DOI: 10.2478/aoj-1991-0006

Reliability of eruption rate measurements of the rat incisor

Aart A. R. Taverne B.D.Sc.(Qld), Spec.DMO., DDentMed.(Utr.)*
Brisbane, Australia

ABSTRACT: The reliability of the easy method to measure rat tooth eruption proposed by Schour and Van Dyke has frequently been challenged. To assess its true trustworthiness an experiment was set up using three different groups of rats and two different methods for eruption assessment. One group was used for 'control'. The second group received a potent lathyrogen, while the third group was used as pair-fed+ for the second group. Measurements were made clinically and radiographically. Comparison between the three groups led to the conclusion that the much easier and less expensive method, using the clinical manual measuring method is reliable and may be used in future calculations of eruption rate of rat incisors. It furthermore provides an excellent method to assess the lathyrogenic condition of these animals.

Reference: Aust.Orthod.J.12(1):33-36

MeSH words: tooth eruption
Key words: eruption rate, rat incisors, radiographic evaluation

INTRODUCTION

Tooth movement may be associated with eruption, chewing and traumatic or orthodontic displacement. Eruption and chewing seem to give rise to physiologically accepted forces.

Whereas chewing forces will not normally result in large or permanent displacement of a tooth, eruption does cause a translocation of the tooth. Traumatic forces, so called because they will notably cause some form of undesirable displacement to occur, may be classified as pathological. Whether orthodontic tooth displacement is pathological is a matter for discussion. All these forces have one thing in common, that is that a specific force acts on the tooth resulting in movement of the tooth. In some cases there is eventual permanent displacement, in other cases there is only transient movement.

In the literature a lot of research has been done using the rat as the experimental animal. Especially many experiments on the periodontal ligament (PDL) have involved the rat incisor. The rat has continually erupting incisors and is therefore a good model to study. Even after all those years of intense research the question still remains: how is it possible that a tooth moves in relation to the alveolar bone without getting dislodged from its socket? In order to explore this field any further, wider knowledge must be obtained of what is normal. Measuring the eruption rate of the incisor is an integrate part of expanding this knowledge. Is there an accurate clinical method for measuring the eruption rate?

Various methods have been described in the past. To measure eruption rate, MacGillavry (1875) made markings on the labial surfaces of rat incisors and measured the distances between the applied groove and the incisal edge at certain intervals. However, unknowingly MacGillavry did not measure eruption rate but attrition rate. Many years later Schour and Van Dyke (1931) also tried to establish the true eruption rate. They grooved the labial surface of the tooth, and measured the distance between that point and the most apical position of the labial tooth gingiva. After a period of time this distance would increase. The difference between the two measurements would be the eruption for that particular period of time.

However the reliability of this method has been questioned as one of the measuring points is on the gingival margin. How reliable is the gingiva as a fixed point? For this reason various variations on this particular method have been devised to eliminate the gingival point.

Bryer (1957) published a method in which he shortened one of two adjacent incisors. He then applied grooves to the shortened tooth and the adjacent normal tooth. However, this form of measurement actually measured the unimpeded rate, certainly not the impeded eruption rate. A totally different way of establishing the eruption rate was devised by Ness (1964) and Main and Adam (1965). They placed small amalgam implants into the incisor teeth. Then by the use of cephalometric radiographs, measurements were taken between these filling and the supracrestal alveolar ridge. The problem with this method is the reliability of the highest point of the supracrestal ridge. According to Slootweg (1976) it seemed to change slightly with a higher eruption rate. Yet these methods did give results which were close to the results obtained using the method published by Schour and Van Dyke (1931).

Thomas (1976) described a variation of the method by Ness (1964). He also used amalgam implants in the incisors, but fixed the other point by positioning stainless steel implants in the skull and the lower jaw, rather than using anatomical landmarks. He made his measurements also on radiographs.

Matthews and Berkovitz (1972) developed a method using a variable capacitance displacement

*Senior Lecturer, Department of Orthodontics, Faculty of Dentistry, University of Queensland Dental School, Turbot Street, Brisbane.

+This meant that every experimental procedure on the experimental animal was repeated exactly on its corresponding pair-fed animal, except that the latter did not receive the chemical substance which was given to the experimental animal. The pair-fed animal did however receive the same amount of food ingested by the experimental animal, this being checked each day.

transducer, to register eruption rate with very short time intervals or even continually. Chiba et al. (1973) in principle used the method by Schour and Van Dyke (1931) but performed their measurements on photographs made of the labial aspect of the tooth every 2 hours.

