A cephalometric search for the ideal African-American soft-tissue profile

Dr. Larry White shares research that can aid clinicians in diagnosis and treatment planning for African-American patients

Abstract

Researchers have devoted considerable time and effort to the study of ideal soft issue profiles for Caucasians, but by comparison have neglected any systematic or thorough consideration for ideal African-American profiles. Forty female adolescents and 42 male adolescents (all between the ages of 13 and 18 years of age) were selected for their ideal Class I occlusions combined with their acceptable soft-tissue profiles, i.e., lips that occluded comfortably and naturally without any mentalis strain regardless of their protrusiveness. As other researchers previously determined, African-American cephalometric measurements differ considerably from Caucasian values. The primary goal of the study sought to establish soft-tissue measurements that clinicians could use to correctly and predictably position the maxillary and mandibular incisors as in Caucasians. The incisor positions for African-Americans varied twice as much as Caucasians, and their acceptable soft-tissue profiles and incisor positions present a much wider variation than those of Caucasians, but significant measurements were discovered that can aid clinicians in diagnosis and treatment planning for African-American patients.

Educational aims and objectives

This article describes how using a soft-tissue profile specifically determined for African-American patients can improve treatment planning and diagnosis.

Expected outcomes

Correctly answering the questions on page 24, worth 2 hours of CE, will demonstrate that the reader can:

- recognize that maxillary incisors and soft-tissue measurements are an integral part of accurate orthodontic diagnosis and treatment planning.
- learn about cephalometric measurements to the soft-tissue profiles of African-American adolescents in an attempt to establish norms for the African-American profile.
- discover a dependable cephalometric formula for positioning the maxillary and mandibular incisors for ideal lip support.

Introduction

Since the time of Tweed[15,16], orthodontists have used cephalometric measurements to assist in diagnosis and treatment planning for patients. Traditionally, these diagnostic and treatment planning schemes relied on having the mandibular incisors in a predetermined position vis-a-vis osseous tissues.[17-21] All of these previous diagnostic and treatment-planning efforts had a narrow and structured view of normality, and those ideas held in place until Casko and Shepherd[22] discovered that persons with untreated Class I occlusions and acceptable soft-tissue profiles had a much wider range than earlier clinicians imagined. McNamara and Ellis[23,24] subsequently upheld the wide variation of normal cephalometric measurements for orthodontically untreated persons with Class I occlusions and acceptable soft-tissue profiles.

Holdaway first suggested the soft-tissue profile as a more reasonable way of diagnosing and treatment planning for orthodontic patients.[25-27] Since that epochal transformation, others[28,29] have offered corroborating evidence that maxillary incisors and soft-tissue measurements held the key to accurate orthodontic diagnosis and treatment planning.

Holdaway, by clinically assessing ideal Caucasian soft tissue profiles, determined that harmonious profiles had two consistent and measurable dimensions that had limited ranges. The depth of the upper lip sulcus measured from a perpendicular line drawn from the Frankfort plane and the distance from subnasale to a line drawn from the soft tissue chin to the outer contour of the upper lip (Figures 1A and 1B).

Figure 1A: Holdaway's ideal subnasale depth is 3mm ± 1mm

Figure 1B: Holdaway's ideal harmony line to subnasale is 5mm ± 2mm

Figure 2: Alvarez A line that positions the maxillary incisor on the A line ± 1 mm

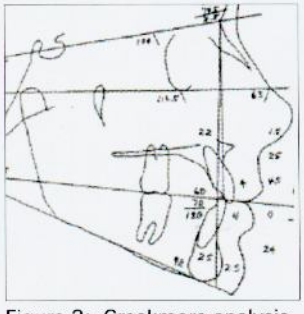

Figure 3: Creekmore analysis that positions the maxillary incisor 4 mm± 1 mm in front of NA (Radney) line and the mandibular incisor on the NA line ± 1 mm

Alvarez analyzed the collections of Casko, Shepherd, McNamara, and Ellis and found consistent positions of the maxillary incisors to the upper lip. By dividing the distance from soft tissue A point to hard tissue A point into thirds, he found that the maxillary incisor typically touched or

