Lower Third Molar Development In Relation To Skeletal Maturity and Chronological Age

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A statistical evaluation finding a positive correlation between third molar development and skeletal maturation.

The development of lower third molar anlage has been described in a great number of reports (Garn *et al* 1959, Moorrees *et al* 1963, Koski 1963, Gravely 1965, Haatja 1965, Weise & Bruntsch 1965, Rantanen 1967, Johansson 1971). In these and most other studies on tooth development, the dental development was related to chronological age.

Many regard skeletal maturation in the individual subject to be a better reference base than age (Tanner 1963, Taranger 1967, Karlberg and Taranger 1976). In some studies (Lamons & Gray 1958, Hotz *et al* 1959, Lauterstein 1961, Green 1961, Krogman 1967), the development of tooth anlage has been related to skeletal maturation as judged by the mineralization of epiphyses in the hand.

None of those studies included the development of third molar anlage, but they did show a correlation between the development of other tooth anlage and skeletal maturation. Björk (1972) showed that the pattern of jaw growth is much more strongly correlated with skeletal age than with chronological age.

This suggests that some of the great variability found in previous studies on third molar development might be due to the fact that the development was related to chronological rather than skeletal age.

This uncertainty regarding third molar development creates clinical problems in several branches of dentistry. For example, it is of value to know when the presence of a third molar can be expected and when this tooth may have reached the optimal stage of development for transplantation. Furthermore, since retarded third molar development is associated with its impaction (Björk *et al*, 1956), knowledge of its development in relation to skeletal maturation could be of value for evaluation of this possibility in orthodontic treatment planning.

In forensic investigations the chronological as well as maturational stage of an individual, living or deceased, is often determined by assessing the development of teeth (Gustafsson, 1966). This method is at present restricted to teeth other than the third molars (Gustafsson & Koch, 1974), so the lower third molars have often not been described. The third molar offers a unique advantage over other teeth because its development tends to continue over a longer period and until a later age.

The aim of this study was to investigate the development of the lower third molar anlage in relation to chronological and skeletal age.

Subjects and Methods

Two hundred and twenty-one young individuals, 123 girls and 88 boys, were selected at random from among children referred to the Department of Orthodontics, Faculty of Odontology, University of Göteborg.

The stages of development of the lower third molars were determined from orthopantomograms. Absence of anlage was also noted. The developmental stages of the lower third molar were categorized into one of the following classes (Fig. 1):

A: Tooth germ visible as a rounded radiolucency
B: Cusp mineralization complete
C: Crown formation complete
D: Root half formed
E: Root formation complete, but apex not closed

Longitudinal records of the stages were obtained in 115 subjects, and single records in an additional 106. The total number of registrations was 391—259 from females and 132 from males.

A hand radiograph was also taken in 37 subjects, and their skeletal development classified as follows (Fig. 2):

PP_2: Proximal phalanx of second finger, the epiphysis as wide as the diaphysis
MP_3cap: Middle phalanx of third finger, the epiphysis caps its diaphysis
DP_3u: Distal phalanx of third finger, complete epiphyseal union
Ru: Distal epiphysis of radius, complete epiphyseal union

The relationship between recorded characteristics was evaluated by correlation and linear regression analysis (Bailey, 1973). Differences between males and females were tested with Student's t-test.

Results

The mean ages in months for the different stages of lower third molar development in males and females are

