

## Original Article

# Age Estimation Methods Used in Dentistry - A Survey among Dental Students

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## INTRODUCTION

Age estimation is an important factor in biological identification in forensic science. It assists in narrowing the search possibilities for unidentified deceased or living individuals for legal purposes. Teeth are the strongest structures in the human body and are protected by the soft and hard tissues in the oral cavity. Thus, the dental structures are highly resistant to external factors. There are three main types of age. They are physiological age, pathological age, and chronological age. Factors determining physiological age are development of root, apical closure, and comparison with tables. Factors determining pathological age are arthritic changes in temporomandibular joint, attrition of teeth, and root dentin transparency.<sup>[1]</sup> Forensic dentists take into account estimates of a person's pathologic and physiologic age to arrive at an assessment of the most likely chronologic age at the time of death. Dental maturity and tooth development play an important role in estimating chronologic age.<sup>[2]</sup> Methods of age determination for children are as follows: Atlas method, scoring method, Demirjian system, and Nolla's method. Methods for determining adults age Gustafson's method. Other methods are the Gleiser and Hunt method. Another evaluation factor for age estimation is neonatal lines.<sup>[3,4]</sup>

## ABSTRACT

**Introduction:** Age estimation is an important factor in biological identification in forensic science. It assists in narrowing the search possibilities for unidentified deceased or living individuals for legal purposes. Teeth are the strongest structures in the human body and are protected by the soft and hard tissues. Thus, the dental structures are highly resistant to external factors. There are three main types of age. They are physiological age, pathological age, and chronological age. This research is needed to improve the knowledge on age estimation methods used in dentistry. This research also fulfills the deficiency of work on knowledge about age estimation methods.

**Aim:** This study aims to create awareness about the age estimation methods used in dentistry and to make mindfulness about the age estimation methods used in dentistry.

**Materials and Methods:** The method involved in this study was an online survey of questionnaires, which involves assessing the awareness and knowledge on radiographs used in dentistry. Approval from the institutional ethical committee and informed consent from the participants were obtained. The total number of participants was 100. The data collected were exported to Google Sheets and were analyzed by using the software SPSS version 23. The *P* value is 0.00.

**Conclusion:** Among the population, postgraduate students have higher awareness and knowledge than the undergraduate students.

**KEY WORDS:** Age estimation, forensic odontology, forensic radiographs

## ATLAS METHOD

In which radiographic dental development is compared with published standards<sup>[5]</sup> (mineralization)

## SCORING METHOD

Dental development is divided into many stages, which are then assigned scores that are evaluated through statistical analysis.<sup>[6]</sup>

## DEMIRJIAN'S METHOD

Demirjian's method is based on eight developmental stages ranging from crown and root formation to apex closure of the seven left permanent mandibular teeth.

The dental maturity score can be converted into the dental age using available tables.<sup>[7]</sup>

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### NOLLA'S METHOD

Nolla's method of age estimation is the estimation of age by showing the different stages of tooth development.<sup>[8]</sup>

### GUSTAFSON'S INDEX

Gustafson's method is based on morphological and histological changes of the teeth.

Factors determining Gustafson index are as follows:

1. Attrition (A)
2. Apical migration of periodontal ligament (P)
3. Deposition of secondary dentin (S)
4. Cemental opposition (C)
5. Root resorption (R)
6. Transparency of the root dentin (T).

For each of these regressive changes or variables (given above in alphabets), different scores ranging from 0 to 3 were assigned.

#### Attrition

- A0 – No attrition present
- A1 – Attrition is limited to enamel level
- A2 – Attrition is limited to dentin level
- A3 – Attrition up to the pulp cavity.

#### Periodontal disease

- P0 – No obvious periodontal disease seen
- P1 – Beginning of periodontal disease but there is no bone loss
- P2 – Bone loss is more than one-third of the root
- P3 – Bone loss is more than two-third of the root.

#### Secondary dentin

- S0 – No secondary dentin formation
- S1 – Secondary dentin forms till upper part of the pulp cavity
- S2 – Secondary dentin forms till two-third of the pulp cavity
- S3 – Secondary dentin forms to the entire pulp cavity.

#### Root transparency

- T0 – No root transparency
- T1 – Beginning of the root transparency
- T2 – Root transparency is more than one-third of the apical root
- T3 – Root transparency is more than two-third of the apical root.