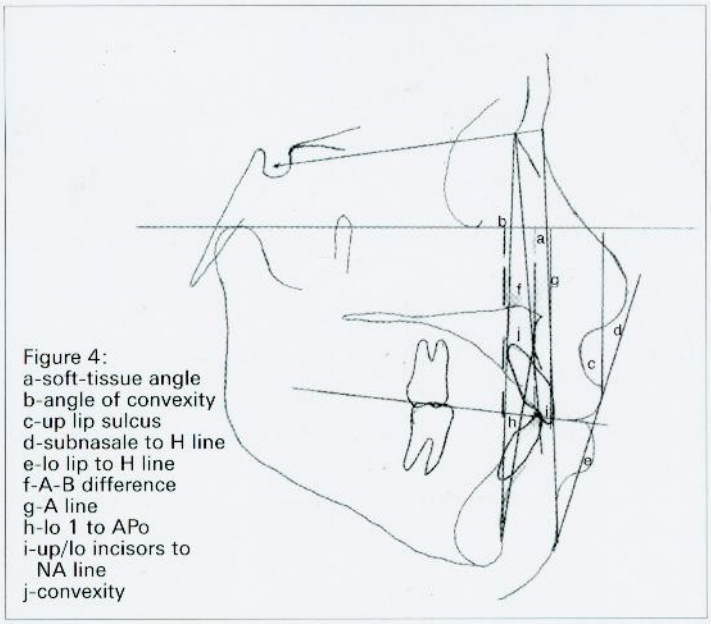

Figure 4:
a-soft-tissue angle
b-angle of convexity
c-up lip sulcus
d-subnasale to H line
e-lo lip to H line
f-A-B difference
g-A line
h-lo 1 to APo
i-up/lo incisors to NA line
j-convexity

was within 1 mm to a perpendicular line drawn from True Horizontal to the third nearest hard tissue A point (Figure 2).

Using the same Casko, Shepherd, McNamara and Ellis collections, Creekmore discovered that the line NA bisected the mandibular incisor or was within 1 mm of that tooth, while the maxillary incisor was 4-5 mm anterior to the line NA (Figure 3).

Unfortunately, these latter-day diagnostic efforts remained as race-based as their predecessors since they depended entirely on measurements of Caucasians as did all earlier cephalometric norms.[1-6] Clinicians[7] quickly observed that other races had different facial measurements and characteristics, but few studies emerged, apparently because orthodontics remained primarily a Caucasian-driven profession. Altemus[8] offered one of the early descriptions of cephalofacial comparisons between Caucasians and African-Americans, and others[9-14] followed with their own assessments that continued to demonstrate that African-Americans with Class I occlusions had distinctive cephalometric characteristics that differed substantially from Caucasian norms.

This study was designed to study the relation of cephalometric measurements to the soft-tissue profiles of African-American adolescents in an attempt to establish norms for the African-American profile and, hopefully, discover a dependable cephalometric formula for positioning the maxillary and mandibular incisors for ideal lip support.

Materials and methods

Cephalometric radiographs were selected from African-Americans who presented to a private clinic for correction of perceived malocclusions. The selected people were adolescents between the ages of 13 to 18 and who presented with ideal Class I occlusions and acceptable profiles; i.e., lips that in repose had no strain or mentalis constriction regardless of protrusion. None had a history of orthodontic therapy of any kind or facial trauma. The perceived dental malocclusions consisted of minor rotations and/or spaces, but none had seriously misplaced teeth. None of the participants had any severe or noticeable vertical, transverse or anteroposterior discrepancies, and none had missing or primary teeth. The cephalometric profile images eliminated influences of skin tone, hair styles, body piercings, etc. that might influence judgments. The principal investigator manually traced each lateral head film on 8 x 10 paper printouts of the X-rays, identified cephalometric landmarks, completed linear and angular measurements of 13 features, and recorded the measurements in a statistical data base in order to evaluate the information. To ensure consistency, the investigator used a tooth template of the Dome cephalometric protractor for outlining the teeth. Each linear and angular measurement was made to the nearest 0.5 mm and 0.5° respectively. Tracings used a midline bisection when bilateral images lacked coincidence. Each cephalometric X-ray was taken at True Horizontal and many of the measurements made from that reference line.

A random selection of 10 radiographs was retraced several months after the original tracings to assess method error.

Results

Statistical analysis

Statistics determined intraoperator tracing and identification error. Any variation greater than 20% received paired t tests to validate the measurements.

The investigator selected the following measurements for this study (Figure 4):

- soft-tissue facial angle
- skeletal convexity
- maxillary lip sulcus
- subnasale to H line
- H angle
- lower lip to H line
- A-B discrepancy
- anterior face height
- A line
- APO line
- Radney line
- maxillary central incisor to NA line
- skeletal convexity.

