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ISPITIVANJE POUZDANOSTI POZICIONIRANJA TAČAKA PRI ANALIZI ASIMETRIJE LICA NA FOTOGRAFIJAMA: PILOT STUDIJA

TESTING THE RELIABILITY OF POINT POSITIONING IN THE ANALYSIS OF FACIAL ASYMMETRY IN PHOTOGRAPHY: A PILOT STUDY

Enita E. Nakaš[1], Jasmina D. Bukejlović[2]

[1]UNIVERZITET U SARAJEVU, STOMATOLOŠKI FAKULTET SA STOMATOLOŠKIM KLINIČKIM CENTROM, SARAJEVO, REPUBLIKA BOSNA I HERCEGOVINA
[2]MEDICINSKA ŠKOLA, DOBOJ, REPUBLIKA SRPSKA, BOSNA I HERCEGOVINA

[1] FACULTY OF DENTISTRY WITH CLINICS SARAJEVO, BOSNIA AND HERZEGOVINA
[2]PUBLIC INSTITUTION MEDICAL SCHOOL DOBOJ, BOSNIA AND HERZEGOVINA

Sažetak

Uvod: *U kliničkoj praksi mobilni telefoni i DSLR aparati (Digital Single Lens Reflex) koriste se za snimanje intraoralnih i ekstraoralnih fotografija. Postojanje velikog broja istraživanja omogućilo bi uspostavljanje standarda za analizu fotografija i kao i njihovu širu upotrebu u svakodnevnoj praksi radi uspostavljanja brze dijagnoze, predvidljivosti rezultata i razvoja teledentologije tokom pandemije COVID-19.*
Cilj *pilot studije je da se utvrdi ponovljivost pozicioniranja tačaka u analizi simetrije lica na digitalnim 2D fotografijama.*
Materijali i metode: *Jedno lice je fotografisano korišćenjem dve različite tehnike fotografisanja. Tačke su pozicionirane na jednoj fotografiji i korišćene za svako sledeće merenje. Dva ocenjivača su pozicionirala 20 poena u tri vremenski razdvojena perioda.*
Rezultati: *Rezultati sugerišu relativno visok stepen saglasnosti pozicioniranja tačaka koje su dala dva evaluatora. Apsolutno poklapanje procena registrovano je na 22 parametra (ICCs = 1.00), dok je na još 17 ova vrednost bila visoka (ICCs> .96.)*
Zaključak: *Ovo istraživanje pokazuje da su vrednosti međuklase koeficijenata korelacije izračunate metodom dvosmernih slučajnih efekata za svaki od šest indeksa veće od vrednosti donje granice prihvatljivosti (ICC> 0,70). Neophodno je uraditi dodatna istraživanja koja će obuhvatiti veći uzorak i različite modele telefona za utvrđivanje dijagnoze asimetrije lica i razvoja teledentologije.*

Ključne reči*: fotografija, teledentizam, asimetrija lica, covid19*

Corresponding author:
Jasmina Bukejlović, PhD student,
Medical school, Doboj,
54 A2 Svetog Save st, 74000, Doboj,
Republic of Srpska, Bosnia and Herzegovina
E-mail: jasmina_bukejlovic@yahoo.com
Phone: +38765060668

Abstract

Introduction: *In dental clinical practice, devices such as mobile phones and DSLR cameras (Digital Single Lens Reflex) are used to take intraoral and extraoral photographs. The existence of a large number of studies would allow the establishment of standards for the analysis of photographs and their wider use in daily practice in order to establish a rapid diagnosis, predictability of results and the development of teledentology during the COVID-19 pandemic.*
The aim *of the pilot study was to determine the repeatability of point positioning in the analysis of facial symmetry in digital 2D photography.*
Materials and methods: *One face was photographed using two different photography techniques. Points were positioned in one photo and used for each subsequent measurement. Two evaluators positioned 20 points in three time-separated periods.*
Results: *The results suggest a relatively high degree of agreement of the point positioning provided by the two evaluators. Absolute matching of estimates was registered on 22 parameters (ICCs = 1.00), while on another 17 this value was high (ICCs >.96)*
Conclusion: *This study shows that the values of the interclass of correlation coefficients calculated by the method of two-way random effects for each of the six indices are higher than the values of the lower limit of acceptability (ICC> 0.70). It is necessary to do additional research that will include a larger sample and different phone models to establish the diagnosis of facial asymmetry and the development of teledentistry.*

