Dental-craniofacial Characteristics of Southern Vietnamese People with Well-balanced Face on Cephalometric Films and Its Comparison with Caucasians and Northern Vietnamese Population

ThuyTrang Thi Ho¹, QuynhTam Thi Luong²

Department of Orthodontics, Faculty of Odonto-Stomatology, University of Medicine and Pharmacy, Ho Chi Minh City, Vietnam, ¹Ucare Dental Clinic, 487B Nguyen Dinh Chieu, Ward 2, Dist 3, Ho Chi Minh City, Vietnam

Objectives: The objective of this study was to evaluate the dental-craniofacial measurements of the Southern Vietnamese people aged 18 to 25 with well-balanced face on cephalometric films. Materials and Methods: This cross-sectional study included 60 cephalometric tracings of students (30 males, 30 females). The cephalometric measurements were made on 34 angles, 26 distances, and 4 ratios of skeletal, dental, and soft tissue cephalometric analysis. The mean and standard deviation (SD) of the dental-craniofacial measurements were calculated and compared among male and female subjects and with Caucasian and the Northern Vietnamese population. Results: Among the Southern Vietnamese cephalometric tracing samples, the majority of the linear measurements were smaller in female than in male, while the angular and ratio measurements showed no significant difference. When compared with Caucasians, the cranial fossa lengths, the vertical facial heights, the lengths of maxilla and mandible, and the facial convexity of the Southern Vietnamese people were significantly smaller ($P < 0.01$), while the upper and lower incisors protrusion, and lip protrusion were larger ($P < 0.01$). The maxillary and mandibular protrusions, and mandibular rotational patterns were similar between these two groups. When compared with the Northern Vietnamese population, the mandibular plane angle and the upper and lower incisor protrusion of the Southern Vietnamese people were significantly larger ($P < 0.05$). Conclusions: The dental-craniofacial measurements of the Southern Vietnamese people were different among male and female, and different than those of Caucasians and Northern Vietnamese population. Such differences should be taken into account when considering orthodontic and orthognathic treatment strategies.

Keywords: Cephalometric films, dental-craniofacial measurements, vietnam

INTRODUCTION

People have their own perceptions of dental beauty, and to convey this into a treatment goal is difficult. Artists and healthcare professionals have attempted to define and create standards for “facial harmony.”[1] A well-balanced face is determined by the three factors: tooth position, bone patterns, and soft tissues.
treatments, a closer look at specific dental-craniofacial measurements is needed. Many authors have published common measurements of facial bones, teeth, and soft tissues on cephalometric films, such as Steiner, Downs, Ricketts, Holdaway, and Tweed.\textsuperscript{[2-6]} Another group of research experts, including Scheideman, Celebi, Milošević, Goldsman, and Riedel proposed standardized measurement values based on age, sex, and ethnicity.\textsuperscript{[7-11]} However, these studies focused mostly on the Caucasian ethnic group, which limited the extrapolation of the results to other ethnic groups.

Currently, in Vietnam, the literature on dental-craniofacial measurements is limited to only one study by Tran et al.\textsuperscript{[12]} in 2016 that looked to establish the norms of Steiner’s analysis for the Northern Vietnamese people. However, more measurements of other cephalometric analysis are needed to identify the problems encountered in orthodontic diagnosis. Besides, there are some differences in dental-craniofacial characteristics between the Southern and Northern Vietnamese people and current data on dental-craniofacial measurements for the Southern Vietnamese population are lacking. As for the increasing demand for orthodontic and orthognathic treatment in Southern Vietnam, it is important to study and develop a dental-craniofacial measurement standard for the Southern Vietnamese population. The present study was conducted with the following objectives:

1. To establish standards for dental-craniofacial measurements for the Southern Vietnamese young adults.
2. To determine the sexual differences between the Southern Vietnamese males and females in dental-craniofacial characteristics.
3. To compare the dental-craniofacial differences with Caucasians and Northern Vietnamese population using various measurements.

**Materials and Methods**

This cross-sectional study included 60 cephalometric tracings of students (30 males, 30 females) of the Odonto-Stomatology Department, Ho Chi Minh University of Medicine and Pharmacy, Vietnam, considering the following inclusion criteria: aged 18 to 25, well-balanced face, no history of previous orthodontic, prosthodontic treatments, or any surgical reconstruction or maxillofacial surgery.