The mean, median, maximum and minimum values for all of the patients were calculated for the 13 measured values to the nearest two decimal points in Tables I and II. A comparison of African-American average values with Caucasian averages are found in Tables III and IV, and Table V juxtaposes the African-American male and female measurements.

Discussion

No previous study has determined many of these measurements for African-Americans, and some of them are not routinely applied to Caucasians, e.g., the A-B discrepancy as measured by using True Horizontal as a reference, the Radney line, the A line developed by Alvarez and the Holdaway measurements of maxillary lip related to the upper lip sulcus. Nevertheless, these measurements have distinct relevance to any evaluation of patient soft-tissue

profiles and need inclusion in the routine cephalometric assessment of patients.

Orthodontic clinicians generally agree that the patient with average measurements rarely appears, and that planning therapy on average quantities imposes unnecessary and undesirable limitations. Nevertheless, averages take on new meaning when combined with normal ranges and can help in differentiating those patients who will benefit from orthodontic procedures from those needing orthopedic therapy or surgical intervention.

Even the most unsophisticated clinician appreciates the uselessness of applying Caucasian measurements to African-American populations, but when assessing soft-tissue profiles of African-Americans, orthodontists have not had a robust guide that provided useful data. This collection of cephalometric particulars provides a numerical basis for

Female African-American Measurements: Table I

	Soft-tissue facial angle	Skeletal angle of convexity	Up sulcus	Subnasale to H line	H angle	Lo lip to H line	A-B diff	A line	APo	Radney line	Maxillary central	Convexity
Patient 1	78.0	76.0	6.0	12.0	23.0	1.0	10.0	-1.0	5.0	2.0	7.0	5.0
Patient 2	85.0	83.0	7.0	13.0	24.0	2.0	4.0	1.0	6.0	4.0	7.0	4.0
Patient 3	83.0	79.0	8.0	11.0	20.0	3.0	8.0	1.0	3.0	-4.0	3.0	8.0
Patient 4	82.0	89.0	6.0	14.0	24.0	3.0	12.0	0.0	4.0		3.0	8.0
Patient 5	85.0	80.0	6.0	10.0	17.0	2.0	6.0	1.0	5.0	3.0	8.0	4.0
Patient 6	80.0	78.0	9.0	10.0	10.0	5.0	-4.0	7.0	6.0	5.0	10.0	1.0
Patient 7	87.0	83.0	7.0	11.0	25.0	4.0	2.0	4.0	7.0	5.0	7.0	5.0
Patient 8	84.0	77.0	8.0	16.0	19.0	5.0	13.0	2.0	8.0	2.0	7.0	8.0
Patient 9	87.0	85.0	6.0	10.0	17.0	6.0	9.0	3.0	8.0	4.0	10.0	4.0
Patient 10	81.0	78.0	5.0	11.0	22.0	1.0	5.0	0.0	4.0	2.0	6.0	4.0
Patient 11	85.0	78.0	7.0	11.0	20.0	1.0	9.0	1.0	7.0	0.0	5.0	9.0
Patient 12	87.0	84.0	5.0	11.0	23.0	3.0	8.0	1.0	5.0	2.0	6.0	6.0
Patient 13	86.0	81.0	6.0	11.0	20.0	5.0	9.0	1.0	7.0	4.0	7.0	4.0
Patient 14	81.0	78.0	4.0	8.0	20.0	3.0	10.0	0.0	4.0	-1.0	5.0	8.0
Patient 15	85.0	79.0	6.0	10.0	16.0	2.0	10.0	0.0	8.0	3.0	6.0	5.0
