Table I shows all the data. A χ^2 test for $R \times C$ contingency on table I approached significance ($P = 0.07$), but the proportion of cells with expected frequency (E) less than 5 was high (70%), which makes χ^2 unreliable. To rectify this, rows and columns were amalgamated, as advocated by Armitage [4], to produce table II: all rows with a row total of 5 or less were pooled (that is, individuals who performed five or fewer intubations in the study period were put in one group); columns 1 and 2 (the easy cases) were amalgamated; and columns 3 and 4 (the difficult cases) were amalgamated. Apart from statistical

K. N. WILLIAMS*, M.A., M.B., B.S., F.C.ANAES.; F. CARLI, D.M.S., F.C.ANAES.; R. S. CORMACK, B.A., B.SC., B.M., B.CH., F.C.ANAES.; Department of Anaesthetics, Northwick Park Hospital & Clinical Research Centre, Harrow HA1 3UJ.
Accepted for Publication: August 17, 1990.
*Present address, for correspondence: Department of Anaesthetics, Charing Cross Hospital, London W6 8RF.

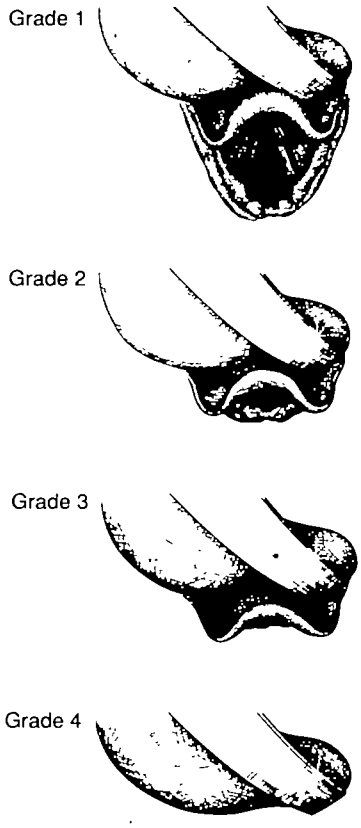

FIG. 1. Grading difficulty of laryngoscopy. It is assumed that care has been taken to get the best possible view of the vocal cords.

TABLE I. *Incidence of each grade of difficulty of laryngoscopy recorded by individual participating anaesthetist.* † *Beginner*

Rank of anaesthetist	Grade of laryngoscopy 1	2	3	4	Totals
Consultant	75	15	2	0	92
	84	4	2	0	90
	70	6	1	0	77
	58	9	2	0	69
	52	9	5	0	66
	36	3	0	0	39
	29	5	1	0	35
	13	2	0	0	15
	14	0	0	0	14
	11	0	3	0	14
	3	1	0	0	4
Clinical Assistant	20	2	1	0	23
Senior Registrar	73	20	5	0	98
	61	4	5	0	70
	27	1	1	0	29
	15	1	0	0	16
	4	1	0	0	5
Registrar	38	7	1	0	46
	35	6	1	0	42
	19	2	2	0	23
	18	3	1	0	22
	17	3	0	0	20
	13	2	2	0	17
	11	0	0	0	11
	9	0	0	0	9
	7	0	0	0	7
	3	0	0	0	3
	1	0	0	0	1
Senior House Officer	78	2	0	0	80
	72	8	0	0	80
	70	2	0	0	72
	65	5	2	0	72
	54	7	1	0	62
	17	8	0	0	25
	12	0	1	0	13†
	11	1	0	0	12†
	7	1	3	0	11†
	3	0	0	0	3
Totals	1205	140	42	0	1387

benefits, table II is more relevant clinically than table I; in effect it emphasizes the ratio of difficult to easy cases reported by each individual.

Amalgamating rows and columns in table II reduced the number of cells with $E < 5$ from 70% to 50%. This is still larger than the recommended maximum of 20%, therefore it seemed advisable to cross-check against a computer simulation, as advocated for controversial cases [5]. Table III shows what would happen if the null hypothesis were true and our trial were repeated 12000 times. The marginal totals were fixed, as in table II, but the body of the table varied randomly. It can be seen (table III) that a small amount of probability has migrated from the middle of the distribution into the tail, but in general the experimental P values match the theoretical ones quite well. This adds weight to previous evidence [6,7] that χ^2 provides a better approximation than was thought in the past. Only 2% of simulated trials produced a χ^2 greater than 54.7 (table III), so the real trial value of 71.3 (table II) can hardly have been produced by random variation.

