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DEFINING A STANDARD INTUBATING POSITION USING "ANGLE FINDER"

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SUMMARY

Study of patients who exhibit only limited morphological abnormality yet present difficulty with direct laryngoscopy is facilitated by a standard intubating position. The "Angle Finder" instrument allows implementation of a simple reproducible geometric standard which is applied easily in formal research work and in clinical practice and teaching. The proposed standard relates to the curved (Macintosh) laryngoscope blade and a supine patient. The lower neck flexion is 35° and extension of the plane of the face 15°, each angle measured relative to horizontal. Initially, the standard was derived from a review of the literature, then validated in a study of the intubating practices of 10 senior anaesthetists. A more detailed study of 10 normal volunteers confirmed reproducibility and, for nine patients with a history of difficult direct laryngoscopy, the standard was shown to be appropriate.

It has been estimated that the incidence of difficult laryngoscopy is approximately 1 in 2000 [1]. Because it is uncommon, studies of relevant factors have involved only small numbers of patients [2–4]. Comparison between such studies is limited by the absence of an agreed standard intubating position. It would be unexpected for any one position to be appropriate for the variety of conditions that may be encountered. In practice, however, attention is directed normally to patients in whom there is either limited deformity or no abnormality at routine preoperative assessment.

The aim of this study was to determine a research standard suitable for such circumstances. The proposed standard evolved from the traditional notion of flexion of the neck and extension of the head and from relatively recent work by Alexopoulos and colleagues [5]. Their study suggested that the lower neck (from the level of the cricoid plate to 40 mm below this) was relatively stable during flexion/extension movements of the head. It seemed possible, therefore, that a standardized position might require definition of just the angles of flexion of the lower neck and extension of the head. The "Angle Finder" instrument facilitates easy alignment by this means.

PATIENTS AND METHODS

Angle Finder instrument

This simple general purpose instrument is shown in figure 1. It consists of an "L-square" section which moves along a metallic ruler. Housed in the body of the L-square is a circular dial around which an eccentrically weighted pointer rotates freely. The pointer responds to gravity, while the dial is fixed and rotates with the ruler. When the ruler is horizontal the pointer reads zero degrees. To ensure free movement of the pointer, the instrument should be kept in a vertical plane.

Proposed standard intubating position

For a curved (Macintosh) laryngoscope blade with the patient supine, the lower neck is flexed 35° relative to horizontal and the plane of the face extended 15° similarly (fig. 2).

Neck flexion is related to the anterior surface of the trachea, from the level of the cricoid cartilage down to the sternal notch. In thin individuals in