Patient 16	83.0	79.0	4.0	8.0	14.0	2.0	6.0	3.0	7.0	5.0	8.0	6.0
Patient 17	87.0	82.0	7.0	10.0	26.0	1.0	4.0	0.50	3.0	1.0	7.0	6.0
Patient 18	85.0	81.0	9.0	16.0	25.0	2.0	6.0	2.0	6.0	3.0	7.0	4.0
Patient 19	88.0	84.0	8.0	14.0	27.0	4.0	7.0	5.0	9.0	3.0	9.0	9.0
Patient 20	85.0	82.0	7.0	12.0	25.0	2.0	-3.0	2.0	4.0	2.0	7.0	3.0
Patient 21	87.0	85.0	8.0	10.0	17.0	3.0	0.0	6.0	7.0	8.0	10.0	2.0
Patient 22	87.0	83.0	7.0	11.0	19.0	1.0	4.0	0.50	6.0	2.0	5.0	6.0
Patient 23	82.0	80.0	4.0	8.0	17.0	3.0	0.0	4.0	6.0	6.0	7.0	1.0
Patient 24	87.0	85.0	8.0	13.0	19.0	0.0	3.0	0.0	2.0	0.0	6.0	3.0
Patient 25	86.0	82.0	4.0	7.0	15.0	1.0	4.0	-1.0	2.0	-2.0	3.0	4.0
Patient 26	84.0	81.0	7.0	13.0	22.0	2.0	7.0	3.0	6.0	4.0	9.0	4.0
Patient 27	83.0	78.0	5.0	10.0	14.0	2.0	10.0	0.0	6.0	2.0	5.0	4.0
Patient 28	88.0	83.0	4.0	10.0	23.0	1.0	4.0	0.50	0.0	-3.0	4.0	5.0
Patient 29	90.0	86.0	8.0	12.0	25.0	4.0	3.0	5.0	6.0	2.0	7.0	7.0
Patient 30	85.0	84.0	4.0	8.0	20.0	4.0	4.0	0.0	4.0	0.0	6.0	6.0
Patient 31	87.0	81.0	8.0	15.0	21.0	1.0	10.0	0.0	5.0	-2.0	5.0	8.0
Patient 32	86.0	83.0	6.0	10.0	16.0	4.0	7.0	1.0	5.0	3.0	7.0	8.0
Patient 33	85.0	80.0	7.0	11.0	21.0	6.0	6.0	5.0	7.0	2.0	8.0	8.0
Patient 34	83.0	78.0	7.0	11.0	18.0	2.0	9.0	0.0	3.0	-2.0	4.0	7.0
Patient 35	88.0	86.0	8.0	10.0	21.0	5.0	-3.0	5.0	2.0	3.0	9.0	2.0
Patient 36	85.0	83.0	6.0	10.0	21.0	0.0	1.0	0.0	3.0	1.0	7.0	3.0
Patient 37	84.0	80.0	7.0	15.0	25.0	4.0	7.0	4.0	7.0	3.0	8.0	7.0
Patient 38	89.0	84.0	6.0	10.0	28.0	6.0	7.0	0.0	3.0	1.0	5.0	4.0
Patient 39	83.0	79.0	8.0	14.0	21.0	-2.0	8.0	0.0	0.0	-6.0	1.0	8.0
Patient 40	81.0	77.0	6.0	10.0	24.0	5.0	7.0	2.0	6.0	0.0	4.0	9.0
Mean	84.85	81.35	6.48	10.80	20.60	2.73	5.73	1.71	5.05	1.72	6.38	5.43
Minimum	78.00	76.00	4.00	7.00	10.00	-2.00	-4.00	-1.00	0.00	-6.00	1.00	1.00
Maximum	90.00	89.00	9.00	16.00	28.00	6.00	13.00	7.00	9.00	8.00	10.00	9.00
Median	85.00	81.00	7.00	11.00	21.00	2.50	6.50	1.00	5.50	2.00	7.00	5.00
Stan.dev.	2.61	3.00	1.45	2.19	3.99	1.85	4.03	2.08	2.16	2.81	2.07	2.27

such an appraisal and offers both doctors and developers of cephalometric software a more inclusive manner in evaluating these patients' profiles.

This study did not find the narrow relationship between ideally positioned maxillary and mandibular incisors and the profiles of these patients as previous investigators found for Caucasian populations, but it has provided some improved parameters that clinicians can rely on when considering soft tissue profiles of African-American patients. For example, Caucasian maxillary incisors will align on or within 1 mm of the Alvarez A line, whereas the African-American has twice that range of 2 mm ± 2 mm. Yet this range, while double that of the Caucasian, can still serve as a dependable reference for planning treatment. When examining patients with thick soft tissue integuments, doctors will be better served by evaluating the amount of soft tissue strain in and