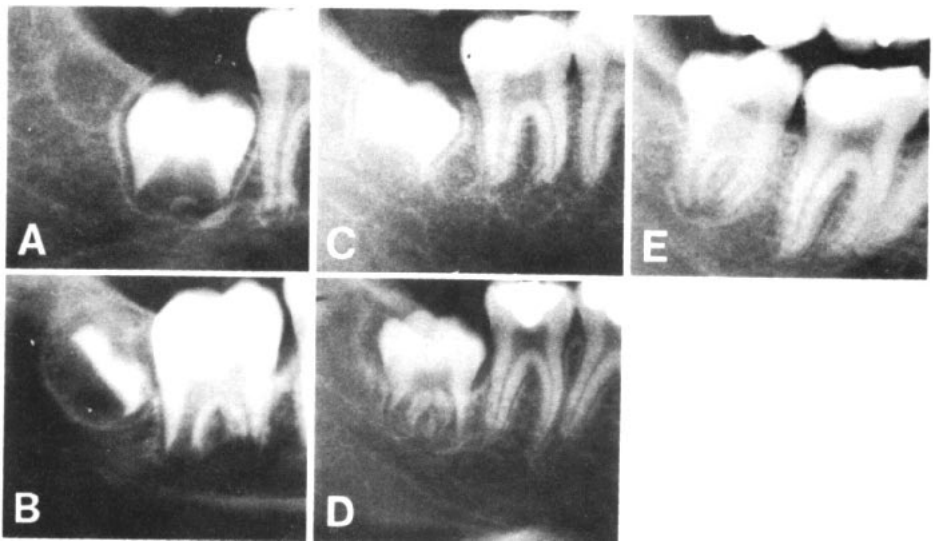

Fig. 1 Developmental stages of the lower third molar.

A Stage 1 Tooth germ visible as a rounded radiolucency
B Stage 2 Cusp mineralization complete
C Stage 3 Crown formation complete
D Stage 4 Root half formed
E Stage 5 Root formation complete, but apex not closed

shown in Table 1. No statistically significant sex difference was found, although the development appeared to be slightly earlier in boys than in girls.

The correlation between chronological age and dental development is shown in Figs. 3 and 4. On the whole, a strong correlation was found between chronological age and lower third molar developmental stage in both sexes (males, $r = 0.85$, $p < .001$; females, $r = 0.77$, $p < .001$).

A strong correlation was also found between chronological age and skeletal maturity ($r = 0.88$, $p < .001$) (Fig. 5) and between lower third molar development and skeletal maturity ($r = 0.72$, $p < .001$) (Fig. 6).

At stage PP_2, the lower third molar showed signs of completed crown mineralization in the majority of the subjects (Fig. 7).

TABLE 1

Age in Months When the Different Development Stages (1-5) of Lower Third Molars Have Been Reached in Males and Females. (x: mean, SD: standard deviation)

	MALE			*FEMALE*		
	n	*x*	*SD*	*n*	*x*	*SD*
STAGE 1...	10	118	1.05	10	119	1.20
STAGE 2...	22	144	1.74	31	140	1.47
STAGE 3...	35	172	1.92	90	175	2.26
STAGE 4...	25	193	1.46	55	197	1.92
STAGE 5...	40	220	1.89	73	216	1.81
TOTAL ...	132			259		

At stage MP_3cap, the lower third molar crown formation was completed in the majority of the subjects, and the root development had begun in some individuals.