#### Cementum thickness

- C0 – Normal cementum
- C1 – Thickness of cementum but normal
- C2 – Abnormal thickness of cementum near the apex of root
- C3 – Generalized abnormal thickening of cementum throughout the root apex.

#### Root resorption

- R0 – No resorption
- R1 – Spotted resorption
- R2 – Resorption limited to cementum

- R3 – Extensive resorption in cementum and dentin.

$$An + Sn + Pn + Cn + Rn + Tn = X$$

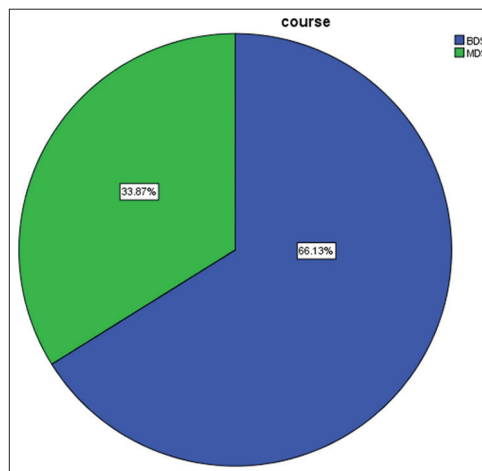


Figure 1: Pie chart representing the course of study

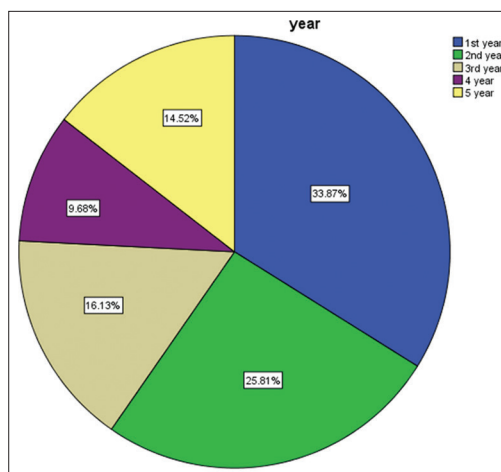


Figure 2: Pie chart showing the year of study

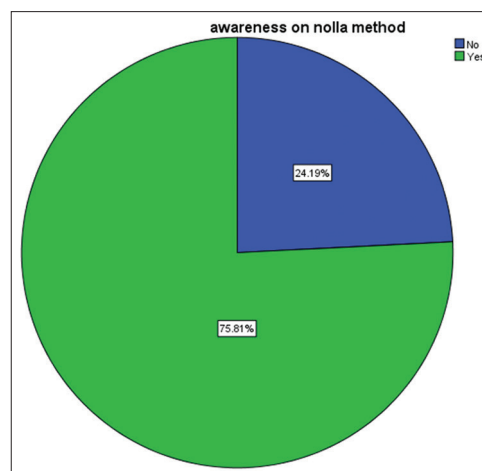


Figure 3: Pie chart representing the awareness on Nolla's method

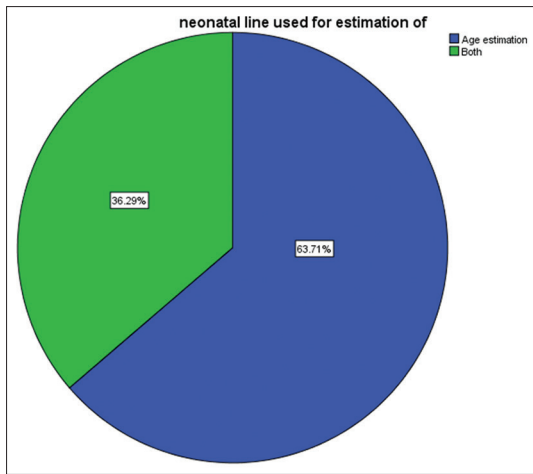


Figure 4: Pie chart representing neonatal line uses

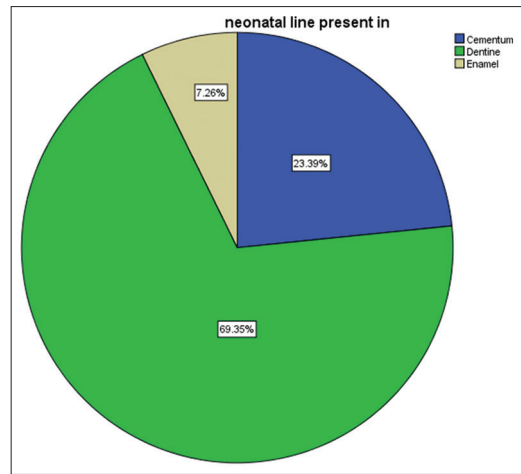


Figure 5: Pie chart representing the area where the neonatal line is present