Male African-American Measurements: Table II

	Soft-tissue facial angle	Skeletal angle of convexity	Up sulcus	Subnasale to H line	H angle	Lo lip to H line	A-B diff	A line	APo	Radney line	Maxillary central	Soft-tissue facial angle
Patient 1	84	83	7	14	18	1	11	0	4	0	5	6
Patient 2	82	81	6	16	25	2	15	0	4	-2	3	9
Patient 3	90	85	7	11	26	0	2	5	10	4	8	5
Patient 4	88	83	9	14	22	1	11	2	6	0	6	10
Patient 5	87	82	8	12	19	5	6	1	6	3	6	4
Patient 6	89	87	4	11	24	4	11	2	5	2	6	6
Patient 7	84	79	5	10	24	5	6	1	5	2	6	5
Patient 8	84	81	9	17	24	1	9	3	6	1	6	8
Patient 9	90	87	4	9	20	5	8	2	6	3	7	4
Patient 10	82	80	6	11	28	1	7	0	4	3	6	3
Patient 11	95	80	9	12	20	1	8	0	0	-6	1	7
Patient 12	88	82	8	14	25	0	8	-2	3	1	3	3
Patient 13	82	80	5	17	15	0	4	-2	0	0	5	4
Patient 14	80	77	9	15	22	5	9	5	9	5	9	7
Patient 15	86	82	9	15	25	5	4	5	4	1	7	6
Patient 16	87	85	10	16	23	4	6	3	5	5	9	4
Patient 17	85	81	5	10		4	7	3	8	5	8	4
Patient 18	86	84	6	9	25	3	2	3	4	0	6	7
Patient 19	88	84	8	11	20	2	3	2	4	2	8	4
Patient 20	87	83	9	14	22	4	4	2	7	3	6	6
Patient 21	90	88	7	10	18	-3	5	0	3	-6	3	4
Patient 22	80	78	6	15	25	3	13	0	6	1	6	9
Patient 23	86	82	10	23	26	5	12	1	10	4	8	5
Patient 24	83	80	5	12	29	4	7	0.5	2	-3	4	7
Patient 25	82	80	5	11	22	3	5	6	8	4	10	5
Patient 26	84	81	6	10	18	1	1	5	7	7	11	3
Patient 27	86	84	5	10	19	0	3	1	5	2	7	4
Patient 28	82	77	6	15	25	7	14	0	10	5	7	7
Patient 29	81	78	7	15	30	6	6	3	7	4	10	6
Patient 30	87	82	10	16	27	2	4	1	5	1	7	5
Patient 31	81	78	9	17	25	2	7	1	5	4	7	3
Patient 32	81	78	6	11	16	4	10	-1	4	4	5	1
Patient 33	86	82	8	11	19	1	3	0.5	4	3	6	3
Patient 34	87	85	10	15	24	5	0	7	8	7	10	3
Patient 35	83	80	6	10	17	5	11	2	6	2	7	6
Patient 36	82	77	8	17	22	6	12	1	10	5	5	5
Patient 37	82	76	7	11	23	5	5	3	5	3	11	3
Patient 38	88	82	8	16	27	4	12	0.5	6	2	5	7
Patient 39	86	82	7	12	18	4	5	0	7	6	5	2
Patient 40	87	84	8	15	24	7	6	5	12	8	10	4
Patient 41	85	80	6	16	28	5	14	3	9	4	10	9
Patient 42	84	80	6	10	18	2	6	1	6	1	7	6
Means	85.2	81.4	7.1	13.2	22.6	3.1	7.2	1.8	5.8	2.4	6.7	5.2
Median	85.2	81.4	7.0	13.2	23.0	4.0	7.0	1.0	6.0	3.0	6.7	5.0
Minimum	80	76	4	9	15	-3	0	-2	0	-6	1	1
Maximum	90	88	10	24	30	7	15	7	12	8	11	10
Stand. Devi												

around the lips. As long as patients can close into centric occlusion with the lips comfortably and naturally opposed without straining the mentalis muscle, clinicians can reasonably conclude that the soft tissue profile has a natural and acceptable contour–regardless of the lip thickness.

However, an esthetic desire to reduce patient soft tissue protrusiveness will benefit from the application of data that can assist doctors in the development of a treatment plan that will satisfy those patient demands. When combined with information developed by Diels[30] et al and Yogosawa[31], this study will provide orthodontic clinicians with measurements that can assist them in setting realistic goals for the retraction of lips and incisors subsequent to the removal of posterior teeth. Doctors can share this information with requesting patients in the form of Visualized Treatment Objectives[32,33,34] to determine if such expected changes meet with their esthetic ambitions.