The tracing landmarks were identified and reviewed by the study investigator who was an orthodontic master trainee and also a practicing dentist at the time. The trainee was closely supervised by a professional orthodontist on the team. The tracings were scanned to a research computer on 1:1 ratio, and digitized on a Scriptel digitizer using a user-defined analysis mode on the Vistadent OC Cephalometric Analysis software program on Window XP computer. The cephalometric measurements were made on 34 angles, 26 distances, and 4 ratios of skeletal, dental, and soft tissue measurements chosen from Tweed’s, Steiner’s, Downs’s, McNamara’s, Burstone’s, Ricketts’s, Rakosi’s, Schwarz’s, Jarabak’s, and Holdaway’s cephalometric analysis [Figures 1–8].

On tracing the samples, the landmarks and parameters were identified and measured on two separate occasions 1 week apart by the same researcher. The Intraclass Correlation Coefficient (ICC) index between two measurements was calculated. An ICC score of >0.85, which confirmed high degree of consistency, was required.

The means and standard deviations (SD) were determined for the total sample. The means and SD of measurements among the male and female subjects were compared using a 2-sample Student $t$-test using the SPSS 22. The level of significance was set at 0.05. In addition, the means and SD of measurements of the study tracing samples were compared with those measurements of the Caucasian population, published by Burstone, McNamara, Scheideman, and Legan and Burstone,\textsuperscript{[7,13-15]} and of the Northern Vietnamese population published by Tran et al.\textsuperscript{[12]} A 2-sample $t$-test was also used to assess the significance of difference.
The means, SD, and significant differences between males and females were provided for the skeletal, dental, and soft tissue measurements as shown in Tables 1–3, respectively. The measurement differences of the study
Among the Southern Vietnamese cephalometric tracing samples, the majority of the linear measurements were smaller in female when compared with male, while the majority of the angular and ratio measurements showed no significant difference.