Key words: *photography, teledentistry, facial asymmetry, Covid-19*

Uvod

U kliničkoj praksi mobilni telefoni i DSLR aparati (Digital Single Lens Reflex) koriste se za snimanje intraoralnih i ekstraoralnih fotografija. Primena fotografije nastale pametnim telefonom u stomatologiji je jednostavna, brza i vrlo korisna za dokumentaciju kliničkih postupaka, kao i za pomoć u edukaciji pacijenata i za klinička ispitivanja[1,2,3]. Bez značajnih statističkih rezultata, možemo smatrati da će u narednim godinama fotografski aparat i opremu zameniti lagani pametni telefon[3]. Imajući na umu brzi napredak informacijskih tehnologija i mobilnih i računarskih sistema, očekuje se, u bliskoj budućnosti, da će se određivanje parametara lica pacijenata i analiza dobijenih podataka vršiti pomoću pametnih telefona[4,5]. Softver može pozicionirati tačke, izračunati parametre i analizirati ih za vreme koje je potrebno ortodontu da odabere sliku za analizu – otprilike jednu sekundu[5]. Trodimenzionalna analiza lica (3D analiza lica) nije dostupna u svakodnevnoj kliničkoj praksi, i to zbog velikog troška snimanja i potrebnih aparata[5]. Ključni zahtev u dvodimenzionalnoj fotografiji je adekvatna standardizacija fotografske postavke, posebno kod pozicioniranja pacijenta. Ovakvim pristupom mogu se postići odgovarajući nivoi reproduktivnosti, s ciljem da se tematska merenja mogu dobro povezati s kliničkim mišljenjem[6]. U ortodonciji se upotrebljavaju tri standardna prikaza fotografije lica. To su *en face*, snimak profila i *en face* sa osmehom. Udaljenost između spoljnjeg ugla oka i gornjeg ruba uha treba biti upoređena sa interpupilarnom linijom[7].

Danas se upotrebljavaju različite tehnike merenja vrednosti asimetrije lica. Za analizu lica putem 2D fotografije (dvodimenzionalna fotografija) neophodno je koristiti referentne tačke, koje imaju tačan broj, tačnu distribuciju i ponovljivost za dobijanje rezultata. Fotografije se pregledaju, analiziraju i utvrđuje se prisustvo asimetrije putem matematičkih formula, kao što su opisali Berlin i sar.[8] Standardizovane fotografije, sa kojih su dobijena današnja merenja, pružaju jedinstvenu priliku za proučavanje rasta lica. Uprkos ograničenjima merenja dobijenih pomoću dvodimenzionalnih fotografija, smatra se da prikupljeni podaci predstavljaju prilično precizan opis promena na licu. Ovaj se nalaz može primeniti za procenu promena, koje se događaju tokom ortodontskog lečenja i da pomogne u pronalasku nestale dece[9].

Introduction

In dental clinical practice, devices such as mobile phones and DSLR cameras (Digital Single Lens Reflex) are used to take intraoral and extraoral photographs. Using a photography taken by a mobile phone in dentistry is simple, fast, and very useful for documenting clinical procedures, help in patients' education and clinical trials[1,2,3]. We can assume that in the coming years, the lightweight mobile phone will replace the DSLR camera and its equipment[3]. Given the rapid advances in information technology and mobile computer systems, determining the parameters of patients' faces and analysing the data obtained via mobile phones are expected soon[4,5]. A software can position the points, calculate the parameters, and analyze them in the same time it takes the orthodontist to select an image for analysis—approximately one second. 3D facial analysis (three-dimensional facial analysis) is not available in everyday clinical practice due to the high cost of photography and the necessary devices[5]. The key requirement in two-dimensional photography is adequate standardization of the photographic setting, especially when positioning the patient. With this approach, appropriate levels of reproducibility can be achieved with the aim that thematic measurements can be well linked to clinical thinking[6]. In orthodontics, when photographing a patient, three standard facial positions are used. These are *en face*, profile shot, and *en face* with a smile. The distance between the outer corner of the eye and the upper edge of the ear should be compared to a horizontal plane[7].