At stage DP_3u, the lower third molar crown was still incomplete in some

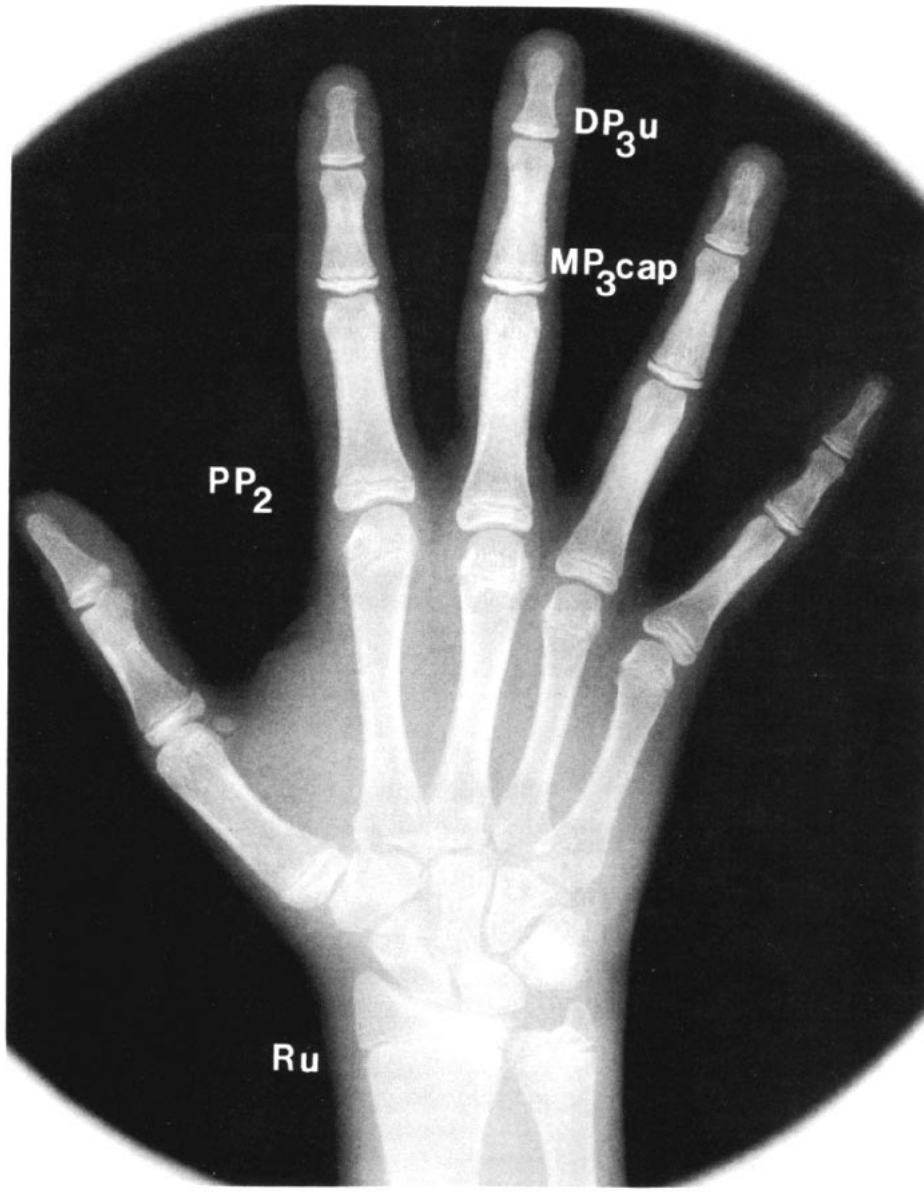

Fig. 2 Radiograph of a hand, showing the ossification centers used for classification of skeletal development.

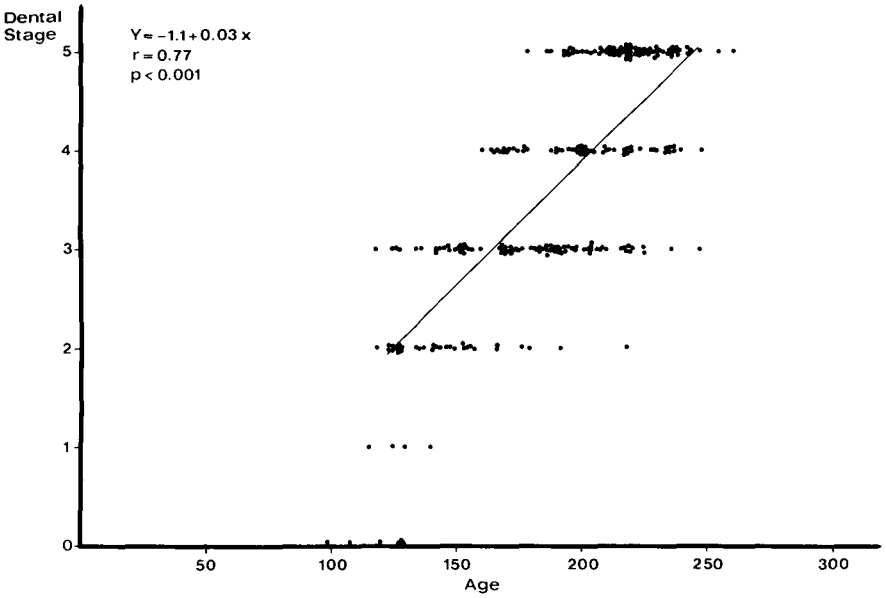

Fig. 3 Scatter diagram showing the relationship between chronological age in months (horizontal axis) and dental stage (vertical axis) in females. The estimated regression line, correlation coefficient (r) and significance level (p) are also shown.