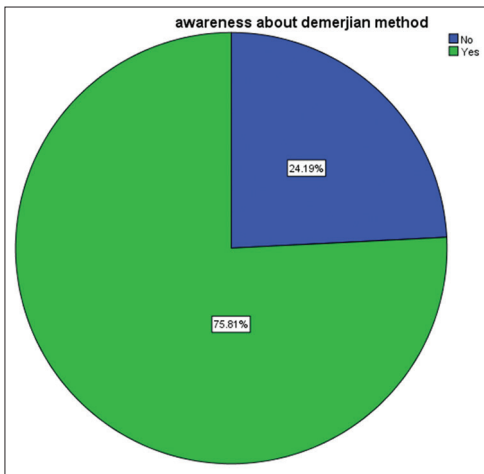


Figure 6: Pie chart representing the awareness on Demirjian method

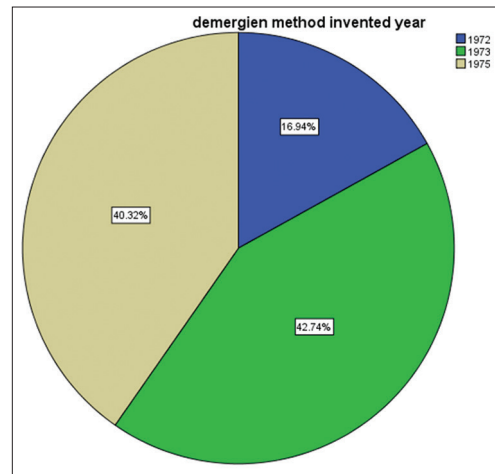


Figure 7: Pie chart representing the year of Demirjian method proposed

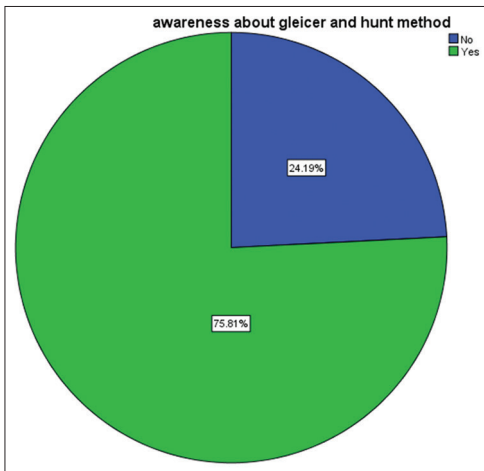


Figure 8: Pie chart representing the awareness on Gleiser and Hunt method

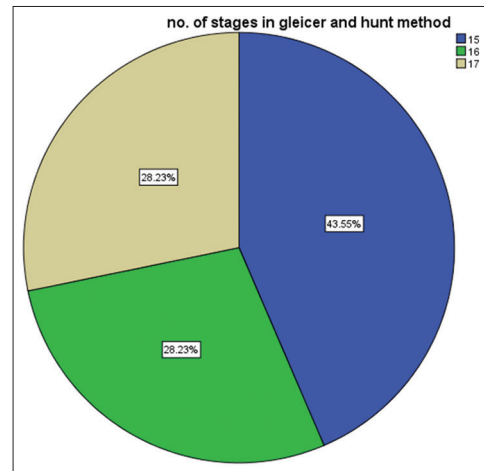


Figure 9: Pie chart representing the stages of Gleiser and Hunt method

Age was estimated using the standard formula. Age =  $(11.43 + 4.56 [X])$  years.

An increase or decrease in the total score would result in an increase or decrease in age, respectively.<sup>[9]</sup>

### GLEISER AND HUNT METHOD

In this method, age estimation is using the developing third molar. The development of the third molar was divided into nine stages. The stages were estimated, and each stage was converted into a developmental score.<sup>[10]</sup> Using this, age is estimated.

