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Myelinated axon counts of human inferior alveolar nerves

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INTRODUCTION

Previous quantitative studies of inferior alveolar nerves have been undertaken on animal models (Thomas, 1946; Mohiuddin, 1951; Honma, 1959; Murphy & Thomson, 1966; Kizior, Cuozzo & Bowman, 1968; DeLange, Hannam & Matthews, 1969; Sakurada, 1973; Biedenbach & Brown, 1977; Holland, 1978). Studies carried out on human material have reported only single specimen analyses (Murphy & Grundy, 1969; Rood, 1978). Considerable variation has been reported in myelinated fibre counts of nerves, both from within and between studies of identical species (Mohiuddin, 1951; Kizior *et al.* 1968; Murphy & Grundy, 1969; Rood, 1978). The aim of this study was to analyse quantitatively myelinated fibre counts from a series of human inferior alveolar nerves and to observe any trends or correlation in the counts with age, weight or number of mandibular teeth of the subjects. It was also intended to observe with the light microscope variations in the fascicular arrangement of the nerve at the mandibular foramen.

MATERIALS AND METHODS

Specimens of inferior alveolar nerve, approximately 1 cm long, were removed within 48 hours of death from 36 human subjects, none of whom had suffered from either central or peripheral nerve disease during life. Each specimen was dissected from the level of the mandibular foramen, fixed for 24 hours in 1 % neutral buffered formalin and postfixed and stained with 10 % osmium tetroxide for 6 days. Transverse tissue sections were prepared for light microscopy using routine histological procedures. Under the light microscope, the number and arrangement of the nerve fascicles were noted. Using a Conference microscope at a projection of ×500, a view of each nerve was projected on to a screen and a suitable fascicle was selected for counting. The number of myelinated axons within the fascicle was recorded using a pen marker and hand counter. The total myelinated fibre count (TMFC) for each nerve was evaluated using the equation:

$$\text{TMFC} = \frac{\text{Area of nerve}}{\text{Area of fascicle}} \times \begin{array}{c}\text{Number of fibres in}\\ \text{counting fascicle.}\end{array}$$

The areas of both the counting fascicle and total nerve section were measured with a Videoplan digital analyser unit. The subjects' age, sex, number of teeth on the side of the mandible from which the nerve was dissected, height and body weight were recorded. The latter two measurements were used to calculate the Quetelet