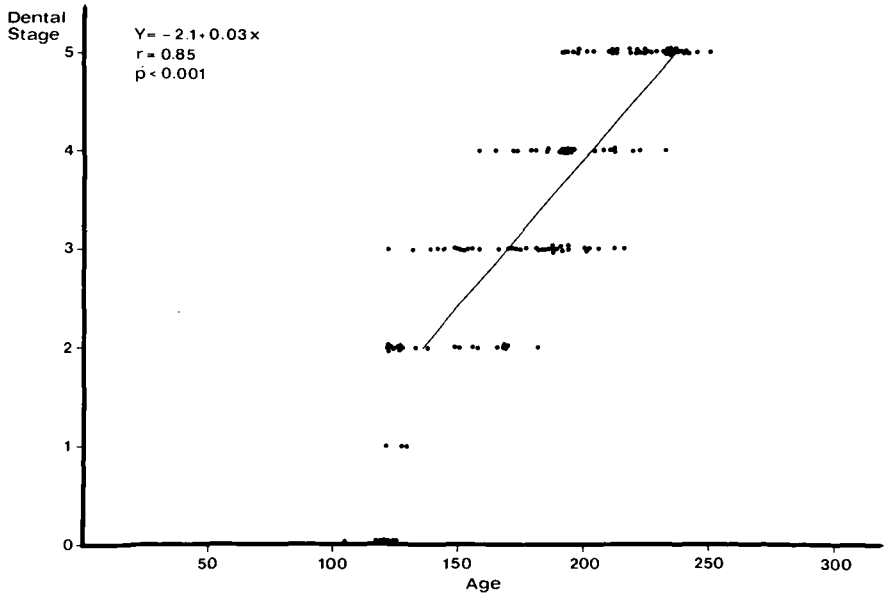

Fig. 4 Scatter diagram showing the relationship between chronological age in months (horizontal axis) and dental stage (vertical axis) in males. The estimated regression line, correlation coefficient (r) and significance level (p) are also shown.

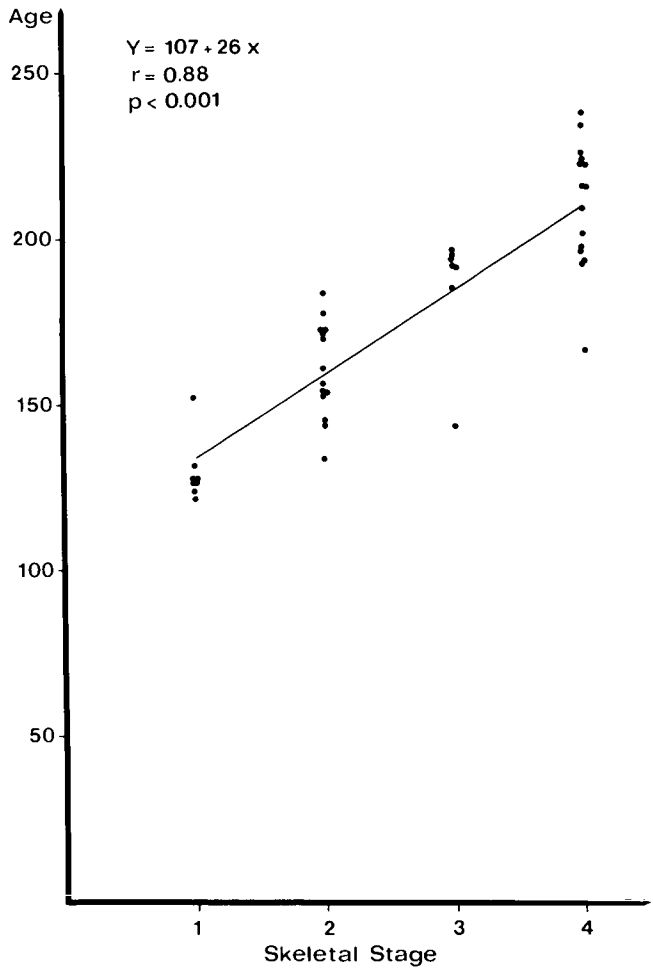

Fig. 5 Scatter diagram showing the relationship between skeletal stage (horizontal axis) and chronological age (vertical axis) in males and females combined. The estimated regression line, correlation coefficient (r) and significance level (p) are also shown.

subjects, but it had already attained full root length in others.

At stage Ru, only the crown was completed in one third of the subjects. Half of the root had developed in one third, and the root had reached full length in another third.

Absence of one or both lower third molars was observed in 11% of the subjects.