Conclusion

Although researchers have devoted considerable time and effort to the study of ideal soft issue profiles for Caucasians, they have neglected any systematic or thorough consideration for the ideal African-American profile. Eighty-two African-American adolescents between the ages of 13 to 18 (40 females, 42 males) participated in this study that evaluated and measured their soft tissue profiles among other cephalometric features. All of the participants with perceived malocclusions presented with untreated Class I occlusions and acceptable profiles; i.e., lips that in repose had no strain or mentalis constriction, regardless of protrusion. None had a history of facial trauma or any noticeable vertical, transverse or anteroposterior discrepancies, and none had any missing or primary teeth. The cephalometric profile images eliminated influences of skin tone, hair styles, body piercings, etc. that might influence judgments.

Alvarez, Holdaway and Creekmore discovered among Caucasians with acceptable profiles and untreated Class I occlusions a highly defined and narrow relationship between the maxillary incisors and lip position. The range of measurements of this African-American population was typically twice the quantity of the Caucasian groups, but they still provide measurements that orthodontic clinicians can usefully apply to patient therapies. As expected, the cephalometric measurements of this group of individuals differed substantially from Caucasians. Although this study did not find a limited and restrictive formula for the placement of maxillary and mandibular incisors as in Caucasians, this investigation did discover that these African-Americans presented with much wider variations

Table III

VALUE	AFRICAN-AMERICAN MALES	CAUCASIAN MALES
Soft-tissue facial angle	84°± 3°	91° ± 7°
Skeletal profile convexity	81° ± 3°	82.5° ± 4°
Upper lip sulcus	7mm ± 2mm	3mm ± 1mm
Subnasale to H line	13mm ± 3mm	5mm ± 2mm
H angle	23° ± 4°	10° ± 4°
Lo lip to H line	3mm ± 2mm	0 ± 1mm
A-B difference	7mm ± 4mm	4mm ± 2mm
A line	2mm ± 2mm	0 ± 1mm
APo line to mandibular incisor	6mm ± 3mm	2mm ± 2.5mm
Radney line (Lo 1 to NA)	2mm ± 3mm	0 ± 1mm
Maxillary central incisor from NA	7mm ± 2mm	4mm ± 1mm
Convexity	5mm ± 2mm	0 ± 2mm

Table IV

VALUE	AFRICAN-AMERICAN FEMALES	CAUCASIAN FEMALES
Soft-tissue facial angle	85°± 3°	91° ± 7°
Skeletal profile convexity	81° ± 3°	85° ± 3°
Upper lip sulcus	6mm ± 1mm	3mm ± 1mm
Subnasale to H line	11mm ± 2mm	5mm ± 2mm
H angle	21° ± 4°	10° ± 4°
Lo lip to H line	3mm ± 2mm	0 ± 1mm
A-B difference	6mm ± 4mm	4mm ± 2mm
A line	2mm ± 2mm	0 ± 1mm
APo line to mandibular incisor	5mm ± 2mm	2mm ± 2.5mm
Radney line (Lo 1 to NA)	2mm ± 3mm	0 ± 1mm
Maxillary central incisor from NA	6mm ± 2mm	4mm ± 2.5mm
Convexity	5mm ± 2mm	0 ± 2mm

Table V

VALUE	AFRICAN-AMERICAN FEMALES	AFRICAN-AMERICAN MALES
Soft-tissue facial angle	85°± 3°	84°± 3°
Skeletal profile convexity	81° ± 3°	81° ± 3°
Upper lip sulcus	6mm ± 1mm	7mm ± 2mm
Subnasale to H line	11mm ± 2mm	13mm ± 3mm
H angle	21° ± 4°	23° ± 4°
Lo lip to H line	3mm ± 2mm	3mm ± 2mm
A-B difference	6mm ± 4mm	7mm ± 4mm
A line	2mm ± 2mm	2mm ± 2mm
APo line to mandibular incisor	5mm ± 2mm	6mm ± 3mm
Radney line (Lo 1 to NA)	2mm ± 3mm	2mm ± 3mm
Maxillary central incisor from NA	6mm ± 2mm	7mm ± 2mm
Convexity	5mm ± 2mm	5mm ± 2mm

in all of their cephalometric measurements than those of Caucasians and has furnished clinicians with some heretofore unavailable objective guidelines for assessing African-American patient soft-tissue profiles. The measurements discovered with this group of African-American adolescents combined with a thorough clinical examination should afford orthodontic clinicians a more practical and realistic assessment than previous analyses offered. OP

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