Malocclusion and Craniofacial Characteristics in Saudi Adolescents with Sickle Cell Disease

Ahmed Basyouni, Naif Nasser Almasoud, Khalifa Sulaiman Al-Khalifa, Badr Abdulrahman Al-Jandan, Osama Abdulsalam Al Sulaiman, Muhammad Ashraf Nazir
Departments of Preventive Dental Sciences and Biomedical Dental Science, College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Abstract

Background: Sickle cell disease can result in dentofacial abnormalities. However, in Saudi Arabia, there are limited data with respect to orthodontic manifestations in patients with sickle cell disease.

Objective: To determine the malocclusion and craniofacial characteristics in sickle cell disease adolescents and compare them with that of controls from the Eastern Province of Saudi Arabia.

Methods: This comparative cross-sectional study included 112 Saudi patients with sickle cell disease, aged 12–18 years, and 124 age-matched Saudi controls from three major hospitals in Al Khobar and Dammam, Saudi Arabia. The Dental Aesthetic Index was used to assess malocclusion and orthodontic treatment needs. Digital lateral cephalometric radiographs were recorded for each patient and control, and its analysis included linear and angular measurements.

Results: The prevalence of malocclusion was 87.5% in sickle cell disease patients and 54% in controls (P = 0.0001). The percentage of sickle cell disease patients with severe malocclusion that required orthodontic treatment was higher than that of controls (37.5% vs. 26.6%). In the sickle cell disease cohort, incisal segment crowding (72.4%), overjet (67.3%) and maxillary misalignment in the anterior segment (56%) were the most prevalent types of malocclusions and were significantly higher than that of controls (P < 0.05). About 38% and 67% of the sickle cell disease patients had openbite and posterior crossbite, respectively, compared with 19.3% (P = 0.001) and 37.1% (P = 0.0001) of controls, respectively. Cephalometric analysis showed that SNA (86.7°) and ANB (9.9°) angles were significantly higher in sickle cell disease patients than in controls (81.5° and 2°, respectively). In addition, lower central incisor-to-Frankfort horizontal plane (55°) and interincisal angles (121.5°) were significantly lower in sickle cell disease patients than in controls.

Conclusion: Adolescents with sickle cell disease had a higher prevalence of malocclusion and greater orthodontic treatment needs than controls. Similarly, they had greater incisal crowding, overjet, openbite and posterior crossbite and demonstrated higher SNA, ANB and lower interincisal angles than controls. The findings of this study suggest that adolescents with sickle cell disease should be provided frequent dental examinations and early orthodontic treatment to improve their oral health, and thus quality of life.

Keywords: Adolescents, craniofacial, malocclusion, Saudi, sickle cell disease

Address for correspondence: Dr. Muhammad Ashraf Nazir, Department of Preventive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia. E-mail: manazir@iau.edu.sa

How to cite this article: Basyouni A, Almasoud NN, Al-Khalifa KS, Al-Jandan BA, Al Sulaiman OA, Nazir MA. Malocclusion and craniofacial characteristics in Saudi adolescents with sickle cell disease. Saudi J Med Med Sci 2018;6:149-54.
INTRODUCTION

Sickle cell disease (SCD) is a common genetic abnormality that affects about 20–25 million people worldwide, with 300,000 new cases being diagnosed every year. Sickle cell anemia (SCA) is the most common and severe form of SCD. Frequent painful crises, episodes of acute chest syndrome, symptomatic osteonecrosis, priapism, overt stroke, persistent splenomegaly and gallstones are some of the clinical conditions common among SCA patients. SCD results in poor health-related quality of life, and the same has also been reported among Saudi adolescents with SCD. In Saudi Arabia, SCD is widely distributed, but is most prevalent in the Eastern Province, and the SCA patients of this region primarily have the milder Arab–Indian (AI) haplotype.