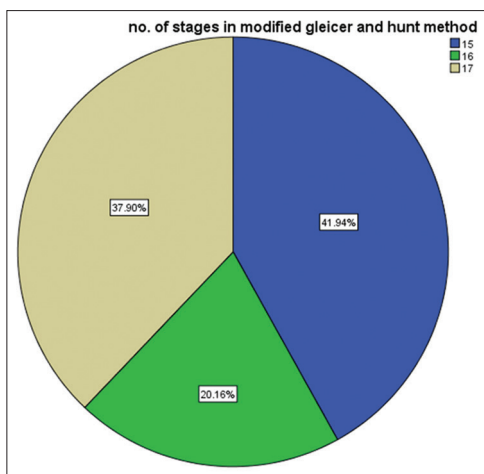


Figure 10: Pie chart representing the stages of modified Gleiser and Hunt method

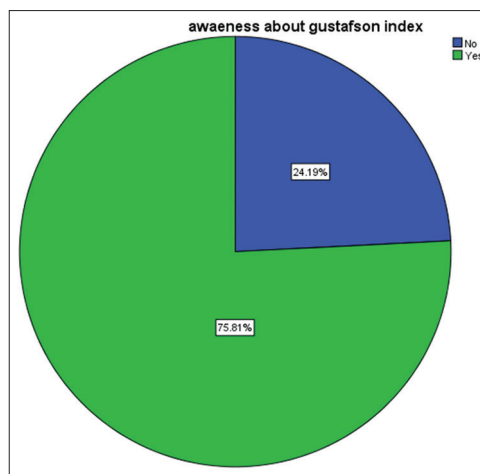


Figure 11: Pie chart representing awareness on Gustafson index

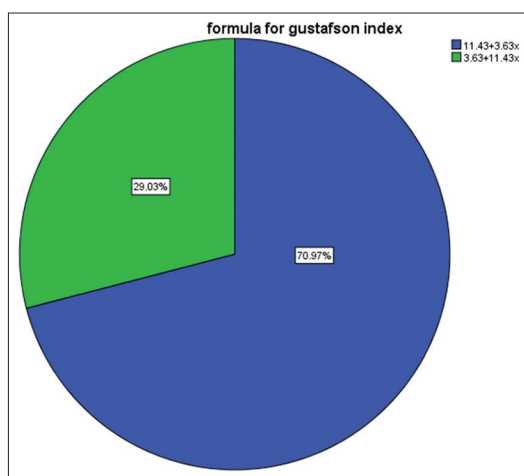


Figure 12: Pie chart representing the formula for Gustafson index

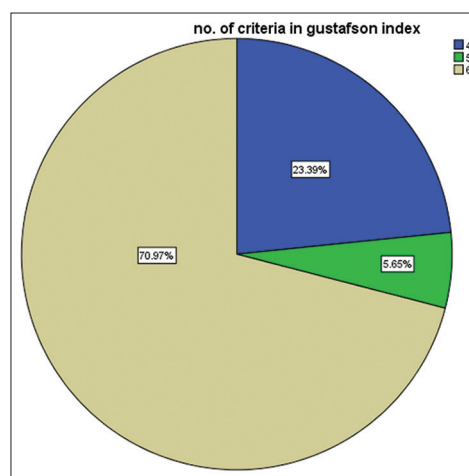


Figure 13: Pie chart representing the number of criteria in Gustafson index

This study aims to create awareness about the age estimation methods used in dentistry and to make mindfulness about the age estimation methods used in dentistry. This research is needed to improve the knowledge on age estimation methods used in dentistry. This research also fulfills the deficiency of work on knowledge about age estimation methods.