We chose to investigate the reliability of the method published by Schour and Van Dyke (1931) because of its simplicity. The least reliable of the two points they used seems to be the gingival 'point'. Checking its stability by experimental means is necessary for future experiments.

MATERIALS AND METHODS

Obtained from a pure colony (Stock Cpb:WU) virgin female Wistar rats were used. They had an average weight of 180 (+12) grams and were approximately 12 weeks old at the start of the experiments. During the experimental period, gain in weight was checked every week. In addition, the food intake was monitored for each animal every day. They were fed on Muracon 10 mm pellets, milled into a powder form. The experiment involved three groups. There was a control group (group 1,n=6). Another group (group 2, n=6) received the lathyrogen AAN, as it was shown extensively in the literature that it changed the rate of eruption (e.g. Levene, 1973). In this experiment pair-fed animals (group 3, n=6) were also used, this eliminated all factors besides those changes, which were entirely due to the experiment itself.

Whenever only eruption rate was measured, animals were anaesthetised by ether. For longer anaesthesia a subcutaneous injection containing 0.7 ml hypnorm and 0.7 ml stesolite, and an intra-peritoneal injection with 0.5 ml atropine sulphas was administered. Data were analysed by Student's t-test and P-values of <0.05 were accepted as statistically significant (two-tailed).

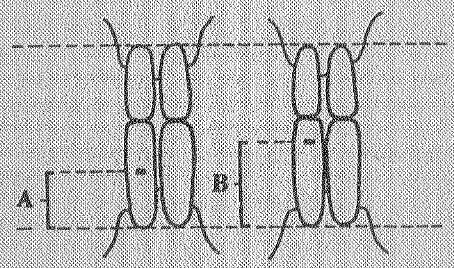
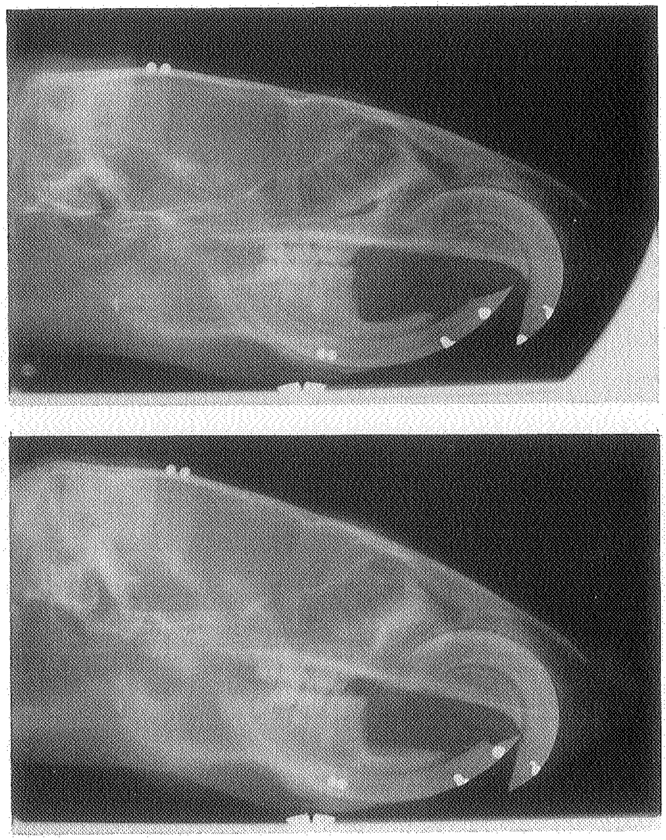


Figure 1. Method using labial grove on tooth surface and gingival point. The height A is subtracted from height B, the resultant is the distance the tooth has erupted in time T, where T is the interval between taking measurement A and B.

Experiment: In three groups of rats, 6 animals per group, amalgam implants (about 0.3 mm in diam.) were placed in the buccal surface of one upper and lower tooth, being positioned in such a way that maximum eruption could take place without the loss of the implants. Stainless-steel implants (0.2 mm diam.) were positioned in the skull in the parietal bone just adjacent to the midline, and in the lower jaw along the body of the mandible at the level of the first right molar. The stainless-steel implants were always in pairs, approximately 1 mm. apart as any alteration in distance between them, during a certain time interval, would mean that some dislodgment had taken place during that time interval and therefore all further readings would be unreliable. A standard cephalogram (75kV, focal object 30 cm, $1^1/_2$ sec exposure) was made during weekly intervals



Figures 2(a) and 2(b). Radiographs depicting the locations of stainless steel implants in the skull and in the lower jaw. Notice the relocations of the amalgam implants after one week interval e.g. the 'round' amalgam implant has moved more incisally within the period. This is also true for the other amalgam implant in the upper incisor tooth. After the second reading has been taken, new amalgam implants, now more gingivally were placed.