Reduced oxygen supply to oral tissues can cause osteomyelitis of the jaw. This, in turn, leads to neuropathic changes in the mental nerve and results in numbness of areas supplied by this nerve such as the chin and lower lip. Oral manifestations of SCD include delayed tooth eruption, pallor of oral mucosa, orofacial pain and increased susceptibility to oral infections. In addition, hypercementosis, development of pulpal stones, necrosis of pulp as well as enamel and dentine hypomineralization can occur. In SCD, the craniofacial complex can undergo abnormal changes including oxycephaly, a large trabecular bone pattern and protrusion of jaws, and these changes can lead to skeletal and dental malocclusions, thereby compromising patients’ psychosocial behavior and esthetics. Several dentofacial abnormalities have been reported in African SCA patients, including opacity of the teeth, malocclusion, delayed tooth eruption, developmental problems of enamel and dentine, calcification of pulp and greater maxillary incisor proclination.

In terms of prevalence and types of malocclusions in SCD patients, in Nigeria, the prevalence of malocclusion has been reported in 88.5% of SCA patients, with 48.2% having increased overjet. Another study from Nigeria observed that 35% of SCD patients, compared with 16.6% of controls, had increased overbite and overjet. In Brazil, a study found that all the 36 SCD adolescent patients analyzed had malocclusion. In a retrospective study of SCD patients, 56% were reported to have increased overjet in the United States. Further, cephalometric analysis has shown that maxillary incisor proclination is significantly higher among SCD patients than among controls.

Despite the high prevalence of SCD in Saudi Arabia, limited data are available about the craniofacial anomalies, including malocclusion, among Saudi SCD patients. The objective of the study was to determine the prevalence of malocclusion, orthodontic treatment needs and craniofacial characteristics in SCD adolescents and compare them with that of non-SCD adolescents from Al Khobar and Dammam, Saudi Arabia.

METHODS

This comparative cross-sectional study included 112 SCD Saudi patients aged 12–18 years attending the SCD clinics at King Fahd Hospital of the University, Al Khobar, and at Dammam Central Hospital and Al-Qatif Central Hospital, Dammam, between October 2012 and November 2013. This study included adolescents because they tend to exhibit changes in bone that affect their facial profile. SCD clinics diagnosed patients based on hematological, molecular and genetic tests. Subsequently, 124 age-matched, Saudi, non-SCD controls were recruited from the surgical outpatient and pediatric clinics of these hospitals. A convenience sampling technique was used for recruiting the study participants.

Exclusion criteria included current, or a history of, orthodontic or orthopedic treatment that involved facial surgery (orthognathic or plastic), carriers of a congenital syndrome or craniofacial abnormality and/or SCD patients who were fully edentulous. SCD patients in crisis and those with no genotype records were also excluded from the study. An informed consent form was sent to the parents or guardians, and adolescents whose parent/guardian provided a signed consent were included in the study. The study was also conducted in accordance with the Declaration of Helsinki, 2013. Ethical approval for this study was obtained from the Institutional Review Board (#2017-2-206) of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia.

Each participant provided demographic data including age, gender and parents’ education. Subsequently, each participant underwent intraoral clinical examinations and radiographic assessments. The Dental Aesthetic Index (DAI) was used to assess the severity of malocclusion and orthodontic treatment needs of the study participants. Ten components of DAI that broadly evaluate dentition, spacing and occlusion were assessed. The World Health Organization guidelines for oral examination were followed during data collection. Clinical examination was conducted using community periodontal probe, a mirror, gloves, a wooden spatula, cotton gauze and artificial light. Calibration of the examiner was carried out on a sample of 20 patients by an experienced orthodontist.
(gold standard) who was an expert in using DAI (κ > 0.80). About 15 participants were reexamined by the examiner to ensure intraexaminer reliability. Moreover, the severity of malocclusion was also assessed by evaluating posterior openbite, posterior crossbite and overbite,[20] as DAI does not cover these occlusal traits.[21]

Standardized digital lateral cephalometric radiographs were recorded for each patient and control. Cephalometric radiographs were obtained using X-ray Kodak 8000c (Care Stream Health, Rochester, NY, USA). Furthermore, to ensure consistency, the machine was positioned at an identical height and distance from each patient. The films were traced using acetate paper by the examiner. Cephalometric analysis included linear and angular measurements that were performed twice to reduce errors. Intraexaminer reliability was evaluated twice within 2 months.[22]

Statistical analysis was conducted using the SPSS software (version 22; IBM SPSS Statistics for Windows, Armonk, NY, USA). Means and standard deviations were calculated for quantitative variables, and percentages were calculated for qualitative variables. Comparisons were made between SCD patients and controls using Pearson’s chi-square test and Student’s t-test. P < 0.05 was considered statistically significant.