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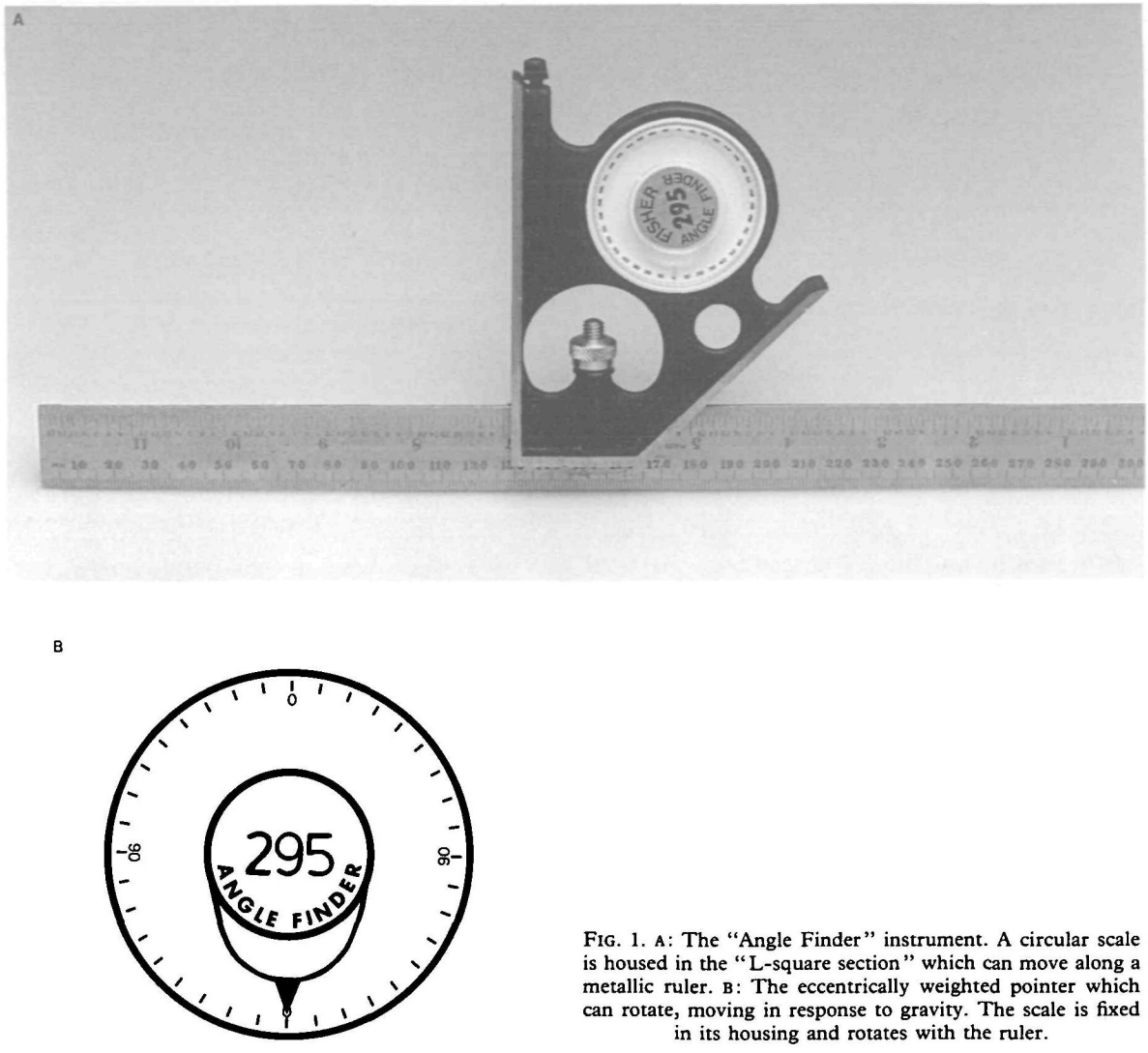

FIG. 1. A: The "Angle Finder" instrument. A circular scale is housed in the "L-square section" which can move along a metallic ruler. B: The eccentrically weighted pointer which can rotate, moving in response to gravity. The scale is fixed in its housing and rotates with the ruler.

whom the trachea is obviously superficial, aligning the Angle Finder with it is easy. When the sternomastoids are prominent or neck swellings, obesity or short neck make this alignment difficult, the instrument is lined up with the cricoid cartilage above and the depth of the sternal notch below.

Head extension is defined relative to the plane in which the supraorbital, infraorbital and mental foramina lie. Normally, these foramina are aligned in both frontal and lateral aspects [6]. In certain conditions where difficult intubation occurs (e.g. receding mandible), alignment fails. Appropriate allowances (which were not required in any subjects in the present study) are facilitated by drawing the landmarks. When the mouth is opened the mental foramen loses alignment, so it is ignored when measuring extension at laryngoscopy (fig. 3).

Observed intubation study

Ten senior anaesthetists (two senior registrars and eight consultants) were observed during 10 laryngoscopies in the course of their normal clinical practice. In all but one, competitive neuromuscular blocking drugs were used. After induction and before intubation the initial neck flexion and face-plane extension were measured as

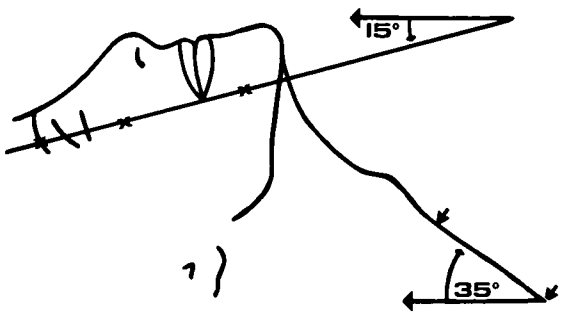

FIG. 2. The standard intubating position (SIP). The supra-orbital, infraorbital and mental foramina are labelled x and shown to be in line at an angle of 15° of declination. The line of neck flexion is defined by two points: the upper is the cricoid and the lower is level with the lowermost depth palpable in the sternal notch.