(*Figures 2(a)* and *(b)*). Clinically the distance between the amalgam implant and gingival margin at the most apical 'point' was measured, using slide-calipers (Schour and Van Dyke,1931).

From the direct measurement, readings in tenths of a millimetre were obtained (*Figure 1*). This was done for both incisors, once every week, coinciding with the taking of the cephalogram. From these weekly readings, the eruption rate per week per group could be calculated. If required, new amalgam implants were placed.

From every cephalogram, using a standard magnification of 4x, a tracing was made (*Figure 3*). The tracings were than superimposed using the stainless-steel implants and certain stable anatomical structures – the outline of the skull, the lower mandibular border. This made it possible to measure the distance moved by the amalgam implants in the erupting tooth during the period between taking the two consecutive cephalograms.

As one group of animals (n=6) received 0.25 AAN/g body wt per day by way of stomach probe, the other group was regarded as the 'control' group while the third group being the pair-fed group for the AAN group received physiological salt solution instead of AAN by way of stomach probe, also had implants and was measured similarly.

RESULTS

Tables for the results of measuring eruption in lower incisors are shown. Similar table for upper incisors could

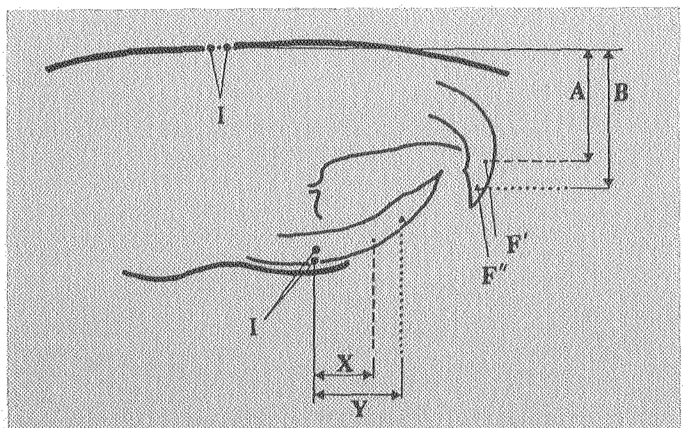


Figure 3. Superimposed tracing allowing the evaluation of tooth movement during a particular time interval. I: stainless-steel implants. F' is position of filling at point when time interval T commences and F'' is position of filling after time interval T has passed where T is the interval between taking measurement F' and F''. By constructing perpendicular lines, from the amalgam implants, the distance A and B as well as X and Y were measured. Distance erupted in units (E_U = distance of eruption of upper incisor; E_I = distance of eruption of lower incisor) during interval time T.

for upper incisor $E_U = \dfrac{B - A}{T}$

for lower incisors $E_I = \dfrac{Y - X}{T}$

be produced. However as the eruption curvature for the upper incisor is more convex, a slightly higher but probably still insignificant error in measurement could occur. All results are expressed in percentages, so as to allow and correct for enlargement of the cephalograms. When assuming that the initial eruption rate of lower incisors is 100%, results are produced showing the relative percentage in eruption and comparing the two different methods (1. slide-calipers 2. standardised radiographs).

In order to interpret these results correctly the 'radiograph' readings must be compared to the 'slide-caliper' readings and between and within the groups. To do this the reader is referred to *Tables 1,2,3,4*.

Table 1. Showing the relative percentage in eruption of the same lower incisors (control group) using two different methods.

	% of slide-callipers	% radiography	time interval
	100	100	100
*	120.3 (0.8)	116.8 (1.9)	after 1 week
**	126.8 (2.0)	123.8 (2.9)	after 2 weeks
**	115.7 (2.2)	117.3 (1.4)	after 3 weeks

Initial eruption of lower incisors in control animals is 100% (n=6)
* Significant difference (p<0.001) between the two reading after 1 week
** No significant different (P.0.05) between the two readings after 2, 3 weeks

Table 2. showing the relative percentage in eruption of the lower incisors (pair-fed groups) using the slide-callipers method.