Table 1: Skeletal measurements

| Measurements                        | Description          | Unit | Male (n = 30) Mean ± SD | Female (n = 30) Mean ± SD | Both (n = 60) Mean ± SD | P      |
|-------------------------------------|----------------------|------|-------------------------|---------------------------|------------------------|--------|
| Cranial base assessment             |                      |      |                         |                           |                        |        |
| Posterior cranial base              | Ar - Ptm (/HP)       | mm   | 30.49 ± 3.1             | 28.6 ± 2.24               | 29.55 ± 2.85           | 0.009  |
| Anterior cranial base               | Ptm - N (/HP)        | mm   | 47.72 ± 3.87            | 46.61 ± 2.92              | 47.16 ± 3.44           | 0.214  |
| Saddle angle                        | NSAr                 | (°)  | 123 ± 5.72              | 124 ± 4.97                | 123.5 ± 5.33           | 0.473  |
| Articular angle                     | SArGo                | (°)  | 150.43 ± 6.06           | 148.23 ± 5.92             | 149.33 ± 6.04          | 0.16   |
| Vertical facial height              |                      |      |                         |                           |                        |        |
| AFH                                 | N - Me               | mm   | 116.59 ± 5.78           | 110.89 ± 5.83             | 113.74 ± 6.43          | 0.000  |
| PFH                                 | S - Go               | mm   | 80.79 ± 5.64            | 75.84 ± 5.54              | 78.31 ± 6.08           | 0.001  |
| UAFH                                | N - ANS              | mm   | 52.97 ± 3.05            | 50.06 ± 2.55              | 51.51 ± 3.15           | 0.159  |
| LAFH                                | ANS - Me             | mm   | 64.53 ± 4.45            | 61.68 ± 4.12              | 63.1 ± 4.49            | 0.013  |
| UAFH/LAFH                           | N - ANS/ANS - Me     | %    | 82.42 ± 6.77            | 81.38 ± 5.18              | 81.9 ± 6              | 0.507  |
| UAFH/AFH                            | N - ANS/N - Me       | %    | 45.46 ± 2.05            | 45.17 ± 1.57              | 45.31 ± 1.82           | 0.546  |
| LAFH/AFH                            | ANS - Me/N - Me      | %    | 55.32 ± 2.08            | 55.6 ± 1.58               | 55.46 ± 1.84          | 0.552  |
| PFH/AFH                             | S - Go/N - Me        | %    | 69.33 ± 4.19            | 68.41 ± 3.78              | 68.87 ± 3.98          | 0.376  |
| Maxillary skeletal assessment       |                      |      |                         |                           |                        |        |
| Maxillary protrusion                | SNA                  | (°)  | 83.45 ± 4.35            | 83.26 ± 2.98              | 83.36 ± 3.7           | 0.85   |
| Effective MX length                 | Co - A               | mm   | 80.51 ± 4.24            | 77.38 ± 3.97              | 78.95 ± 4.37          | 0.004  |
| MX length                           | ANS - PNS (/HP)      | mm   | 47.08 ± 2.3             | 45.71 ± 2.26              | 46.39 ± 2.72          | 0.052  |
| UAFH                                | N - ANS (∟LHP)       | mm   | 52.73 ± 3.11            | 49.9 ± 2.57               | 51.31 ± 3.17         | 0.000  |
| UPFH                                | N - PNS (∟LHP)       | mm   | 51.06 ± 3.02            | 48.97 ± 3.27              | 50.01 ± 3.29         | 0.013  |
| Mandibular skeletal assessment      |                      |      |                         |                           |                        |        |
| MD protrusion                       | SNB                  | (°)  | 80.73 ± 3.86            | 80.72 ± 2.69              | 80.72 ± 3.3         | 0.991  |
| Chin protrusion                     | N - Pog (/HP)        | mm   | -2.31 ± 7.36            | -2.5 ± 5.18               | -2.4 ± 6.31          | 0.908  |
| Effective MD length                 | Co - Gn              | mm   | 111.44 ± 5.06           | 106.31 ± 5.46             | 108.87 ± 5.83        | 0.000  |
| MD body length                      | Go - Pog             | mm   | 74.99 ± 4.12            | 71.03 ± 4.24              | 73.01 ± 4.6          | 0.001  |
| Chin depth                          | B - Pog (/MP)        | mm   | 5.95 ± 1.21             | 5.14 ± 1.14               | 5.54 ± 1.23         | 0.010  |
| MD plane angle                      | MP - HP              | (°)  | 22.96 ± 4.84            | 23.68 ± 4.5               | 23.32 ± 4.64         | 0.551  |
| MD plane angle                      | FH - GoMe            | (°)  | 22.87 ± 4.56            | 23.43 ± 4.32              | 23.15 ± 4.41         | 0.623  |
| MD plane angle                      | SN - GoGn            | (°)  | 29.5 ± 4.49             | 29.71 ± 4.19              | 29.6 ± 4.3           | 0.85   |
| MD ramus length                     | Ar - Go              | mm   | 48.79 ± 4.76            | 46.44 ± 4.39              | 47.61 ± 4.7        | 0.051  |
| Gonial angle                        | zeGo                 | (°)  | 116.47 ± 5.36           | 118.40 ± 4.85             | 117.43 ± 5.16        | 0.148  |
| Maxillomandibular relation          |                      |      |                         |                           |                        |        |
| Relation of MX to MD                | ANB                  | (°)  | 2.7 ± 2.38              | 2.54 ± 1.71               | 2.62 ± 2.06         | 0.757  |
| Maxillomandibular differential      | [CoA - CoGn]         | mm   | 31.07 ± 3.13            | 28.96 ± 3.53              | 30.02 ± 3.47         | 0.017  |
| LAFH                                | ANS - Gn (∟LHP)      | mm   | 63.37 ± 4.43            | 60.54 ± 4.1               | 61.95 ± 4.46         | 0.013  |
| Facial convexity                    | N - A - Pog          | (°)  | 3.6 ± 5.59              | 3.67 ± 4.15               | 3.63 ± 4.88         | 0.958  |
| Y axis                              | PoOr - SGo           | (°)  | 60.17 ± 2.69            | 59.73 ± 3.35              | 59.95 ± 3.02         | 0.583  |
| Bjork’s sum                         | NSAr + SArGo + zeGo  | (°)  | 389.93 ± 4.76           | 390.67 ± 4.48             | 390.30 ± 4.60        | 0.541  |
| PP - MD plane angle                 | ANS.PNS- GoMe        | (°)  | 20.87 ± 4.68            | 22.90 ± 4.28              | 21.88 ± 4.36         | 0.084  |
while the upper and lower incisors protrusion, and the upper and lower lips protrusion were larger. Though, the maxillary and mandibular protrusions, and the mandibular rotational patterns were similar between Caucasians and the Southern Vietnamese group.