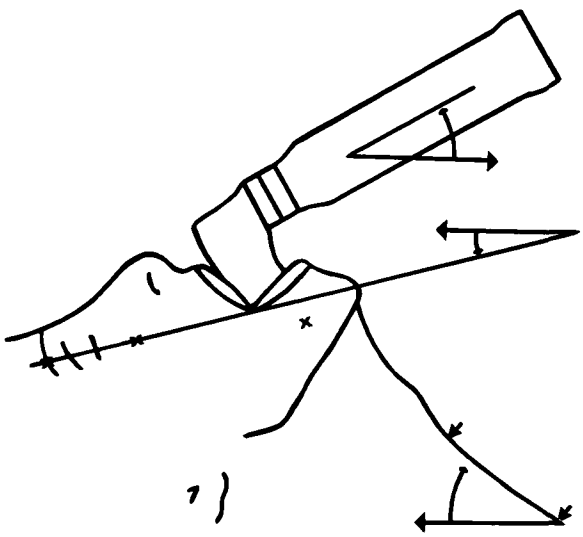

FIG. 3. Angles measured at intubation. The neck flexion is equivalent to the SIP situation. The line of the face-plane is similar, but note that because the mouth is open the mental foramen is now irrelevant. The angle of the laryngoscope handle is the elevation from horizontal.

for the standard position (fig. 2). When laryngoscopy was effected and the tracheal tube about to be passed, the anaesthetist paused momentarily to allow the initial measurements to be repeated and the angle of the laryngoscope handle was noted also (fig. 3).

Reproducibility and relevance to difficult intubation

Because the disposition of the upper neck is not defined by the proposed standard, 10 young adults (five male; mean age 32 (SD 6) yr) acted as controls to determine reproducibility. In each subject direct laryngoscopy was known not to be difficult. The test used was simply to alter the height of a rigid base on which the head rested and make repeated observations to determine the range of base height over which the standard position could be achieved.

Relevance to subjects difficult to intubate was assessed by examining nine patients (six male; mean age 53 (18) yr) in whom difficulty with intubation had been documented during anaesthesia in the preceding 12-month period. None of these anaesthetics was associated with pregnancy. In addition to determining whether or not the standard position could be achieved, overall head and neck flexion/extension movements as used in routine preoperative assessment [7] were measured using the Angle Finder.

RESULTS

In the observed intubations, study angles were measured to the nearest 5° increment (0, 5, 10 *etc.*), relative to 0° horizontal. Angles of face-plane extension were denoted negative when the face sloped upwards rostrally. The overall measurements before and at intubation for neck flexion are shown in figure 4 and those for face-plane extension in figure 5. In each subject the peak value increased at intubation and the distribution became more Normal. Differences between the two sets of values were attributable to the initial laryngoscope blade placement rather than any subsequent manipulations to improve on the view obtained. At intubation the overall mode value for flexion was 35° (in 42/100) and for face-plane extension 20° (in 28/100). The 35° neck flexion was also the individual mode for 7/10 anaesthetists.

All but three measurements of laryngoscope handle angle were in the range 20–50°, the mode value was 30° and the mean 35.5 (9.2)°. The neck and face-plane angles at intubation and handle angles were subjected to correlation coefficient analysis. No correlation was shown for neck flexion and the angle of the handle ($P > 0.1$). A significant relationship was found for neck flexion and face-plane extension ($P < 0.01$) and a highly significant relationship occurred between the angle of the handle and face-plane extension ($P < 0.001$). The linear equation derived for this latter relationship was:

$$(\text{angle of face extension})^\circ = 0.30 \times (\text{angle of handle})^\circ + 9.7.$$