Having established that these were real differences, we tried next to identify the cause. The distribution of difficult cases was unrelated either to seniority of the individual or to the type of surgery (table IV). The last step was to go back to table II and examine the results of each an-

TABLE II. *Data from table I summarized to highlight the ratio of easy:difficult laryngoscopies seen by each anaesthetist: Grades 1+2 = easy cases; grades 3+4 = difficult cases. Mixed rank = pooled data for those who performed a total of five or fewer laryngoscopies.* $\chi^2 = 71.33$ *with 33 degrees of freedom;* $P < 0.0001$. ** *Contribution to* $\chi^2 > 15.0$; * *Contribution to* $\chi^2 > 4.0$

Rank of anaesthetist	Grade of laryngoscopy 1+2	3+4	Totals
Consultant	90	2	92
	88	2	90
	76	1	77
	67	2	69
	61	5*	66
	39	0	39
	34	1	35
	15	0	15
	14	0	14
	11	3**	14
Clinical Assistant	22	1	23
Senior Registrar	93	5	98
	65	5	70
	28	1	29
	16	0	16
Registrar	45	1	46
	41	1	42
	21	2	23
	21	1	22
	20	0	20
	15	2*	17
	11	0	11
	9	0	9
	7	0	7
Senior House Officer	80	0	80
	80	0	80
	72	0	72
	70	2	72
	61	1	62
	25	0	25
	12	1	13
	12	0	12
	8	3**	11
Mixed Rank	16	0	16
Totals	1345	42	1387

TABLE III. *Verification of the statistics of table II using computer simulations [7]. This shows what would happen if the null hypothesis were true and our trial were repeated 12000 times. The experimental* χ^2 *values followed the* χ^2 *distribution quite well, despite many cells with expected values of* < 5. *Only 2% of trials made* $\chi^2 > 54.7$, *so the value of 71.3 in table II cannot be ascribed to random variation*

χ^2	Predicted P	Experimental P (95% confidence limits)
> 32.3	0.502	0.473 (0.464–0.481)
> 38.1	0.250	0.244 (0.238–0.250)
> 43.7	0.100	0.115 (0.109–0 121)
> 47.4	0.050	0.070 (0.065–0.074)
> 54.7	0.010	0.023 (0.020–0.025)

TABLE IV. *Negative findings. There was no evidence that the distribution of difficult cases was related to the seniority of the anaesthetist* ($\chi^2 = 6.18$; $df = 4$; $P = 0.19$) *or to the type of surgery* ($\chi^2 = 3.14$; $df = 4$; $P = 0.53$)

	Grade of laryngoscopy 1+2	3+4	Totals
Rank of anaesthetist			
Consultant	499	16	515
Clinical Assistant	22	1	23
Senior Registrar	207	11	218
Registrar	194	7	201
Senior House Officer	423	7	430
Totals	1345	42	1387
Type of surgery			
General surgery	495	12	507
Genito-urinary surgery	63	4	67
Orthopaedics	364	11	375
Gynaecology	320	12	332
Vascular	103	3	106
Totals	1345	42	1387

aesthetist. Four individuals contributed more to χ^2 than the remainder—they had abnormally high incidences of difficult laryngoscopy (mean incidence overall 3%): 27% and 21% for two (one a consultant, the other an S.H.O.), and 12% and 8% for two others (one a consultant, the other a trainee).

DISCUSSION

Difficult laryngoscopy vs *difficult intubation*

To avoid confusion, a distinction should be drawn between difficult laryngoscopy and difficult intubation. If the cords cannot be seen (grade 3 or 4), this is described reasonably as difficult laryngoscopy, but it may not necessarily be a difficult intubation. Many grade 3 patients have a trachea which may be intubated at a first attempt, even by a comparative novice. Difficult tracheal intubation is much harder to define. It depends on the skill of the individual, so that any survey of its frequency depends greatly on the dexterity of those involved; variable results are inevitable.

By contrast, difficult laryngoscopy, as defined above, should be more objective. The four requirements for gaining the best view are well known: head in the Magill position, good relax-

TABLE V. *Surveys of the incidence of difficult laryngoscopy in routine general surgery*

Source	Grades 3+4	*n*	Incidence	95% confidence limits
Mallampati et al. [1]	28	210	1:8 (13%)	1:5–1:11
Cohen, Laurito and Segil [9]	48	665	1:14 (7%)	1:11–1:19
Present study	42	1387	1:33 (3%)	1:25–1:46
Wilson et al. [8]	12	778	1:65 (1.5%)	1:37–1:126
Bellhouse and Doré [2]	13	3800	1:292 (0.3%)	1:171–1:551

ation, firm forward traction on the laryngoscope and, if necessary, firm backward pressure on the cricoid. All these are easy manoeuvres, so a beginner should obtain the same view as an expert. The novice may take longer, but should obtain the same result, provided s/he follows instructions. It has been suggested that exact positioning of the blade tip is crucial, but watching different anaesthetists raises doubts on this point. Typically, the expert gives the grade within seconds—it is the beginner who takes a long time trying different positions of the blade, usually with no improvement in the view of the larynx.