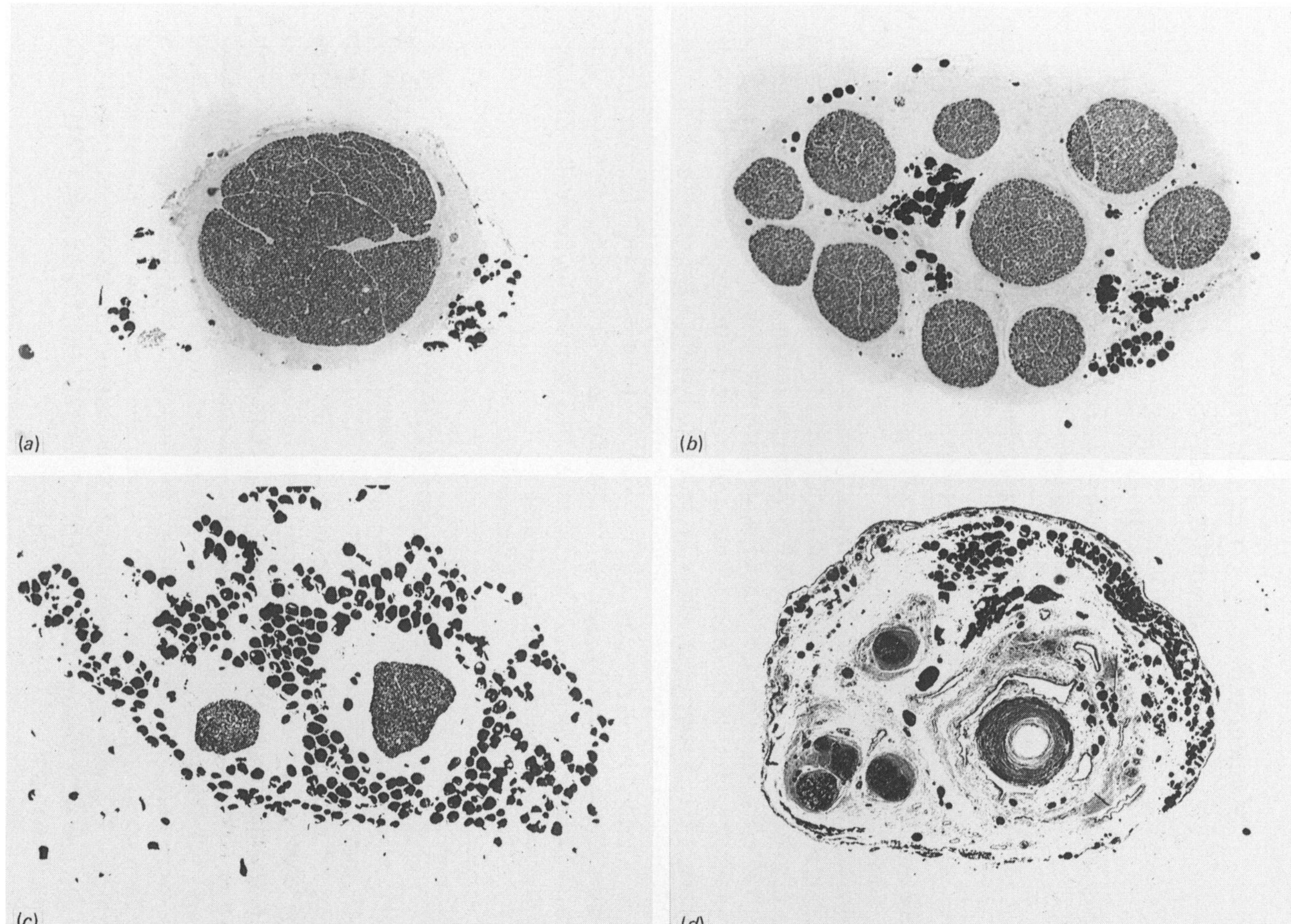


Fig. 1 (*a*–*d*). Variation in the structure of the inferior alveolar nerve bundle at the level of the mandibular foramen. (*a*) Single fascicle. ×40. (*b*) Nerve bundle of 10 fascicles. ×40. (*c*) Section of nerve from a 97 years old edentulous subject showing an abundance of perineural fat. ×40. (*d*) TMFC of 1307 from nerve of 66 years old edentulous subject. ×40.

Table 1. *Means, standard deviations and ranges of ages, weights and TMFC of inferior alveolar nerves from* 36 *human subjects*

	Mean	S.D.	Range
Age (years)	62·20	23·89	12–97
Weight (kg)	58·57	10·56	35–80
TMFC	15424	2931	1307–21220

Table 2. *Correlation coefficients* (*r*) *between age, weight and TMFC for dentate and edentulous subjects*

	Age (years)		Weight (kg)	
v. TMFC	Dentate	Edentulous	Dentate	Edentulous
r	+0·502	−0·162	+0·616	+0·676
Significance	$P > 0{\cdot}05$	$P > 0{\cdot}1$	$P > 0{\cdot}05$	$P < 0{\cdot}001$

Table 3. *Mean* (±S.D.) *TMFC of male and female groups matched for age and weight*

	Subjects	Mean age	Mean weight	Mean TMFC±S.D.
Males	10	71·6	60·6	*15290±2810
Females	10	72·8	57·6	*13942±1833

* $P > 0{\cdot}1$, Student's *t*-test.

