Research Article

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Crown Angulation and Crown Inclination in Angle's Class I Malocclusion in a Sample of Nepali Population

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ABSTRACT

Introduction: Universal applicability of Andrews' measurements remains uncertain. This becomes relevant in ethnically diverse South Asian population, where craniofacial features differ from Andrew's population. Ideal axial inclinations of all teeth are essential for obtaining function and aesthetic at the end of active treatment. In Nepal, currently no standard data exist on tip and torque values in individuals with untreated Angle's Class I malocclusion.

Objective: To compare tip and torque values of Nepali sample calculated using digital software with Andrews' values to determine their relevance and guide future appliance design.

Methodology: This analytical cross-sectional study included patients visiting Orthodontics department during 2022 January after institutional ethical approval. Patients with skeletal Class I (ANB±2), aged 18-40 years, with an Angle's Class I malocclusion, and no prior orthodontic treatment were included using convenience sampling. Data were analysed using SPSS v.20. Measurements were expressed as mean±standard deviation. One-sample t-test compared tip and torque values of Nepali sample with Andrews' values.

Result: Maxillary and mandibular dental casts of 39 individuals were scanned. Statistically significant differences ($p < 0.05$) were observed for maxillary central incisors, lateral incisors, canines, first and second premolars, first and second molars; and mandibular lateral incisors, second premolars, first and second molars. Mean torque values of Nepali sample were significantly different from Andrews' normative data across most teeth ($p < 0.05$). When mean tip values of Nepali sample were compared with Andrews' norms, statistically significant differences ($p < 0.05$) were observed for maxillary central incisors, lateral incisors, canines, first and second premolars, and first and second molars; and mandibular lateral incisors, second premolars, first and second molars. No significant differences ($p > 0.05$) were found for mandibular central incisors, canines, and first premolars.

Conclusion: Comparing with Andrews' normal data, statistically significant differences were observed in both tip and torque measurements for several teeth, indicating ethnic variations in dental morphology.

Keywords: Angle's class I malocclusion; crown angulation; crown inclination; tip; torque.

Citation

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INTRODUCTION

Malocclusion affects both function and aesthetics of patients, making its correction a key focus of orthodontic treatment.[1] While the modern approach considers the entire facial structure, achieving an ideal occlusion remains just as important today as it was during the early days of orthodontics. The idea of "ideal occlusion" can be traced back to the 18th century with John Hunter's early observations,[2] but it was Andrews, in 1964, who set the new standard. By studying 120 untreated dental casts from White North American individuals, he defined the "six keys to normal occlusion," which later became the foundation for preadjusted edgewise appliances and the straight-wire technique.[3,4] These systems have since become the backbone of orthodontic mechanics worldwide.

However, Andrew's measurements were based on a narrow population group, and their universal applicability, particularly in ethnically diverse regions, remains uncertain. This issue is especially relevant in South Asia, where craniofacial features often differ from those of the original study population. In Nepal, there is currently no standard data available on tip and torque values in individuals with untreated Angle's Class I malocclusion. Given the widespread use of bracket prescriptions based on Andrews' values, it is essential to assess whether these standards are suitable for the Nepali population.

With the advent of digital dental cast analysis software, it is now possible to measure tip and torque values more accurately and efficiently. This study, therefore, aimed to analyse tip and torque values in a sample of Nepali population using digital software and compare them with Andrews' original values to determine their relevance and guide future appliance design.

METHODOLOGY

This analytical cross-sectional, observational study was conducted at the Department of Orthodontics, Kantipur Dental College Teaching Hospital and Research Centre, Basundhara, Kathmandu, Nepal from 2022 January 1 to 2022 January 31. The ethical approval was taken from the institutional review committee of Kantipur Dental College Teaching Hospital and Research Centre (Reference number: 32/021).

The study population included was patients visiting the Department of Orthodontics during the study period. The inclusion criteria consisted of patients with skeletal Class I (ANB ± 2), aged 18 to 40 years, with an Angle's Class I malocclusion and no prior orthodontic treatment. In contrast, those with Angle's Class II and Class III malocclusion and craniofacial anomalies were excluded. Individuals were included in the study using convenience sampling technique.

The sample size was calculated using OpenEpi software based on the study done by Gupta et al.[5]

Maxillary and mandibular dental casts of 39 subjects with full permanent dentition were scanned using a three-dimensional (3-D) model scanner (Dentsply Sirona EOS X5, USA) and converted into STereoLithography (STL) file formats (Figure 1). These files were imported into Maestro3-D dental computer-aided design (CAD) software (AGE Solutions), where individual tooth segmentation was performed to measure the tip and torque based on the facial axis of the clinical crown (FACC) and its midpoint. The facial axis point was marked on each crown in both maxillary and mandibular arches, with the FACC serving as the reference line for crown angulation and inclination measurements.