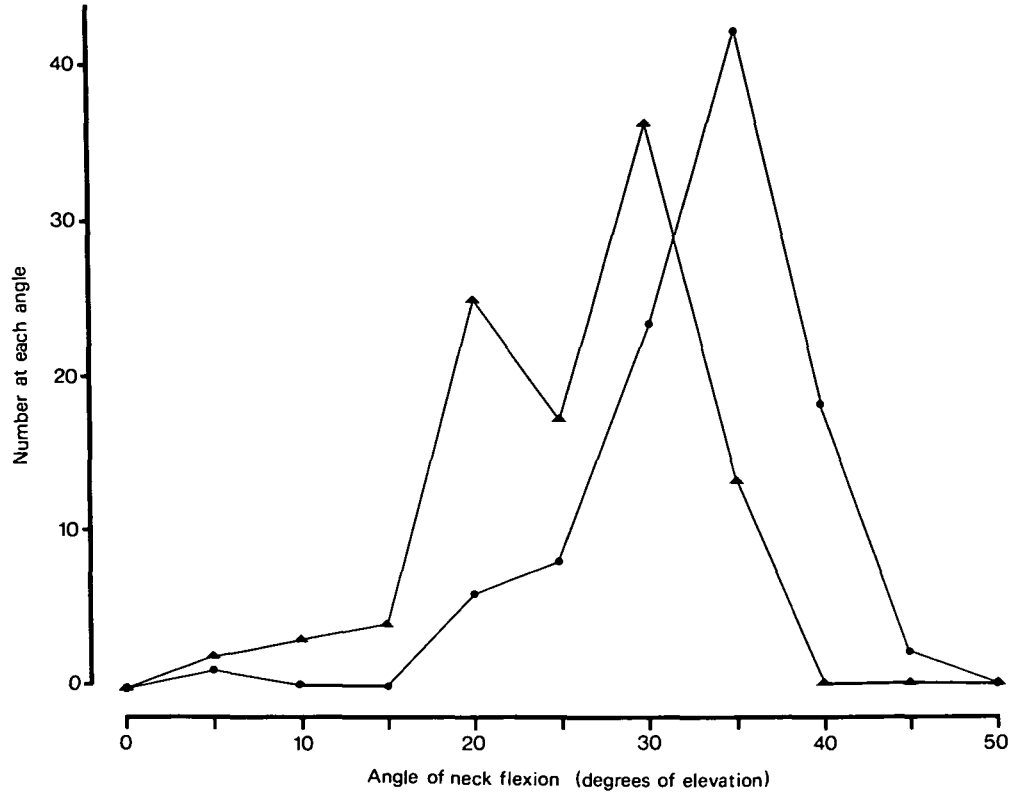

FIG. 4. The frequency of each angle of neck flexion (degrees of elevation from zero horizontal) before laryngoscopy (▲) and at the moment of full glottic exposure (●).