Table 4. *TMFC: variation with number of mandibular teeth*

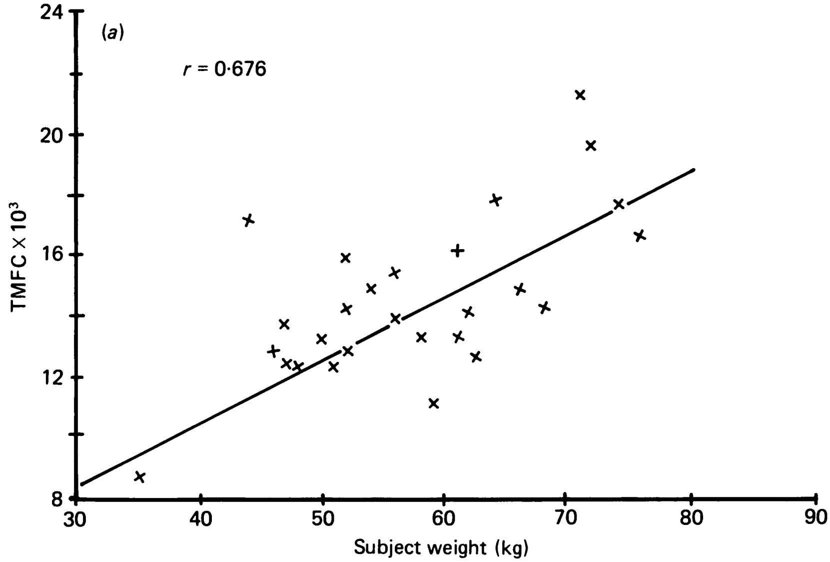
	Subjects	Mean age	Mean weight	Mean TMFC±S.D.
Dentate	9	28·8	62·4	*18154±1467
Edentulous	9	75·2	62·0	*14591±1696

* $P < 0{\cdot}001$, Student's *t*-test.

Body Mass Index (Bray, 1979) for each subject, which was then used to modify any observed weight which was excessive for the observed height recording.

RESULTS

The means, standard deviations and range values for the ages and weights of subjects and the TMFC of the inferior alveolar nerves are given in Table 1. There was an even distribution of TMFC in the range 8645–21220, apart from one specimen (Fig. 1*d*) with a TMFC of 1307 which was significantly lower than other readings. There was great variation between subjects in the fascicular arrangement of axons at the level of the mandibular foramen (Fig. 1). Pearson's correlation cceﬃcients and P values between TMFC and the ages and weights of subjects (dentate and edentulous) are shown in Table 2. A significantly positive correlation was found between weights and TMFC for edentulous subjects ($r = 0{\cdot}676$, $P < 0{\cdot}001$; Fig. 2*a*). A positive correlation of similar magnitude ($r = 0{\cdot}616$) was seen between weights



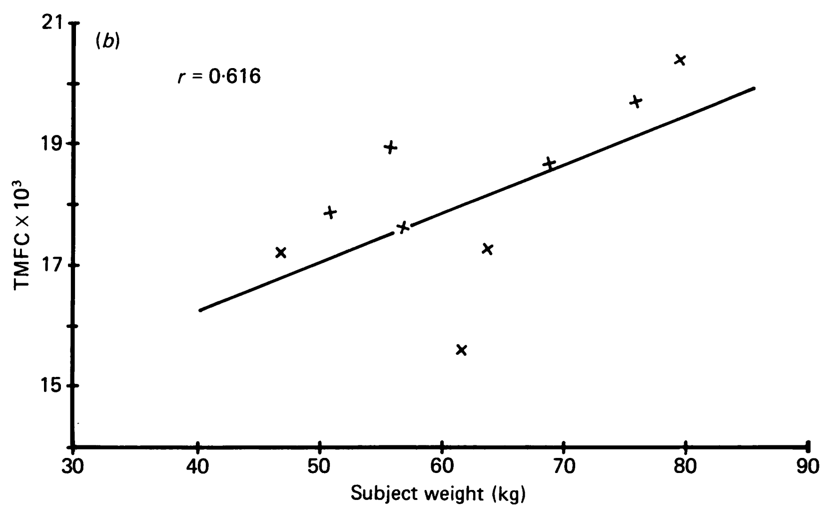


Fig. 2(*a–b*). (*a*) Graph of TMFC v. body weights of edentulous subjects. (*b*) Graph of TMFC v. body weights of dentate subjects.