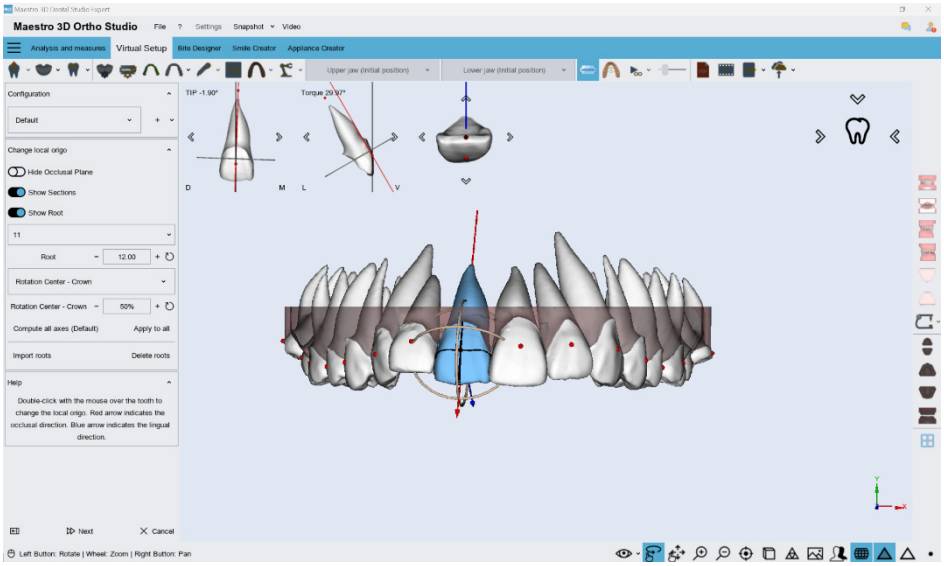

Figure 1: Scanned image using the three-dimensional model scanner.

Data analysis was performed using IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA). The measurements were expressed as mean ± standard deviation (SD). To assess the reliability of the measurements, the intraclass correlation coefficient (ICC) was calculated for 20% of the sample after two weeks. Data normality was evaluated using the Shapiro-Wilk test, which confirmed that the data were normally distributed. Consequently, a sample t-test was performed to compare the tip and torque values obtained from the Nepali sample with Andrews' original values.

RESULT

The intraexaminer reliability assessed using ICC for 20% of the sample showed good to excellent agreement for tip and torque measurements, with ICC values ranging from 0.79 to 0.98 across both maxillary and mandibular teeth.

Mean difference between maxillary and mandibular angulation - mean and standard deviation of mandibular and maxillary angulation were 7.5 ± 8.3 and -0.02 ± 8.2, respectively. At 80% power, 95% confidence interval, and an equal group ratio (Tables 1 and 2).

The mean tip values were assessed and their statistical comparison with Andrews' normal values were done (Table 3). Statistically significant differences ($p < 0.05$) were observed for the following teeth: maxillary central incisors, lateral incisors, canines, first and second premolars, first and second molars; and mandibular lateral incisors, second premolars, first and second molars. No significant differences ($p > 0.05$) were found for the mandibular central incisors, canines, and first premolars.

The mean torque values of the Nepali sample were significantly different from Andrews' normative data across most teeth ($p < 0.05$, Table 4). In the maxillary arch, central and lateral incisors showed higher torque values, while canines and posterior teeth exhibited lower torque than Andrew's values. Similarly, in the mandibular arch, all teeth demonstrated significantly lower torque values compared to Andrews, except the central and lateral incisors, which showed positive torque values in contrast to Andrews' negative values.

Table 1: Descriptive statistics of tip values for maxillary and mandibular teeth, (N = 39).

Teeth as per two digit numbering system	Minimum	Maximum	Mean±SD
17	-2.22°	5.50°	2.23±1.98
16	-4.47°	8.49°	2.85±3.29
15	-3.90°	18.30°	3.42±4.24
14	-.57°	16.69°	5.74±4.67
13	2.27°	17.22°	8.79±3.54
12	-11.27°	15.74°	4.64±5.59
11	-9.03°	9.32°	1.45±3.90
21	-5.96°	9.90°	1.94±3.27
22	-.17°	10.91°	4.82±2.93
23	-1.64°	18.13°	7.50±4.55
24	.45°	9.96°	5.54±2.64
25	-4.15°	9.59°	3.38±2.89
26	-4.88°	7.91°	1.86±3.41
27	-10.50°	14.40°	1.76±5.24

Table 2: Descriptive statistics of torque values for maxillary and mandibular teeth, (N = 39).

Teeth as per two digit numbering system	Minimum	Maximum	Mean±SD
17	-15.20	2.55°	-6.90±5.26
16	-13.20	5.03°	-4.81±3.98
15	-15.70	-1.70°	-8.40±3.20
14	-12.70	-3.50°	-7.98±2.50
13	-14.20	-1.00°	-6.95±4.06
12	1.30	8.70°	3.60±2.11
11	1.00	16.24°	7.11±3.60
21	-1.00	12.60°	3.87±3.49
22	-2.69	11.00°	6.73±2.98
23	-9.00	8.00°	-2.34±5.41
24	-10.00	3.99°	-3.10±4.60
25	-9.18	5.16°	-2.47±3.80
26	-14.00	5.03°	-3.67±4.49
27	-17.00	2.53°	-6.76±5.66

Table 3: Comparison of mean tip values (in degrees) between the Nepali sample and Andrews' normative data, (N = 39).