RESULTS

The mean age of the SCD controls was 15.6 ± 1.7 years, while the mean age of the controls was 16.2 ± 1.9 years. In the SCD patient group, 54.5% (n = 61) were males, whereas in the control group, 58.9% (n = 73) were females [Table 1]. The results indicate that 34.8% of SCD patients presented with canine Class II, 41% with increased overjet, 15.2% with deep overbite and 67% with posterior crossbite. On the other hand, 27.4% of the control group had canine Class II, 22.5% had increased overjet, 16.1% had deep overbite and 37.1% had posterior crossbite. About 38.4% (n = 43) of the SCD patients had openbite compared with 19.3% (n = 24) of controls (P = 0.001) [Table 2].

Table 3 shows that 37.5% of SCD patients had severe malocclusion (DAI: 31–35) that required orthodontic treatment and 12.5% had very severe or disabling malocclusion that required mandatory orthodontic treatment. However, in the control group, only 26.6% had severe malocclusion and 6.5% had very severe or disabling malocclusion. According to the DAI criteria, more SCD patients (72.4%) had incisal crowding than controls (56.7%). Overjet was found in 67.3% of SCD patients and in 32.8% of controls. Similarly, a greater percentage of SCD patients exhibited maxillary and mandibular misalignment than controls [Table 4].

The results in Table 5 indicate that the SNA (86.7°) and ANB (9.9°) angles in SCD patients were significantly higher than the angles in the control group (81.5° and 2°, respectively). Lower central incisor-to-Frankfort horizontal (FH) plane (55°) and interincisal (121.5°) angles were significantly lower in SCD patients than that in controls. The ratio of posterior facial height to anterior facial height was significantly lower in SCD patients (60.4%) than that in controls (66.8%). In addition, the SNB (76.8°), SNPog (76.4°), facial angle (81.2°) and angle of convexity (11.4°) in SCD patients were significantly lower than that in controls. Furthermore, the nasolabial angle was significantly smaller in SCD patients (80.5°) than in controls (95.6°). Figure 1 shows a cephalometric radiograph of an SCD patient with maxillary protrusion.

DISCUSSION

Oral manifestation of SCD can result in several changes and abnormalities.[3,4,8‑10] However, little is known about the orthodontic manifestations in Saudi SCD patients. In Saudi

| Table 1: Gender and parents’ education level of the study participants |
|------------------------------------------------------------|
| Variables | SCD patients (n = 112), n (%) | Non-SCD controls (n = 124), n (%) |
| Gender | | |
| Male | 61 (54.5) | 51 (41.1) |
| Female | 51 (45.5) | 73 (58.9) |
| Parents’ education level | | |
| College degree | 27 (24) | 55 (44.4) |
| High school education | 47 (42) | 46 (37.1) |
| Primary school education | 38 (34) | 23 (18.5) |

SCD – Sickle cell disease

| Table 2: Malocclusion among sickle cell disease patients and non-sickle cell disease controls |
|------------------------------------------------|
| Variables | SCD patients (n = 112), n (%) | Non-SCD controls (n = 124), n (%) | P |
| Malocclusion | | |<0.0001* |
| Canine classification | | | |
| Class I | 73 (65.2) | 90 (72.6) | 0.243 |
| Class II | 39 (34.8) | 34 (27.4) | |
| Overjet | | | |
| Normal | 66 (59) | 96 (77.5) | 0.003* |
| Increased | 46 (41) | 28 (22.5) | 0.001* |
| Overbite | | | |
| Normal | 28 (25) | 51 (41.1) | 0.009* |
| Deep | 17 (15.2) | 20 (16.1) | 0.832 |
| Reduced | 24 (21.4) | 29 (23.4) | 0.711 |
| Openbite | 43 (38.4) | 24 (19.3) | 0.001* |
| Posterior crossbite | | | |
| Present | 75 (67) | 46 (37.1) | <0.0001* |
| Absent | 37 (33) | 78 (62.9) | |