% of slide-callipers	% radiography	time interval
100	not done	at 0 week
100 (0.1)	not done	after 1 week
117.8 (0.1)	not done	after 2 weeks
112.3 (0.9)	not done	after 3 weeks

Initial eruption of lower incisors of pair-fed animals is 100% (n=6)

Table 3. Showing the relative percentage in eruption of the same lower incisors (AAN group) using two different methods.

% of slide-callipers	% radiographs	time interval
100	100	at 0 weeks
77.2 (0.9)	81.2 (1.2)	after 1 week
59.2 (0.1)	44.7 (1.1)	after 2 weeks
25.5 (0.5)	19.5 (1.1)	after 3 weeks

Initial eruption of lower incisors of animals receiving 0.25mg AAN/g body wt. per day is 100% (n=6)

Table 4. Comparison between two measuring methods after 2 weeks.

Group	Measurement	Group	Measurement	Significance
control	S	control	R	not significant
control	S	pair-fed	S	p < 0.01
control	S	AAN	S	p < 0.001
control	R	AAN	R	p < 0.001
AAN	S	AAN	R	not significant

S = slide callipers method R = radiographic method
see table 1 and 3

DISCUSSION

A significant decrease in eruption rate was recorded after the administration of AAN regardless of the method for measurement used. From the tables it is obvious that the eruption rate, whereby the increase in eruption is expressed as a relative percentage to the average value found for the control in the first week, is greatly influenced by the administration of AAN.

There was some difference in eruption rate between the control and the pair-fed group, when using the method of Schour and Van Dyke. Although this difference may be expressed in terms of significance, when compared to the AAN group, it once again shows how 'significance' only means that this difference due to chance alone is very small, but does not necessarily mean that it has any *true* relevancy. It was also noted that the eruption rate was slightly lower in pair-fed animals than in the control animals. This could possibly be explained by the fact that changes in food intake may influence the mechanical properties of PDL, as Moxham and Berkovitz (1984) found in rabbit PDL. The more food the animal eats the more occlusal activity is required and this in turn causes attrition of the incisors. The attrition will shorten the clinical incisor length. Eruption will be necessary to compensate for this shortening. Therefore one may possibly postulate: less food intake - less eruption.

Because impeded eruption rate may therefore be related to attritional behaviour (and food texture), any change in eruption rate produced experimentally may reflect a change in masticatory behaviour rather than an actual change in the eruptive mechanism.

CONCLUSION

As there was no great difference in results between the two methods of measurement, the less time consuming method using the slide-calipers is advocated to be used in experiments involving measuring eruption rate of the rat incisor. It is sufficiently reliable to obtain accurate results for both control and experimental groups.

REFERENCES

BRYER,L.W. (1957)
An experimental evaluation of the physiology of tooth eruption
Int. Dent. J. 7,432-478

CHIBA,M., TSURUTA,M. and ETO,K. (1973)
A photographic method of measuring eruption rates of rat mandibular incisors Arch. Oral Biol. 18,1003-1010
MacGILLAVRY,J.H. (1875)
Les dens incisives du Mu decumanus.
Arch. Neerl. Sc. exact. et nat., Haarlem
MAIN,J.H.P. and ADAMS,D. (1965)
Measurement of the rate of eruption of the rat incisor
Archs. Oral Biol. 10,999-1008
MATTHEWS,B. and BERKOVITZ,B.K.B. (1972)
Continuous recording of tooth eruption in the rabbit.
Archs. Oral Biol. 17,817-820
MOXHAM,B.J. and BERKOVITZ,B.K.B. (1984)
The mobility of the lathyritic rabbit mandibular incisor in response to axially-directed extrusive loads
Archs. Oral Biol. 29,773-778
NESS,A.R. (1964)
Movement and forces in tooth eruption. In: 'Advances in oral biology' Vol.1, P.H. Staple (ed), pp 33-75
London, Academic Press
SCHOUR,I. and VAN DYKE,H.B. (1931)
Histologic changes in the rat incisor following hypophysectomy
J. Dent. Res. 11,873-875
SLOOTWEG,R.N. (1976)
Veranderingen van collageen en niet-collagene eiwitten in het wortelvlies bij versnelling van de eruptie.
Thesis, Rijks Universiteit Utrecht
THOMAS,N.R. (1976)
Collagen as the generator of tooth eruption. In: 'The eruption and occlusion of teeth' (Colston Papers No 27), D.F.G. Poole and M.V. Stack (eds.) pp 290-309.
London, Butterworths

Correspondence to:
Dr A.A.R. Taverne
Department of Orthodontics
Faculty of Dentistry
University of Queensland Dental School
Turbot Street
BRISBANE
Queensland 4000.