Discussion

The young people studied in this investigation appeared to have normal skeletal development. This conclusion is based on the strong correlation between chronological and skeletal stage, which is consistent with previous investigations of this relationship (Demisch & Wartman, 1956,

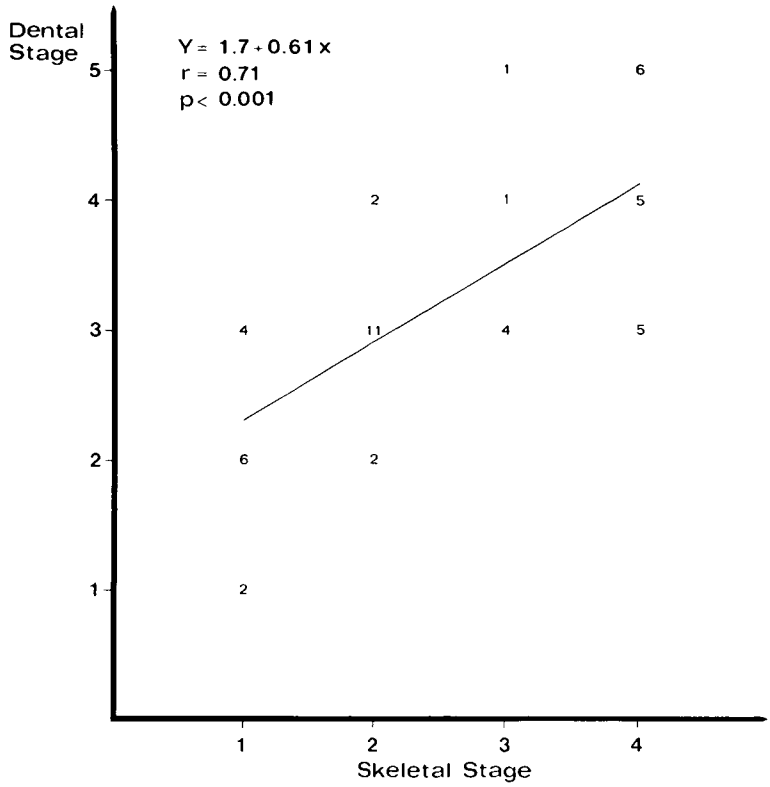

Fig. 6 Scatter diagram showing the relationship between skeletal stage (horizontal axis) and dental stage (vertical axis) in males and females combined. The estimated regression line, correlation coefficient (r) and significance level (p) are also shown.

Lauterstein, 1961, Tanner, 1972, Taranger, 1976).

A large number of dental stages makes it very difficult to discriminate the tooth development. Furthermore, short time intervals between the different dental development stages may adversely affect the possibility of identifying the relationship between tooth development and maturation, as stated by Moorrees *et al* (1963).

In this study, the different tooth developmental stages of the third molars were chosen according to the findings of Björk & Helm (1967) in order to facilitate clear discrimination between the stages. They found that these skeletal stages in the hand provided a good description of the skeletal maturation of an individual, in accordance with the suggestion of Garn *et al* (1967). It could also be assumed that the time between the different dental stages was long enough to span the various skeletal stages and so provide a meaningful comparison.

The lower third molar was found to develop slightly earlier in boys than in girls, although the difference in age at the various lower third molar developmental stages was not statistically significant at the $p < .05$ level. A moder-