*Statistically significant. SCD – Sickle cell disease
Table 3: Dental Aesthetic Index results of the study participants

| DAI classification                                      | SCD patients (n = 112, n (%)) | Non-SCD controls (n = 124, n (%)) | P     |
|--------------------------------------------------------|-------------------------------|-----------------------------------|-------|
| No abnormality or mild malocclusion (DAI ≤25) (no or slight treatment need) | 22 (19.6)                    | 46 (37.1)                         | 0.002*|
| Definite malocclusion (26–30) (treatment elective)    | 34 (30.4)                     | 37 (29.8)                         | 0.867 |
| Severe malocclusion (31–35) (treatment highly desirable) | 42 (37.5)                     | 33 (26.6)                         | 0.068 |
| Very severe or disabling malocclusion (≥36) (treatment mandatory) | 14 (12.5)                     | 8 (6.5)                           | <0.0001*|

*Statistically significant. DAI – Dental Aesthetic Index; SCD – Sickle cell disease

Table 4: Criteria of the Dental Aesthetic Index

| Variable                               | SCD patients, n (%) | Non-SCD controls, n (%) | P      |
|----------------------------------------|---------------------|-------------------------|--------|
| Malocclusion                           |                     |                         |        |
| Yes                                    | 98 (87.5)           | 67 (54)                 | <0.0001*|
| No                                     | 14 (12.5)           | 57 (46)                 |        |
| Number of missing teeth                |                     |                         |        |
| None                                   | 68 (69.4)           | 58 (86.6)               | 0.001* |
| One tooth                              | 19 (19.4)           | 7 (10.4)                | 0.051  |
| Two to six teeth                       | 11 (11.2)           | 2 (3)                   | 0.015* |
| Incisal segment crowding               |                     |                         |        |
| Present                                | 71 (72.4)           | 38 (56.7)               | 0.016* |
| Absent                                 | 27 (27.5)           | 29 (43.3)               |        |
| Incisal segment spacing                |                     |                         |        |
| Present                                | 28 (28.6)           | 30 (44.8)               | 0.011* |
| Absent                                 | 70 (71.4)           | 37 (55.2)               |        |
| Diastema                               |                     |                         |        |
| Present                                | 21 (21.4)           | 12 (17.9)               | 0.561  |
| Absent                                 | 77 (78.6)           | 55 (82.1)               |        |
| Maxillary misalignment                 |                     |                         |        |
| Present                                | 55 (56)             | 20 (30)                 | <0.0001*|
| Absent                                 | 43 (44)             | 47 (70)                 |        |
| Mandibular misalignment                |                     |                         |        |
| Present                                | 45 (45.9)           | 21 (31.3)               | 0.017* |
| Absent                                 | 53 (54.1)           | 46 (68.7)               |        |
| Overjet                                |                     |                         |        |
| Present                                | 66 (67.3)           | 22 (32.8)               | <0.0001*|
| Absent                                 | 32 (32.7)           | 45 (67.2)               |        |
| Anterior openbite                       |                     |                         |        |
| Present                                | 42 (42.9)           | 14 (20.9)               | 0.0003*|
| Absent                                 | 56 (57.1)           | 53 (79.1)               |        |
| Anteroposterior molar condition         |                     |                         |        |
| Normal                                 | 34 (34.7)           | 26 (38.8)               | 0.525  |
| Half cusp                              | 26 (26.5)           | 25 (37.3)               | 0.069  |
| Entire cusp                            | 38 (38.8)           | 16 (23.9)               | 0.013* |

*Statistically significant. SCD – Sickle cell disease

**Arabia, SCD is most prevalent in the Eastern Province.**[6,7]** Accordingly, this study provides valuable information about malocclusion, orthodontic treatment needs and craniofacial characteristics of patients with SCD in the Eastern Province of Saudi Arabia.**