Various techniques for measuring facial asymmetry values are used today. For facial analysis, 2D photography (two-dimensional photography), it is necessary to use landmarks with the correct number, correct distribution, and repeatability to obtain results. Photographs are examined, analysed, and the presence of asymmetry is determined by mathematical formulas, as described by Berlin et al.[8]. The standardized photographs from which today's measurements were obtained provide a unique opportunity to study facial growth. Despite the limitations of the measurements obtained on the two-dimensional photographs, the collected data represent a reasonably accurate description of the changes on the face. This finding can be used to assess changes that occur during orthodontic treatments and help locate missing children[9].

Ne postoje apsolutni standardi za ono što daje idealnu estetiku lica, mada su neki parametri korisni za kliničara u procesu planiranja lečenja. Možda su najvažniji elementi u analizi estetike lica simetrija, koncept prosečnosti ili norme, proporcija i rodni dismorfizam[10]. Nedostatak standardizacije u (digitalnim) metodama prikupljanja i bodovanja podataka ugrožava uporedivost nalaza i ograničava procenu asimetrije[11]. Uspostavljanje dijagnoze paralize *n. facialis*, procenjivanje odnosa malokluzije i držanja tela, kao i upotreba aplikacije *WhatsApp TM* za slanje fotografija, prikazuju upotrebu informacijskih tehnologija u cilju uspostavljanja dijagnoze, razmene kliničkih informacija putem digitalne fotografije[12,13,14].

Teledentistika je oblast telemedicine koja omogućava razmenu fotografija i kliničkih informacija putem interneta. Teledentistika je nov način pružanja stomatološke usluge i predstavlja ogroman potencijal za razvoj u sistemu javnog zdravstva. Naime, stomatološki pregledi na daljinu postaju mogući, a posebno mesto zauzimaju u primarnom nivou zdravstvene zaštite[15]. Konsultacije sa pacijentom obuhvataju snimanje fotografija od interesa, merenja i klasifikaciju merenja, psiho--socijalnu podršku i motivaciju[10]. Za razvoj teledentistike zasnovane na dokazima nisu potrebni samo tehnološki resursi već i prihvatanje teledentistike od strane opšte populacije, pacijenta, ali i zdravstvenih radnika. Teledentistika može biti primenjiva za lečenje pacijenata sa stanjima poput oralne bolesti sluznice, parodontitisa, malokluzija, temporomandibularnih poremećaja i oralnih bolova[15]. Fotografija kao digitalni materijal koristi se za procenu u napretku dentalnih bolesti i daje široke mogućnosti istraživanja[16].

Za vreme pandemije virusa COVID-19 nije bila dopuštena poseta ortodontu; upravo to je omogućilo prikazivanje prednosti korišćenja digitalnih tehnika u ortodonciji za sprovođenje terapije kod kuće, Skeniranje, planiranje, praćenje i odgovor na hitne situacije prednosti su teleortodoncije[17]. Teleortodoncija može pružiti značajno ortodontsko usmerenje stomatolozima u situacijama kada odlazak specijalisti ortodontu nije izvodljiv. ortodontsko lečenje nadzirano na daljinu putem teleortodoncije pokazalo se kao obećavajući pristup smanjenju ozbiljnosti malokluzija, onda kada odlazak ortodontu nije bio moguć[18]. Ključ budućnosti teleortodoncije bilo bi obezbeđivanje odlične usluge, individualnog pristupa i balansiranje poseta pacijenta ortodontu[19].