and TMFC of dentate subjects (Fig. 2*b*) but this was not significant ($P > 0{\cdot}05$). No correlation was found between TMFC of inferior alveolar nerves and the ages of subjects in either dentate or edentulous groups (Table 2). From the edentulous group, 10 males and 10 females were matched for age and weight and the mean TMFC for each subgroup calculated. No significant difference was found between the TMFC in males and females (Table 3). Similarly, a subgroup of 9 dentate subjects was weight-matched with a group of 9 edentulous subjects. The mean TMFC for the edentulous group was 14591 and for the dentate group 18154 (Table 4). These means were significantly different ($P < 0{\cdot}001$).

DISCUSSION

The number of fascicles identified in each nerve trunk showed considerable variation between subjects ranging from a single bundle (Fig. 1*a*) to 10 fascicles (Fig. 1*b*). Murphy & Thomson (1966) showed that the number of fascicles in the sheep inferior alveolar nerve depends upon the level from which the section is taken and the result of the present study shows that the number of fascicles varies between subjects, even when sections are taken from approximately the same level. The inferior alveolar nerve of one subject, aged 97 years, showed large quantities of perineural fat and a TMFC of 13677 (Fig. 1*c*). It is possible that a degree of axonal atrophy had occurred with age, the fibres being replaced by connective tissue prior to lipid infiltration (Cottrell, 1940). The inferior alveolar nerve with a TMFC of 1307 (Fig. 1*d*) was taken from an edentulous, 66 years old male subject and no explanation could be found for such an anomalous count with respect to other nerves in the series.

Overall, considerable variation was noted in the TMFC from nerves in the series. An attempt was therefore made to relate this variation in TMFC to any of the variable parameters between subjects, notably age, sex, weight and the number of ipsilateral mandibular teeth. Subjects were divided into dentate and edentulous groups so that any correlation between TMFC and age or body weight would not be offset by possible atrophy of myelinated axons occurring with mandibular tooth loss (Rood, 1978). No correlation is found between age of subjects and TMFC. The correlation ($r = 0{\cdot}676$) between TMFC and edentulous subject weight could be explained on the basis that skeletally heavier subjects would have correspondingly larger jaws, teeth and supporting structures which would necessitate a proportionately greater innervation. Previous studies tend to confirm this suggestion. Mohiuddin (1951) gave a mean TMFC of 5051 from an inferior alveolar nerve series in 32 cats. Honma (1959) reported a mean TMFC of 10554 in a study of dog inferior alveolar nerves and Murphy & Thomson (1966) studied a sheep inferior alveolar nerve and found a TMFC of 13151 axons. A further contribution to this variation, however, may be the discrepancy in the number of mandibular teeth found between these animals (cat, 14; dog, 22; sheep, 20). In the present study, the correlation between TMFC and weights of dentate subjects ($r = 0{\cdot}624$) is not significant ($P > 0{\cdot}05$) due, perhaps, to the small size of the group.

Age and weight-matched groups of 10 males and 10 females show no significant difference in TMFC for inferior alveolar nerves. The difference between mean TMFC in the nerves of dentate and edentulous groups is significant ($P < 0{\cdot}001$) and suggests axonal atrophy in the main nerve trunk following tooth loss. This result corroborates a suggestion made by Rood (1978) who found a TMFC of 15513 in an inferior alveolar nerve from a 40 years old dentate male and compared the result to that of a previous study (Murphy & Grundy, 1969) where a TMFC of 9506 was found in an inferior alveolar nerve taken from an elderly edentulous male.

SUMMARY

A quantitative, postmortem study of 36 human inferior alveolar nerves is described. The total myelinated fibre count (TMFC) of nerves was not related to sex or age of the subjects but significant positive correlations were found between TMFC and subject body weight in both dentate ($r = 0{\cdot}616$) and edentulous ($r = 0{\cdot}676$) groups.

The TMFC was significantly lower in nerves from edentulous subjects than in nerves from dentate subjects.

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