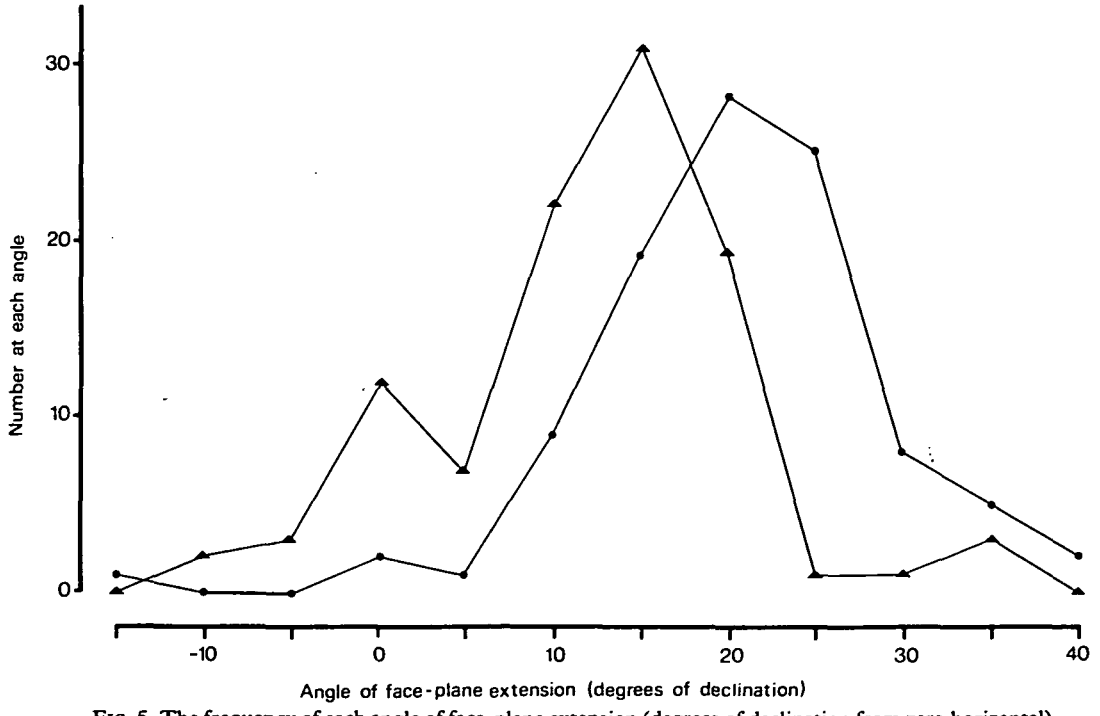

FIG. 5. The frequency of each angle of face-plane extension (degrees of declination from zero horizontal) before laryngoscopy (▲) and at the moment of full glottic exposure (●).

TABLE I. *Reproducibility of standard intubating position (SIP) in control subjects*

Subject No.	Overall head and neck movements (°)			Difficulty positioning in SIP	Height range of head base for SIP (mm)		
	Flexion	Extension	Range		Min.	Max.	Range
1	60	70	130	No	53	58	5
2	70	70	140	No	44	50	6
3	70	85	155	No	31	37	6
4	55	75	130	No	56	60	4
5	65	100	165	No	64	67	3
6	60	70	130	No	64	71	7
7	65	65	130	Yes	—	—	—
8	65	85	150	Yes	—	—	—
9	55	85	140	No	46	51	5
10	60	90	150	No	62	67	5
Mean	62.5	79.5	142	—	52.5	57.6	5.1
n	10	10	10	—	8	8	8

TABLE II. *Standard intubating position (SIP) and neck movements—difficult intubation patients.* ***P < 0.001 *compared with control subjects*

Patient No.	Overall neck movements (°)			Difficulty positioning in SIP
	Flexion	Extension	Range	
1	50	60	110	Yes
2	55	30	85	Yes
3	45	50	95	Yes
4	45	45	90	No
5	40	65	105	No
6	45	65	110	No
7	50	60	110	No
8	50	50	100	Yes
9	45	50	95	No
Mean	47.2***	52.8***	100***	—

Provided that face-plane extension was taken as 15° to the nearest 5°, all controls (table I) and patients (table II) could be placed in the standard position. At 35° of neck flexion, certain individuals in both groups could not manage the full 15° extension, but in each subject the extension achieved was nearer 15° than 10°. This limitation was evident in 4/9 of the subjects in whom laryngoscopy was difficult and in 2/10 controls.

In the eight control subjects in whom the full position was achieved, the inclusive range of base height under the head for which the position was possible is shown in table I. The inclusive range of base height was never greater than 8 mm (measurements were to the nearest 1 mm). The overall range for base height was 31–71 mm and the mean mid-range value was 55 mm. Overall neck flexion/extension measurements are also recorded in tables I and II. With one exception, all were within the range usually quoted: 90–165° [8].

DISCUSSION

The case for a standard intubating position in the investigation of patients presenting difficult direct laryngoscopy with no gross morphological abnormality should be considered self evident. While many studies [2, 3, 9] have promoted indices of abnormality derived from radiographs, certain of these measurements, such as "atlanto–occipital gap", vary with posture [10].

The present investigation began with a detailed analysis of the relevant literature to derive angles for neck flexion and face-plane extension (table III). Surprisingly few reference works had illustrations of actual laryngoscopy and diagrams or photographs of suggested postures were common. As the present study shows, laryngoscopy itself alters positioning, even when considered placement has preceded it. Early references often had gross anatomical inaccuracies and so were excluded as, in general, were citations of previous work. The literature review suggested 35° for neck flexion, but the angle of face-plane extension was less obvious—15° was a compromise. While it was felt that a modest extension was common practice, it was also considered important not to define a standard that excluded too many of the relevant cases.