There are no absolute standards for an ideal facial aesthetics, but some parameters are useful for the clinician in the treatment planning process. Perhaps the most important element in the analysis of facial aesthetics is symmetry, the concept of mediocrity or norm, proportion, and gender dysmorphism[10]. The results of research linking facial asymmetry and clinical disorders, comparing asymmetry before and after surgery in facial plastic surgery, are heterogeneous. The lack of standardization in (digital) data collection and scoring methods jeopardizes the comparability of findings and limits the assessment of asymmetry[11]. Establishing a diagnosis of facial nerve paralysis, assessing the relationship of malocclusion and posture, as well as the use of the *WhatsApp TM* application to send photographs, show the use of information technology to establish a diagnosis, and exchange clinical information through digital photography[12,13,14].

Teledentistry is a new way of providing dental services and has a vast potential to develop in the public health system. Remote dental examinations are possible and occupy a special place in health care[15]. Consultations with the patient include taking photographs of interest, measurement and measurement classification, psychosocial support, and motivation[10]. The development of evidence-based teledentistry requires technological resources and the acceptance of teledentistry by the general population, patients, and health professionals. Teledentistry may be applied to treat patients with conditions such as oral mucosal disease, periodontitis, malocclusion, temporomandibular disorders, and oral pain[15]. Photography as a digital material is used to assess the progress of dental diseases and for the wide range of research opportunities[16].

During the COVID-19 pandemic, visits to the orthodontist were not allowed. However, the benefits of using digital techniques in orthodontics to conduct therapy at home were demonstrated with an estimate of the costs and benefits of a remote orthodontic approach in everyday practice in the near future. Scanning, planning, monitoring, and responding to emergencies are the benefits of tele-orthodontics. Teleorthodontics is fundamental not only for the possibility of continuing orthodontic therapy but also from a psychological point of view in order to convince patients of the positive development of their smiles[17]. Teleorthodontics can provide significant orthodontic guidance to dentists in situations where referral to an orthodontist is not feasible. Between the groups, interceptive orthodontic treatment monitored remotely via teleorthodontics proved to be a promising approach to reducing the severity of

Stopa prihvatljivosti teledentistike (95,3%) među pacijentima i njihovim porodicama bila je izvrsna[20]. Teledentistika bi mogla biti važan faktor u smanjenju neprikladne stope upućivanja pacijenata ortodontu. To bi značajno smanjilo vreme čekanja na ortodontske tretmane preporuke[21]. U ovako visokoj potražnji za ortodontskim lečenjem, neophodno je utvrditi potrebu za ortodontskim lečenjem kao osnovnu, tako da se osobama sa najvećim potrebama može dodeliti prioritet[22].

Stoga, uprkos naprednim antropometrijskim metodama poput trodimenzionalne stereofotogrametrije, fotogrametrija ostaje optimalan izbor za velike epidemiološke studije, koje za cilj imaju uspostavljanja populacijskih normi, posebno u zemljama u razvoju, u kojima sofisticirana oprema nije dostupna. Rezultati različitih antropometrijskih metoda nisu direktno uporedivi. Wen YF i sar. navode potrebu za kvalitetnijim fotogrametrijskim studijama, koje koriste standardizovane fotografske tehnike, i koje bi, po mogućnosti, bile izvedene iz velikog randomizovanog uzorka, koji uključuje različite etničke/rasne skupine[23].

Iz navedenog proizilazi da je potrebno sprovesti što više istraživanja kako bi se došlo do standarda za analizu fotografija, kao i proširila njihova upotreba u svakodnevnoj praksi, sa ciljem uspostavljanja brze dijagnoze, predvidivosti rezultata i razvoja teledentistike za vreme trajanja pandemije virusa COVID-19.