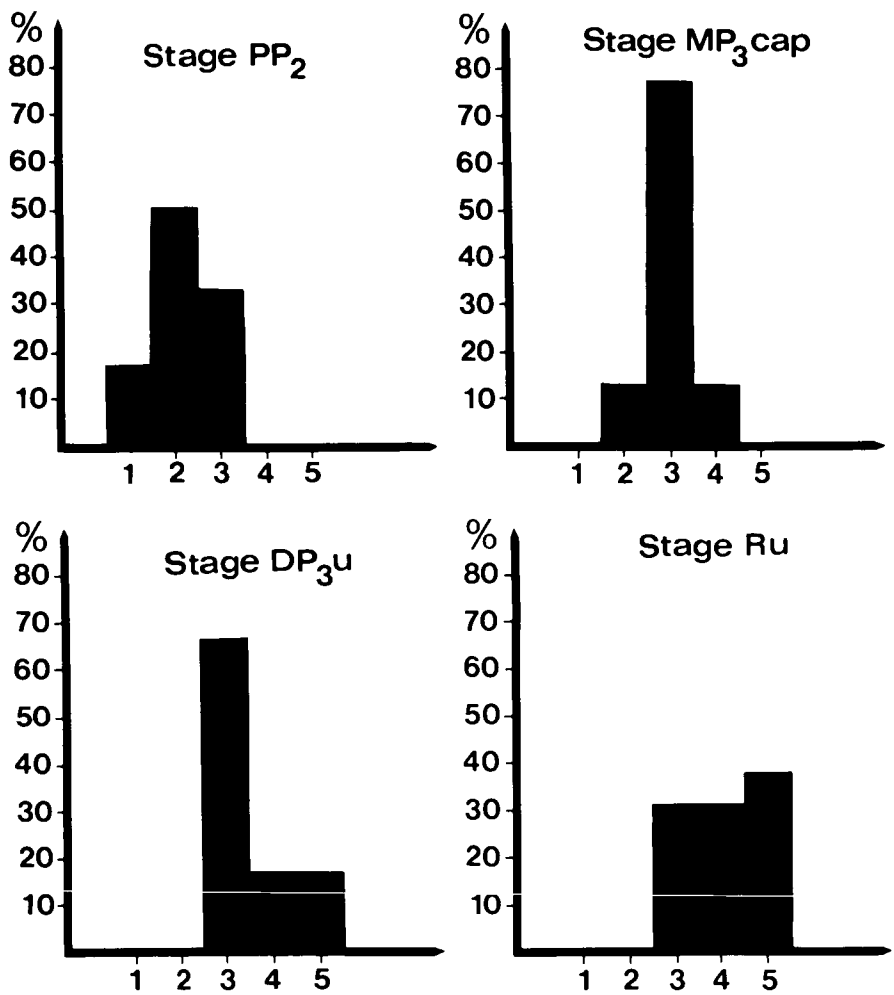

Fig. 7 Distribution of dental stages for males and females combined at each skeletal stage.

ate sex difference was also reported by Moorrees *et al* (1963), Demisch & Wartman (1956) and Garn *et al* (1962).

The mean ages for the lower third molar developmental stages in this study seem to be within the age ranges reported by previous authors (Garn *et al* 1959, Moorrees *et al* 1963, Koski 1963, Gravely 1965, Haatja 1965, Weise & Bruntsch 1965). On the whole, a strong correlation was found between lower third molar development and both skeletal maturation and chronological age. This is consistent with observations that the development of the whole dentition is correlated to skeletal maturation as well as to chronological age (Lamons & Gray 1958, Green 1961, Krogman 1967).

Hotz *et al* (1959) found strong correlations with both skeletal matura-

tion and chronological age for lower first bicuspids and incisors. Lauterstein (1961) found strong correlations between lower first molar development and both skeletal maturation and chronological age.

In contrast to the findings in this study, Garn *et al* (1962) and Lewis & Garn (1960) found low correlations between lower third molar development and skeletal maturation. However, in those studies more stages of lower third molar development were differentiated and related to fewer maturational characteristics (union of the epiphyses in the tibia and hand). Statistical correlations are very sensitive to such scales of measurement.

The strong correlations between lower third molar development and both skeletal maturation and chronological age show a relationship between lower third molar development and skeletal maturation. This observation, as well as the findings of mean ages for different tooth development stages, may be of clinical value.

Since retarded maturation of the lower third molar is significantly associated with its impaction (Björk *et al* 1956), the charts presented in Figs. 3-7 can aid in evaluation of this possibility. On the other hand, the great variation in lower third molar development at each skeletal stage means that use of the charts for evaluation of maturation in an individual, as for determination of age for forensic purposes, must include recognition of the range of this variation.

The prevalence of third molar absence observed in these subjects (11%) is slightly lower than that found by Grahnén (1956) and Gravely (1965) for maxillary and mandibular third molars combined (14-15%).

Summary

The development of lower third molar anlage was investigated longitudinally and related to chronological age and to skeletal maturation stage as judged by the mineralization of epiphyses in the hand. Strong correlations were found between lower third molar development and both skeletal maturation and chronological age. These results indicate that lower third molar development on the whole seems to be correlated with skeletal maturation.

One or two lower third molars were found to be missing in 11% of the subjects.

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