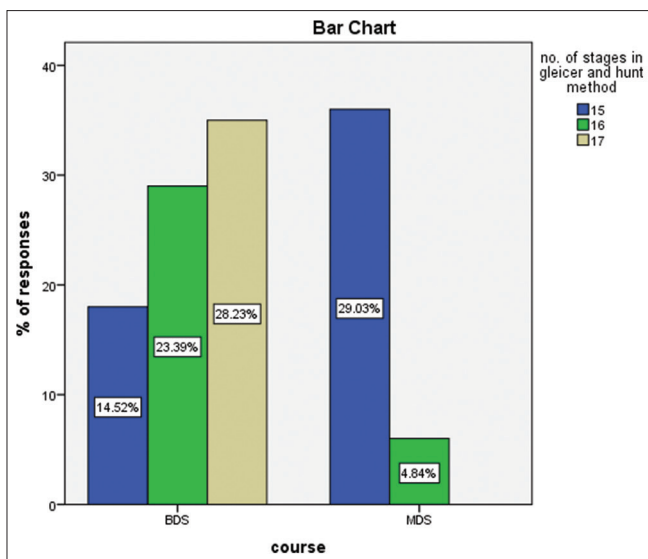
## MATERIALS AND METHODS

The method involved in this study was an online survey of questionnaires, which involves assessing the awareness and knowledge on age estimation methods used in forensic dentistry. The total number of participants was 100. A set of 12 questionnaires were prepared in Google Forms, the link of the same was circulated among the study population, and the data were collected for a duration of 1 month in April 2021. The data collected were exported to Google Excel Sheets and were analyzed by using the software IBM® SPSS® Statistics 23. The data were analyzed and represented by pie charts. The statistical analysis performed in this study was descriptive analysis and Chi-square analysis.

## RESULTS AND DISCUSSION

Among the total population, 66.13% of the students were studying BDS and 33.87% of the students studying MDS [Figure 1]. Among the total population, 33.87% were studying the 1<sup>st</sup> year, 25.81% studying the 2<sup>nd</sup> year, 16.13% of the students studying the 3<sup>rd</sup> year, 9.68% of the students studying the 4<sup>th</sup> year, and 14.52% of the students studying the 5<sup>th</sup> year [Figure 2].

Among the total population, 75.81% were aware of Nolla's method and 24.19% of the population not aware [Figure 3]. Among the total population, 63.71% of the population answered that neonatal line is used for age estimation and 36.29% of the population answered that the neonatal line is used for both age and sex determinations [Figure 4]. Among the total population, 69.35% answered that neonatal lines are present in dentin, 23.39% answered that it is present in cementum, and 7.26% of the population answered that it is present in enamel [Figure 5]. Among the total population, 71.81% were aware of the Demirjian method and 42.74% of the population aware that the Demirjian method was proposed in the year 1973 and 40.32% of the population responded that the Demirjian method



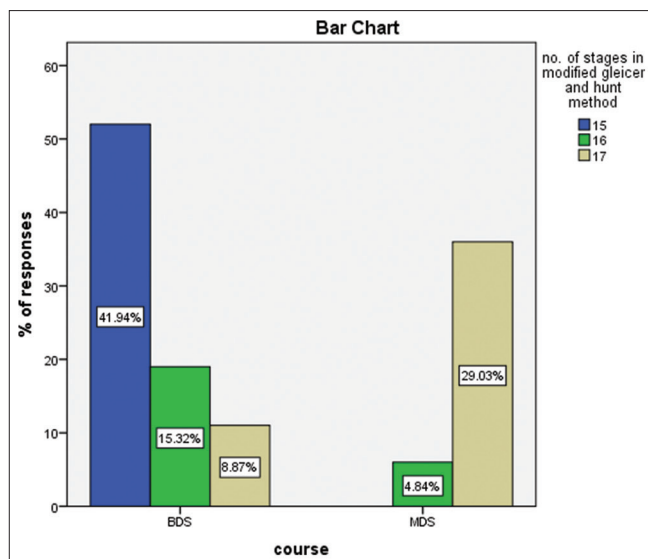
**Figure 14:** Bar graph showing the range between BDS and MDS students' answer on number of stages in Gleiser and Hunt method

was proposed in the year 1975 and 16.94% of the population answered 1972 [Figure 6].