Thus our original hope was that the laryngoscopy grades would provide a reproducible measure, largely independent of the skill of those involved, but the surveys published so far have conspicuously failed to bear this out (table V).

The difference apparent in table V is too big to be fortuitous—most of the confidence limits do not overlap. Were the populations different? Mallampati and colleagues [1] stated that no patient had significant neck pathology. Bellhouse and Doré [2] described 19 patients in whom laryngoscopy was difficult; six had arthritis of the neck, but they have been excluded from the calculations in table V. Thus there is no reason to think there was any real difference between the populations studied; the difference must lie in the techniques used for laryngoscopy.

Analysis of laryngoscopic techniques

In the Results section it was observed that there were very large differences between the results reported by different anaesthetists, not accounted for by seniority or by type of surgery.

On enquiry, one consultant stated that when he encounters a grade 3 patient, which he knows from past experience has been an easy tracheal intubation, he makes no special effort to see the cords, but intubates blind, using the Macintosh method. This has the benefit of maintaining practice with blind intubation, which otherwise is seldom needed.

Another consultant commented that he normally intubates the trachea without full relaxation, but added that, in emergency cases, he would use suxamethonium to obtain total paralysis and would expect to see fewer grade 3 patients. These two factors account for the unexpectedly high incidence of grade 3 reported by some senior anaesthetists.

A third, new, factor was inadequate traction on the laryngoscope. One patient, rated grade 4 initially, was found to be grade 3 by a second anaesthetist, who intubated the trachea without difficulty. Three similar cases occurred in recent years at this hospital [unpublished observations]. The common factor was that the anaesthetist, although different in each case, was small, with thin wrists, whilst the patient was large and heavy. Those who came to help commented that more than normal traction was needed to see the vocal cords. Once identified, the problem is solved easily; for example, the assistant may be asked to apply additional traction on the handle of the laryngoscope. One reason for inadequate traction is concern about possible trauma. When intubation has required more force than normal, the patient should be seen the next day; it is reassuring to find how rarely any complaint of sore throat is elicited.

A fourth source of variation was technical error. A novice may reach the stage of giving anaesthetics unsupervised without having grasped the fact that a grade 3 view sometimes changes to grade 1 merely on institution of cricoid pressure. Cricoid pressure, applied incorrectly, may make laryngoscopy more difficult. Forward traction on the laryngoscope may be counteracted by backward pressure on the larynx, if applied too high up. In doubtful cases the anaesthetist, while performing the laryngoscopy with his left hand, should apply cricoid pressure with his right hand. Having found that position which gives the best view, the assistant should be asked to press on the same spot. This is advisable even if the assistant is fully trained.

These findings help to explain the discrepancies in the literature, referred to above. Laryngoscopy is the most basic of all anaesthetic techniques, but there seems wide variation in what is taught at

different hospitals. Even at this hospital, which has above average awareness of the problem, there is clearly scope for improvement. Surprisingly, most textbooks do not describe the technique. Of course, it cannot be learnt from a book, but a brief text with drawings can be useful. Moreover, at least four of the texts which do describe laryngoscopy make no mention of cricoid pressure yet, in Wilson's study [8], cricoid pressure reduced the frequency of grade 3 from 9% to 1.5%. This might explain the high rates in the studies by Mallampati and colleagues [1] and Cohen, Laurito and Segil [9] (table V).

The true incidence of grade 3

Our interest in the frequency of grade 3 arose, in the first place, because of its crucial importance in emergency anaesthesia. Suboptimal laryngoscopy may not be important in routine surgery, because accidental oesophageal intubation should have no serious consequences in that context, but the emergency patient is different, as oesophageal intubation nullifies cricoid pressure and there may be regurgitation into the pharynx. The only way to guarantee tracheal intubation is to watch the tip of the introducer enter the trachea, which necessitates exposing the cords. Clearly, an anaesthetist who fails to see the cords only once in 292 patients [2] is in a better position than one to whom this happens once in eight patients [1].

Our original estimate [3] of grade 3 frequency was 1 in 2000—providing that care was taken to obtain the best possible view of the cords. This was, as stated, a "guesstimate" and may be too low but, equally, the surveys published (table V) are likely to give too high a frequency because of the factors discussed above.