Using DAI, the present study found high prevalence (87.5%) of malocclusion in the SCD cohort. This finding is in line with that of Costa et al.[10] and Alves e Luna et al.[14] who, also using DAI, reported that 76.3% of SCA and ~100% of SCD patients, respectively, had malocclusion. In addition, similar to our study, Costa et al.[10] found that SCA patients have higher orthodontic treatment needs than controls. In Brazil, Costa et al.[10] reported that 30% of SCA patients had very severe or disabling malocclusion, whereas Alves e Luna et al.[16] found that 80.6% of SCD adolescents presented with very severe or disabling malocclusion. In Nigeria, Onyeaso and da Costa[23] reported that 50% of SCD patients had very severe or disabling malocclusion. The high prevalence of malocclusion among SCD patients could be due to skeletal changes in jaws, orofacial muscular imbalance and lack of proper lip seal.[11]

In the present SCD cohort, incisal segment crowding (72.4%), overjet (67.3%) and maxillary misalignment in the anterior segment (56.0%) were the most prevalent types of malocclusions and were significantly higher than that in controls. The expansion of bone marrow to compensate for premature breakdown of red blood cells and reduced oxygen supply results in higher prevalence of malocclusion in SCD patients than that in healthy individuals.[10] Costa et al.[10] found mandibular misalignment in the anterior segment to be the most prevalent malocclusion (86%) in SCA patients followed by incisal segment crowding (79.6%), maxillary misalignment (68.8%) and overjet (67.7%). Surprisingly, they reported that mandibular and maxillary misalignments were more pronounced in controls than that in SCA patients. Other studies found lower prevalence of different types of malocclusion in patients with SCD. For example, Okafor et al.,[11] daCosta et al.[15] and Taylor et al.[15] found that 35%, 48.2% and 30% of SCD patients, respectively, had overjet malocclusion. The prevalence of
In the present study, the prevalence of malocclusion, orthodontic treatment needs and craniofacial traits was reported in SCD adolescents and compared with the control group. Therefore, this comparative study has greater strength than a similar descriptive study without a control group. In addition, the study used a large sample size, and clinical recordings were measured by a calibrated examiner using standardized procedures. However, due to the limited availability of SCD patients, a convenience sampling technique was used, which has limitations such as improper representation of subgroups of different sociodemographic origins.

CONCLUSION

The study found that SCD patients had a higher prevalence of malocclusion and greater orthodontic treatment needs than controls. Malocclusions such as incisal crowding, overjet, openbite and posterior crossbite were more pronounced in SCD adolescents than in controls. Similarly, SCD patients had higher SNA and ANB angles and lower interincisal angle than controls. Given the high prevalence of malocclusion and the orthodontic treatment needs due to systemic complications of SCD, it is recommended that patients with SCD should be provided with frequent dental examinations and early orthodontic treatment. These measures will help prevent malocclusion, and thus improve the quality of life of SCD patients.

Acknowledgment

The authors would like to thank the Deanship of Scientific Research at Imam Abdulrahman Bin Faisal University for funding this work.

Financial support and sponsorship

This work was funded by a grant (Project #2012133) from the Deanship of Scientific Research at Imam Abdulrahman Bin Faisal University.