When compared with the Northern Vietnamese people, the mandibular plane angle in relation to the cranial base (SN - GoGn) and the upper and lower incisors protrusion of Southern Vietnamese were larger.

**DISCUSSION**

**Skeletal measurements**
The growth of the cranial base can influence the height and depth of the upper face and position of the upper teeth during orthodontic treatments. Therefore, it is essential to assess the anterior and middle cranial fossa length (Ptm - N (///HP)), (Ar - Ptm (///HP)), and flexure (NSAr, SArGo).

Evaluation of the vertical patterns and proportions has a major role in the overall harmony of the face. Vertical dimensions include Anterior Facial Height (AFH) and Posterior Facial Height (PFH). Anterior Facial Height (AFH) is divided into upper anterior facial height (UAFH) and lower anterior facial height (LAFH).

The skeletal components of the maxilla and mandible were assessed in relation to their length (Co-A, ANS-PNS, and Co - Gn, Go - Pog, B - Pog (///MP), Ar - Go), sagittal positions relative to the cranium (SNA, N - A/}

### Table 2: Dental measurements

| Measurements | Description | Unit | Male (n = 30) Mean ± SD | Female (n = 30) Mean ± SD | Both (n = 60) Mean ± SD | P  |
|--------------|-------------|------|-------------------------|--------------------------|------------------------|----|
| **Maxillary dentoalveolar assessment** | Incisor to NA | U1 - NA | (°) | 25.62 ± 5.77 | 25.93 ± 4.96 | 25.77 ± 5.34 | 0.822 |
| | Incisor to A-vert | U1 - A (///FH) | mm | 5.16 ± 2.15 | 5.49 ± 1.65 | 5.32 ± 1.91 | 0.505 |
| | Incisor to A-Pog | isi - APog | mm | 6.37 ± 2.09 | 6.64 ± 1.62 | 6.5 ± 1.86 | 0.576 |
| | Incisor to SN plane | U1 - SN | (°) | 109.06 ± 6.47 | 109.19 ± 4.81 | 109.13 ± 5.65 | 0.93 |
| | Incisor to PP plane | U1 - PP | (°) | 61.87 ± 6.48 | 62.90 ± 5.07 | 62.38 ± 5.79 | 0.494 |
| | Molar to Ptv | A6 - Ptv | mm | 17.59 ± 3 | 21.01 ± 3.42 | 17.3 ± 3.2 | 0.484 |
| | Upper incisor-PP | isi - PP (⊥ PP) | mm | 27.08 ± 2.27 | 26.27 ± 2.44 | 26.67 ± 2.37 | 0.187 |
| | Upper molar-PP | u6 - PP (⊥ PP) | mm | 23.67 ± 2.09 | 22.8 ± 1.67 | 23.24 ± 1.93 | 0.077 |
| **Mandibular dentoalveolar assessment** | Incisor to NB | L1 - NB | (°) | 26.95 ± 6.62 | 28.45 ± 5.38 | 27.7 ± 6.02 | 0.339 |
| | Incisor to mandibular plane | L1 - GoMe | (°) | 96.37 ± 6.48 | 96.97 ± 5.81 | 96.67 ± 6.11 | 0.707 |
| | Frankfort mandibular incisal angle | FMIA | (°) | 60.83 ± 6.93 | 59.43 ± 6.23 | 60.13 ± 6.57 | 0.414 |
| | Incisor to A-Pog | ii - A-Pog | mm | 3.29 ± 2.12 | 3.68 ± 1.64 | 3.48 ± 1.89 | 0.423 |
| | Interincisor angulation | U1 - L1 | (°) | 124.72 ± 9.2 | 123.09 ± 7.84 | 123.9 ± 8.52 | 0.463 |
| | Lower incisor to MP | isi - MP (⊥ MP) | mm | 39.62 ± 2.72 | 37.76 ± 2.1 | 38.69 ± 2.58 | 0.004 |
| | Lower molar to MP | u6 - MP (⊥ MP) | mm | 32.28 ± 2.4 | 30.02 ± 2.38 | 31.15 ± 2.63 | 0.001 |