Among the total population, 75.81% were aware of the Gleiser and Hunt method and 24.19% of the population not aware [Figure 7]. Among the total population, 43.55% answered that Gleiser and Hunt method has 15 stages and 28.23% answered 16 stages and 28.23% answered 17 stages [Figure 8]. Among the total population, 41.94% answered that modified Gleiser and Hunt method had 15 stages and 20.16% answered 16 stages and 237.90% answered 17 stages [Figure 9]. Among the total population, 75.81% were aware of Gustafson's index and 24.19% not aware [Figure 10] and 70.97% answered that Gustafson's index formula was  $11.43 + 3.36x$  and 20.03% answered that  $3.63 + 11.43x$  [Figure 11]. Among the total population, 70.97% answered that the Gustafson's index has 6 criteria, 5.65% answered 5 criteria, and 23.39% answered 4 criteria [Figure 12].

Among the postgraduate and undergraduate students, postgraduate students have more awareness than undergraduate students [Figure 13]. 29.03% of the MDS students answered that there are 15 stages in Gleiser and Hunt method and 28.23% of the undergraduates answered 17 stages and 29.03% [Figure 14] of the postgraduate students answered that there are 17 stages in modified Gleiser and Hunt method and 41.91% of the undergraduate students answered 15 stages [Figure 15].

Determination coefficients ( $R^2$ ) and root-mean-square errors (RMSEs) were determined using the models. The maximum added age details resulted in a 6%  $R^2$  rise and a 0.10-year reduction in RMSE. In the subadult category (15–23 years), forensic dental age estimations on panoramic radiographic data should only be based on third molar growth.<sup>[11]</sup> Limitation of the study is between the unequal response is PG and UG students. Moreover, the  $P$  value is 0.00, where it is significant between the PG and UG students.



**Figure 15:** Bar graph showing the range between BDS and MDS students' answer on number of stages in modified Gleiser and Hunt method

## DISCUSSION

The combination of male tooth number 37 and 38 staging produces decent results with a standard deviation of 1.23 years, whereas the combination of female tooth number 37 and 38 produces average results of 2.18 years. When comparing male and female tooth number staging, males display more accuracy in root maturation than females.<sup>[12]</sup>

## NOLLA'S METHOD

Nolla's method is the most popular gold standard method use for estimation of dental age. Assessment of growth status by comparison between Nolla's dental age and chronological age. In 1960, Nolla studied the tooth development of the permanent teeth.

In the study of child growth and development, it has been pointed out by various investigators that the development of the dentition has a close correlation to some other measures of growth. Nolla conducted that this study consisted of "serial oral radiographs of 25 boys and 25 girls" obtained from the files of the child development laboratories of the University of Michigan School. The total number of radiographs for the girls was 1746 and for the boys 1656. The type of growth displayed by each tooth is the same.

No significant differences in the rates of development were observed in males and females. On the average, differences in the general sequence of development were not apparent between the sexes. Few development differences were shown between right and left teeth of the same kind.<sup>[13]</sup>

## GLEISER AND HUNT METHOD

A serial or longitudinal study of the calcification, eruption, and decay of the right permanent mandibular first molar has been completed as a part of an investigation of child growth at the Forsyth Dental Infirmary for Children and the Harvard School of Public Health. Radiographic images of this tooth were arbitrarily divided into 15 stages of calcification. For

each sex, the ages at which each stage occurred are presented as means and standard deviations. A total of 25 boys and 25 girls, racially americans and residents of Greater Boston, were included in the present series.

Comparisons between dental and osseous calcification in the same child can be made by tracing the ages at which the various stages of dental calcification occur as an additional line on a “red graph” of osseous maturation of the hand. Since delays in calcification affect both the bones and teeth, it is possible to use dental radiographs for the assessment of growth progress in children.<sup>[14]</sup>

### DEMIRJIAN SYSTEM

First proposed in 1973, this is now the most widely used and researched method in forensic dental age estimation. Originally, the method used only seven teeth (central incisor to second molar on mandibular left side). A modification published in 2004 (Chaillet and Demirjian) has included the 3<sup>rd</sup> molar with a view to broaden its application to a wider age group. Widely used and researched, lower left side teeth used. This method has categorized the development of the mandibular left side tooth into ten stages (0–9). Separate stages exist for different classes of teeth.<sup>[15]</sup>

### CONCLUSION

From the above study, it is clear that undergraduate students have less awareness about the age estimation methods such as Gleiser and Hunt method, Demirjian method, and Gustafson index than the postgraduate students. Furthermore, studies will improve knowledge and awareness among the dental students.

### FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

### CONFLICTS OF INTEREST

There are no conflicts of interest.

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