Conflicts of interest

There are no conflicts of interest.
REFERENCES

1. Aygun B, Odame I. A global perspective on sickle cell disease. Pediatr Blood Cancer 2012;59:386-90.
2. Piel FB, Hay SI, Gupta S, Weatherall DJ, Williams TN. Global burden of sickle cell anaemia in children under five, 2010-2050: Modelling based on demographics, excess mortality, and interventions. PLoS Med 2013;10:e1001484.
3. Javed F, Correa FO, Nooh N, Almas K, Romanos GE, Al-Hezaimi K, et al. Orofacial manifestations in patients with sickle cell disease. Am J Med Sci 2013;345:234-7.
4. da Fonseca M, Oueis HS, Casamassimo PS. Sickle cell anemia: A review for the pediatric dentist. Pediatr Dent 2007;29:159-69.
5. Amr MA, Amin TT, Al-Omair OA. Health related quality of life among adolescents with sickle cell disease in Saudi Arabia, Pan Afr Med J 2011;8:10.
6. Al-Qurashi MM, El-Mouzan MI, Al-Herbish AS, Al-Salloum AA, Al-Omair AA. The prevalence of sickle cell disease in Saudi children and adolescents. A community-based survey. Saudi Med J 2008;29:1480-3.
7. Jastaniah W. Epidemiology of sickle cell disease in Saudi Arabia. Ann Saudi Med 2011;31:289-93.
8. Mendes PH, Fonseca NG, Martelli DR, Bonan PR, de Almeida LK, de Melo LA, et al. Orofacial manifestations in patients with sickle cell anemia. Quintessence Int 2011;42:701-9.
9. Ramakrishna Y. Dental considerations in the management of children suffering from sickle cell disease: A case report. J Indian Soc Pedod Prev Dent 2007;25:140-3.
10. Costa CP, Carvalho HL, Souza Sde F, Thomaz EB. Is sickle cell anemia a risk factor for severe dental malocclusion? Braz Oral Res 2015;29, pii:S1808-83242015000100219.
11. Okafor LA, Nonnoo DC, Ojehanon PI, Aikhionbare O. Oral and dental complications of sickle cell disease in Nigerians. Angiology 1986;37:672-5.
12. Licciardello V, Bertuna G, Samperi P. Craniofacial morphology in patients with sickle cell disease: A cephalometric analysis. Eur J Orthod 2007;29:238-42.
13. Oredugba FA, Savage KO. Anthropometric finding in Nigerian children with sickle cell disease. Pediatr Dent 2002;24:321-5.
14. Pithon MM. Orthodontic treatment in a patient with sickle cell anemia. Am J Orthod Dentofacial Orthop 2011;140:713-9.
15. daCosta OO, Kehinde MO, Ibidapo MO. Occlusal features of sickle cell anemia patients in Lagos, Nigeria. Niger Postgrad Med J 2005;12:121-4.
16. Alves e Luna AG, Godoy F, de Menezes VA. Malocclusion and treatment need in children and adolescents with sickle cell disease. Angle Orthod 2014;84:467-72.
17. Taylor LB, Nowak AJ, Giller RH, Casamassimo PS. Sickle cell anemia: A review of the dental concerns and a retrospective study of dental and bony changes. Spec Care Dentist 1995;15:38-42.
18. Cons N, Jenny J, Kohout F. The Dental Aesthetic Index: Iowa City. A Master Thesis. College of Dentistry, University of Iowa, USA; 1986.
19. World Health Organization. Oral Health Surveys: Basic Methods. World Health Organization; 2013.
20. Ovsenik M, Farenik F, Verdenik I. Intra- and inter-examiner reliability of intraoral malocclusion assessment. Eur J Orthod 2007;29:88-94.
21. Cardoso CF, Drummond AF, Lages EM, Pretti H, Ferreira EF, Abreu MH, et al. The dental aesthetic index and dental health component of the index of orthodontic treatment need as tools in epidemiological studies. Int J Environ Res Public Health 2011;8:3277-86.
22. Onyeaso CO, daCosta OO. Dental aesthetics assessed against orthodontic treatment complexity and need in Nigerian patients with sickle-cell anemia. Spec Dentist 2009;29:249-53.
23. Pithon MM, Palmeira LM, Barbosa AA, Perreira R, de Andrade AC, Coqueiro Rda S, et al. Craniofacial features of patients with sickle cell anemia and sickle cell trait. Angle Orthod 2014;84:825-9.
24. Maia NG, dos Santos LA, Coleta RD, Mendes PH, Bonan PR, Maia LB, et al. Facial features of patients with sickle cell anemia. Angle Orthod 2011;81:115-20.
25. Shnorhokian HI, Chapman DC, Nazif MM, Zullo TG. Cephalometric study of American black children with sickle-cell disease. ASDC J Dent Child 1984;51(6):431-3.
26. Altemus LA, Epps CW. Cephalofacial characteristics of North American black individuals with sickle cell disease. Q Natl Dent Assoc 1974;32:80-8.
27. Bornstein MH, Jager J, Putnick DL. Sampling in developmental science: Situations, shortcomings, solutions, and standards. Dev Rev 2013;33:357-70.