### Table 3: Soft tissue measurements

| Measurements | Description | Unit | Male (n = 30) Mean ± SD | Female (n = 30) Mean ± SD | Both (n = 60) Mean ± SD | P  |
|--------------|-------------|------|-------------------------|--------------------------|------------------------|----|
| Total convexity except nose | Gl - Sn - Pog' | (°) | 10.09 ± 4.85 | 8.79 ± 3.92 | 9.44 ± 4.42 | 0.258 |
| Angle of facial convexity | N'SnPog' | (°) | 164.33 ± 5.21 | 165.73 ± 4.05 | 165.03 ± 4.68 | 0.25 |
| Total convexity with nose | N'PnPog' | (°) | 134.5 ± 3.65 | 135.5 ± 3.29 | 135 ± 3.48 | 0.269 |
| Nasolabial angle | \( \alpha \) | (°) | 94.63 ± 11.7 | 97.4 ± 8.3 | 96.02 ± 10.16 | 0.296 |
| Columella tangent to postural horizontal | \( \alpha \) | (°) | 16.11 ± 8.02 | 19.35 ± 6.74 | 17.73 ± 7.52 | 0.095 |
| Upper lip tangent to postural horizontal | \( \alpha \) | (°) | 78.79 ± 7.35 | 78.38 ± 5.62 | 78.59 ± 6.49 | 0.809 |
| Upper lip protrusion | Ls - SnPog' | mm | 4.8 ± 1.52 | 4.59 ± 0.98 | 4.69 ± 1.27 | 0.526 |
| Lower lip protrusion | Li - SnPog' | mm | 3.92 ± 1.75 | 3.65 ± 1.47 | 3.79 ± 1.61 | 0.519 |
| Upper lip to E-line | Ls - PnPog' | mm | -2.26 ± 1.98 | -1.96 ± 1.56 | -2.11 ± 1.78 | 0.515 |
| Lower lip to E-line | Li - PnPog' | mm | 0.72 ± 1.92 | 0.81 ± 1.65 | 0.77 ± 1.78 | 0.846 |
| Mentolabial sulcus depth | Si - LiPog' | mm | 4.16 ± 0.77 | 3.89 ± 0.83 | 4.03 ± 0.81 | 0.195 |
| Chin thickness | Pog - Pog' | mm | 10.77 ± 1.69 | 10.59 ± 1.09 | 10.68 ± 1.41 | 0.624 |
After the maxilla and mandible were individually assessed, their interrelationship was evaluated (ANB, |CoA - CoGn|, N - A - Pog). The lower anterior face height (ANS - Gn (⊥HP)) was a representation of the sum of the anterior dento-alveolar heights of the two jaws and skeletal base inclination. The growth axis (PoOr - SGn) and the Bjork’s sum (NSAr + SArGo + αGo) were assessed to predict the probable direction and pattern of future facial growth.

Our results showed that the majority of the linear measurements among the Southern Vietnamese tracing samples were less in female than in male \((P < 0.05)\), except for Ptm - N (⊥HP), N - A (⊥HP), ANS - PNS (⊥HP), N - Pog (⊥HP), and Ar - Go which showed no significant difference \((P > 0.05)\). The majority of the angular and ratio measurements showed no significant difference between both sexes \((P > 0.05)\) [Table 1]. This revealed that the skeletal dimensions HP, and SNB, N - Pog (⊥HP), vertical positions (N - ANS (⊥HP), N - PNS (⊥HP)), and rotational pattern (MP - HP, FH - GoMe, SN - GoGn, αGo) were assessed to predict the probable direction and pattern of future facial growth.
in female was smaller than in male, while the facial patterns, the maxilla, and mandible in relation to the cranium and their interrelationship were similar between both sexes.

In comparison with Caucasians, the cranial fossa lengths, the vertical facial heights, and the maxilla and mandible lengths were shorter among the Southern Vietnamese population ($P < 0.001$), while the maxillary and mandibular protrusions, and the mandibular rotational patterns showed no significant differences ($P > 0.05$) [Table 4]. When compared with the Northern Vietnamese people, the Southern people also had the upper and lower incisors more protrusive ($P < 0.05$) [Table 5].