One survey [2] seems to have obviated some of these reservations. One anaesthetist with a particular interest in obtaining an optimum view of the larynx, who kept a record of all intubations (3800) over a 7-yr period had an incidence of grade 3 of 1:292. There are several ways in which a false high incidence can arise, but it is not easy to see how a false low one can occur, so this, the lowest figure, is perhaps the best estimate.

Clinical relevance—training for obstetric anaesthesia

Our original study [3] was concerned mainly with training; from that standpoint, the precise incidence of grade 3 cases is not important because, even if the figure were as high as 3%, it is clear that many trainees would have little or no experience of difficult intubation by the time they begin to undertake emergency cases. This is particularly evident when the Poisson effect [10] is taken into account: if the average rate were 3%, then 5% of beginners ($e^{-3} \times 100$) would see none in their first 100 intubations. It follows that a training method is needed which uses simulated difficult intubations. It seems worth stressing this point, because a recent editorial on obstetric anaesthesia [18] discussed antacid therapy at some length, but made no mention of difficult intubation. Similarly, other authorities have stated that there should be at least one consultant session per week in the maternity theatre for teaching purposes. A simple calculation shows that this teaching session would expect to see only about one difficult laryngoscopy per year, even in the busiest maternity unit, so clearly that suggestion does not solve the problem either.

Simulating difficult laryngoscopy is not justifiable in the maternity theatre; it has to be undertaken in the general theatres, on patients who are not at risk from regurgitation. The need for training of this type has been recognized by leading hospitals in the U.K.: the Royal United Hospital, Bath [8], the Royal Postgraduate Medical School [11] and the University Hospital, Cardiff [12]. The method is also on test in the U.S.A. [13, 14].

Possible hazards of the Macintosh method

Two possible hazards of the Macintosh method have been suggested: perforation of the pyriform fossa, and oesophageal intubation. Surveys [15–17] have shown the main cause of pyriform fossa perforation to be rigid stilettes. The Oxford tube was designed for use with a flexible introducer projecting from the end [Sir Robert Macintosh, personal communication], a point which has been re-emphasized [18]. Nearly 30 years ago, a survey of 18000 tracheal intubations with the Oxford tube [19] found no problems; our experience in the past 14 years supports this. Pyriform fossa perforation may occur even when no introducer is used, mainly in hasty emergency cases [20], but occasionally in routine cases [21]. The modern plastic tube is not so resilient as red rubber, so the risk of perforation is arguably higher during routine intubations than in the Macintosh method. Thus no ethical dilemma arises.

Accidental oesophageal intubation is more likely to occur with any blind method, but this

should represent no risk to the patient. Most theatres are, or should be, equipped with carbon dioxide analysers; where these are not yet available the oesophageal detector device [22] is useful and inexpensive. Failure to diagnose oesophageal intubation, especially in the modern context, implies negligence. We conclude that informed consent is not needed for the simulated difficult intubation drill—a view supported by the Ethics Committee of this hospital.

Clinical relevance—making comparisons

As we have seen, the exact incidence of grade 3 cases is not important in relation to the need for training. However, it is important if the aim is to compare the frequency of difficult intubation in different situations. For example, it would be of value to know how often grade 3 cases occur in obstetrics compared with general surgery. Such studies would need to eliminate the sources of error noted above. It would help if each assessor acted as his own control, performing equal numbers of laryngoscopies in both fields. Such a trial could not be double-blind, which would be a serious weakness if the assessments were subjective—but, with the provisos noted above, laryngoscopy grading should be reasonably objective.

Clinical relevance—obstetrics

Two surveys [23,24] have reported a failed intubation rate in obstetric anaesthesia of about 1 in 300. The second of these studies, by Samsoon and Young, also found that failed intubation was much more rare in general surgery (1 in 2200) than in obstetrics. Our prospective study, with no failures in 1387 cases, confirms their retrospective findings. Pooling the obstetric data [23,24] gives 15 failed intubations in a total of 4380, which differs appreciably from 0 in 1387 ($P = 0.04$).

It has been suggested that pregnancy, by its effect on breast size, oedema of the pharyngeal tissues, etc., is the cause of the high failure rate. These changes certainly occur, but are they sufficient to make the difference between success and failure? At least one maternity unit has achieved results as good as those in general surgery. In the decade 1970–80, at the National Maternity and Mater Misericordiae Hospitals in Dublin, a total of 3800 general anaesthetics were given; there were only two failed intubations [J. McCarthy, personal communication]. Thus the Dublin maternity results are similar to those of Samsoon and Young for general surgery.

In the Dublin survey, all the anaesthetics were given by consultants and there seems no doubt that experience is a key factor. That was the main conclusion of our original study [3]. It has been suggested that a senior anaesthetist should be present for induction in all obstetric cases. This problem is analysed in more detail in a forthcoming review.

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