Tip		Nepali sample	Andrew's normal	p-value
Maxillary	Central	1.7°	5°	<0.001*
	Lateral	4.73°	9°	<0.001*
	Canine	8.1°	11°	<0.001*
	1st Premolar	5.6°	2°	<0.001*
	2nd Premolar	3.4°	2°	0.02*
	1st Molar	2.36°	5°	<0.001*
	2nd Molar	2°	5°	<0.001*
Mandibular	Central	2.41°	2°	0.34
	Lateral	3.1°	2°	<0.001*
	Canine	4.3°	5°	0.19*
	1st Premolar	2.2°	2°	0.2
	2nd Premolar	2.9°	2°	0.02*
	1st Molar	3.59°	2°	<0.001*
	2nd Molar	4.71°	2°	<0.001*

*Statistically significant at p <0.05

Table 4: Comparison of mean torque values (in degrees) between the Nepali sample and Andrews' normative data, (N = 39).

Torque		Nepali sample	Andrew's normal	p-value
Maxillary	Central	5.49°	7°	<0.001*
	Lateral	5.16°	3°	<0.001*
	Canine	-4.65°	-7°	<0.001*
	1st Premolar	-5.54°	-7°	<0.001*
	2nd Premolar	-5.4°	-7°	<0.001*
	1st Molar	-4.24°	-9°	<0.001*
	2nd Molar	-6.83°	-9°	0.01*
Mandibular	Central	0.37°	-1°	0.01*
	Lateral	0.93°	-1°	<0.001*
	Canine	-9.39°	-11°	<0.001*
	1st Premolar	-1.26°	-17°	<0.001*
	2nd Premolar	-11.91°	-22°	<0.001*
	1st Molar	-17.71°	-30°	<0.001*
	2nd Molar	-23.25°	-33°	<0.001*

*Statistically significant at p <0.05

DISCUSSION

The present study aimed to evaluate the tip and torque values of maxillary and mandibular teeth in a Nepali sample with untreated Angle's Class I malocclusion and compare them with Andrews' established norms. The results revealed statistically significant differences in both tip and torque measurements for several teeth when compared to Andrews' data, which is similar to the study done by Doodamani et al., Lombardo et al., highlighting important clinical implications for orthodontic practice in ethnically diverse populations.[6,7] The overall tip and torque value was lower compared to Andrew's normal value, except for the tip values of the upper first and second premolars, as well as the lower second premolars and first and second molars, were higher than Andrew's values. Similarly, the torque values of the upper lateral incisors and lower central and lateral incisors were also higher compared to Andrews' standards. This variation may be due to functional adaptation, arch form, and racial difference.[8,9]

Different researchers have employed various methods and devices to measure tip and torque values. For instance, studies such as the one conducted by Kannabiran et al. used a custom-made tip-torque device to assess crown angulation and inclination directly on dental casts.[10] In contrast, our study utilised digital software, which allowed standardised, reproducible, and potentially more accurate measurements, as shown by a study done by Barreto et al.[11]

The ICC values for tip and torque measurements ranged from 0.79 to 0.98, indicating good to excellent reliability. Tip measurements showed the highest consistency in lower anterior teeth (up to 0.98), while slightly lower values were noted in upper second premolars (0.79). Torque values were also reliable, with ICCs ranging from 0.81 to 0.91, highest in lower second molars and first premolars. These results confirm that the digital software used in this study provides reproducible and consistent measurements, making it a reliable tool for orthodontic assessment.[12,13]

The limitation of this study is the use of a single digital software for measuring tip and torque values, which may vary compared to other tools or methods such as manual devices or artificial intelligence (AI) assisted platforms. Additionally, the sample was limited to a specific population group, which may restrict generalisation to broader ethnic or geographic populations.

Future studies could expand the sample size and include diverse ethnic groups to establish more comprehensive normative data. Comparison between multiple measurement methods (manual, digital, and AI-based) on the same sample could further validate reliability and clinical accuracy.

Additionally, superimposition of digital software measurements with cone beam computed tomography derived data could improve accuracy and provide three-dimensional insights into crown angulation and inclination, leading to more precise diagnosis and treatment planning in orthodontics.[14]

CONCLUSION

This study evaluated the tip and torque values of maxillary and mandibular teeth in a Nepali sample with Angle's Class I malocclusion. On comparing with Andrews' normal data, statistically significant differences were observed in both tip and torque measurements for several teeth, indicating ethnic variations in dental morphology. Due to significant tip and torque differences, Andrews-based preadjusted brackets may not ensure ideal tooth positioning in the Nepali population.

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Conflict of interest: None.

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