**Soft tissue measurements**

As the orthodontic treatment influences the position of teeth and jaws, which in turn influences the morphology of the overlying facial soft tissues, the evaluation of the soft tissue components of the face plays an important role in diagnosis and treatment planning. Soft tissue analysis includes evaluating the facial convexity ($Gl - Sn - Pog'$, $N'SnPog'$, $N'PnPog'$), nasolabial angle ($\angle \alpha$, $\angle \alpha_1$, $\angle \alpha_2$), lips protrusion ($Ls - SnPog'$, $Li - SnPog'$), the prominence of the lips relative to E lines ($Ls - PnPog'$, $Li - PnPog'$), the mentolabial sulcus depth ($Si - SnPog'$), and the soft tissue chin thickness ($Pog - Pog'$).

As shown in Table 3, our results revealed that soft tissue measurements showed no significant difference between both sexes among the Southern Vietnamese population ($P > 0.05$).

However, when compared with Caucasians, the facial convexity was less in the Southern Vietnamese population, while upper and lower lips protrusion were larger ($P < 0.01$) [Table 4].

**Table 5: Comparison with Northern Vietnamese**

| Parameter (unit) | Sex   | Southern Mean ± SD | Northern Mean ± SD | $P$   |
|------------------|-------|---------------------|--------------------|-------|
| SNA (°)          | M     | 83.45 ± 4.35        | 84.67 ± 3.24       | 0.2229|
|                  | F     | 83.26 ± 2.98        | 84.03 ± 2.89       | 0.3139|
| SNB (°)          | M     | 80.73 ± 3.86        | 81.24 ± 3.34       | 0.5863|
|                  | F     | 80.72 ± 2.69        | 81.34 ± 2.86       | 0.3907|
| ANB (°)          | M     | 2.7 ± 2.38          | 3.29 ± 1.27        | 0.2358|
|                  | F     | 2.54 ± 1.71         | 2.45 ± 1.36        | 0.8223|
| SN - GoGn (°)    | M     | 29.5 ± 4.49         | 26.13 ± 3.68       | 0.0024|
|                  | F     | 29.71 ± 4.19        | 26.82 ± 5.42       | 0.0244|
| U1 - NA (°)      | M     | 25.62 ± 5.77        | 25.3 ± 4.51        | 0.8117|
|                  | F     | 25.93 ± 4.96        | 24.36 ± 5.96       | 0.2720|
| u1 - NA (mm)     | M     | 5.64 ± 2.09         | 4.23 ± 1.89        | 0.0081|
|                  | F     | 5.88 ± 1.48         | 4.12 ± 1.59        | 0.0000|
| L1 - NB (°)      | M     | 26.95 ± 6.62        | 29.74 ± 6.04       | 0.0935|
|                  | F     | 28.45 ± 5.38        | 28.42 ± 6.13       | 0.9840|
| l1 - NB (mm)     | M     | 6.18 ± 2.15         | 5.14 ± 1.88        | 0.0508|
|                  | F     | 5.94 ± 1.71         | 4.31 ± 2.26        | 0.0026|
| U1 - L1 (°)      | M     | 124.72 ± 9.2        | 121.3 ± 7.58       | 0.1215|
|                  | F     | 123.09 ± 7.84       | 123.98 ± 9.11      | 0.6865|

16 - MP ($\perp$MP), shown to be higher in males than in females ($P < 0.01$) [Table 2].
Ho and Luong: Dental-craniofacial characteristics of Southern Vietnamese people

**CONCLUSIONS**

The dental-craniofacial standards among the Southern Vietnamese people were different between male and female, and different than Caucasians and the Northern Vietnamese group. Such differences should be taken into account when considering orthodontic and orthognathic treatment strategies for Southern Vietnamese patients.

**ACKNOWLEDGEMENT**

The authors wish to thank Professor Hoang Tu Hung, former Dean, Faculty of Odonto-Stomatology, University of Medicine and Pharmacy, Ho Chi Minh City, for his advice in the study and all the Dental and Medical students for attending this study.

**FINANCIAL SUPPORT AND SPONSORSHIP**

Nil.

**CONFLICTS OF INTEREST**

There are no conflicts of interest.

**AUTHORS CONTRIBUTIONS**

TT.T.H conceived the ideas. TT.T.H and QT.T.L collected and analysed the data. TT.T.H and QT.T.L contributed to the writing, editing and review.

**ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT**

This study was approved by the Research Committee of the University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam. Approval number of the present study was 2258/QĐ-DHYD from the University.

**PATIENT DECLARATION OF CONSENT**

The consent not required as student’s identify is not disclosed or compromised.

**DATA AVAILABILITY STATEMENT**

All data generated or analysed during this study are included in this article.

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