In the observed intubation study, the anaesthetists were not aware of the details of the proposed standard. The prevalence (42/100) of

TABLE III. *Analysis of relevant literature*

Source	Year	Material	Posture only or actual laryngoscopy	Blade type	Angles Neck/Face (°)	Original author comment
Jackson [11]	1913	Photograph	Laryngoscopy	Laryngeal speculum	20/55	Patient intolerant of bad positioning (local anaesthesia).
Jackson, Jackson [12]	1934	Diagram	Posture	Laryngeal speculum	35/35	Neck not naturally horizontal when emerging from thorax.
Gillespie [13]	1941	Diagram	Posture	Straight	40/−5	Head raised >10 cm above table.
Bannister, Macbeth [14]	1944	X-rays	Laryngoscopy	Straight	40/0	Two pillows for neck flexion.
Boulton, Cole [15]	1966	Diagram	Posture	Curved	35/25	Pillow should be removed.
Cullen, Larson [16]	1974	Diagram	Posture	Curved and straight	25/0	Too much head extension pushes larynx anteriorly.
Thornton [17]	1974	Photograph	Posture	Curved	35/25	Additional extension of neck when blade in mouth.
Applebaum [18]	1976	Photograph + xeroradiograph	Laryngoscopy	Curved	35/20	Extreme head flexion or extension does not help.
Murrin [19]	1985	Photograph	Posture	Curved	35/0	Pillow flexes lower cervical spine. Extension via finger on upper teeth.
Present study	1988	(Patients)	Laryngoscopy	Curved	35/15	Idealized posture and practice not necessarily the same.

the 35° neck flexion at laryngoscopy was a useful confirmation of the literature-derived value. Extension showed a wider "spread" and a peak at 20°. The more exaggerated extension manoeuvres which certain authors have advocated [17, 20, 21] were not evident.

The anticipated limitation of extension in the subjects of known difficult laryngoscopy was observed. In effect, four of these nine subjects came within the definition of the standard only by taking the extension angle to the nearest 5°. A similar limitation in two of 10 control subjects was unexpected. This difference was not significant. (Subsequent work has confirmed this limitation occurs in 21 % of normal individuals, so of itself it would not predict the difficult subject.)

It could be argued that an extension of 10° might have been a better choice. However, in only 13 of the 100 observed intubations was extension 10° or less and literature citations of such limited extension are not as frequent as table III might imply. Even the photograph referred to in Murrin's work has accompanying diagrams with 30–35° of extension. A recent radiological investigation [22] also confirmed the importance of extending the atlanto–occipital joint for adult intubation. The 15° extension is, therefore, suggested to be an optimal compromise.

Forty-five degrees has been suggested as an appropriate angle of elevation for the laryngoscope handle [18, 23]. In this study the commonest angles were 30° (27/100) and 35° (24/100). Our linear regression equation shows that, as the angle of elevation of the handle decreases (towards 14°), so the face-plane becomes more nearly parallel to it. (The handle effectively draws the face-plane into line behind it.) Leverage forces on the upper incisors would be expected to be less the more nearly parallel these are, so an angle of 30° would be an advantage over the previous recommendation.

Reproducibility was evident clinically and in the study. The control subjects were chosen because they were relatively young and neck mobility would be expected to decrease with age. Certain of the controls had long thin necks and it was important to ensure the lower neck remained straight, to avoid an excessive range of possible positioning. When compared with neck length measurements, the range of head base height was equivalent to an accuracy of less than $\pm 1°$ in the neck flexion angles. Radiologically, cervical spine movements can have complex normal variations, particularly in younger patients [24, 25]. More exact reproducibility would seem unlikely, even if a larger number of parameters was used in an alternatively defined standard.

The overall flexion and extension angles shown

in tables I and II are measured rapidly using the Angle Finder and it can be used for routine preoperative assessment. The mean values for flexion and extension were less in the patient group than in the control subjects ($P < 0.001$ in each case, by Student's t test), but the groups were not matched for age and this could explain the difference. Nevertheless, it is suggested that these results are of interest and warrant further investigation.

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The authors have no financial interest in the Angle Finder instrument. It is made for general engineering use, but for widespread use in operating theatres the company has agreed that it can be made washable and have its sharp corners modified. The instrument reference number is 295 and the manufacturer's address is: Fisher Instruments, Pysons Industrial Estate, Broadstairs, Kent, England.

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