Cilj pilot studije je da se utvrdi ponovljivost pozicioniranja tačaka i merenja pri analizi simetrije lica na digitalnim 2D fotografijama. Glavna studija biće izvodiva ako vrednosti interklasnih koeficijenata korelacije, izračunatih putem metode dvosmernih nasumičnih efekata (engl. two-way random effects), za svaki od šest indeksa bude iznad vrednosti donje granice prihvatljivosti (ICCs > .70).

Metodologija rada

U pilot istraživanju jedno lice starosti 12 godina fotografisano je pomoću dve različite tehnike snimanja. Na jednoj fotografiji su se pozicionirale tačke; ista fotofrafija koristila se za svako naredno merenje. Kada je reč o prvoj tehnici fotografisanja, fotografija je slikana digitalnim foto-aparatom DSLR *Nikon* D 850, objektiva 105 mm, f/8, ISO 100, a od ispitanika je traženo da napravi neutralnu facijalnu ekspresiju, bez pogleda u ogledalo.

malocclusions when referral to an orthodontist was not feasible[18]. The key to the future of teleorthodontics would be to provide excellent service, an individual approach, and to balance patient visits to the orthodontist[19].

The acceptance rate of teledentistry (95.3%) among patients and their families was excellent[20]. Teledentistry is a valid system for the positive identification of appropriate new orthodontic referrals of the patient. Teledentistry could potentially be an important factor in reducing unnecessary referral rates. This would significantly reduce the waiting time for orthodontic recommendations[21]. In such a high demand for orthodontic treatment, it is necessary to identify the basis of the need for orthodontic treatment so that priority can be given to people with high treatment needs[22]. Therefore, despite advanced anthropometric methods such as three-dimensional stereophotogrammetry, photogrammetry remains the optimal choice for extensive epidemiological studies aimed at establishing population norms, especially in developing countries where sophisticated equipment is not available. The results of different anthropometric methods are not directly comparable. Wen YF et al. specify the need for better photogrammetric studies that use standardized photographic techniques, preferably from a large randomized sample of different ethnic/racial groups[23].

From the above, it is necessary to do as much research as possible to reach standards for photo analysis and expand their use in everyday practice to establish a fast diagnosis, predictability of results, and development of teledentistry during the COVID-19 pandemic.

The aim of the pilot study was to determine the repeatability of point positioning and measurements in the analysis of facial symmetry in digital 2D photographs. The main study will be feasible if the values of the interclass correlation coefficients, calculated using the two-way random effects method, are above the lower acceptability limit value for each of the six indices (ICCs >.70).

Material and methods

A 12-year-old person participated in the pilot study. The face was photographed using two different photography techniques. Points were positioned in one photo and used for each subsequent measurement. The first photography technique was performed using a digital camera with settings: Nikon D 850 DSLR camera, 105 mm lens, f/8, ISO 100 with neutral facial expression without looking in the mirror.

U istraživanju koristila se fotografija rezolucije 4128 x 2752 i veličinom od 32,5 M. Druga tehnika fotografisanja je urađena mobilnim telefonom (*Samsung Galaxy Note 9*), uz pomoć aplikacije *Dentalshooting*, App sa okvirom za lice. Drugom tehnikom fotografisanja u istraživanju koristila se fotografija rezolucije 2548x3377 i veličinom od 24,6 M. Nakon fotografisanja, izvršena je analiza fotografija pomoću programa *Photoshop CC 2019, Adobe Systems USA. Dva procenjivača pozicionirala su 20 tačaka u tri vremenski odvojena perioda*.

Pisani informisani pristanak za korišćenje fotografija za objavljivanje pribavljen je od roditelja pacijenta jer je pacijent maloletnik, te je za objavljivanje njegove fotografije u naučnim knjigama i/ili časopisima potrebna pisana dozvola roditelja.

Centralni indeks asimetrije (AI)

Za analizu asimetrije na fotografijama frontalnog pogleda korišćene su apsolutne vrednosti indeksa asimetrije (AI), izračunate pomoću formule AI = ⎜(R-L) / (R+L) x 100%, Orjentiri za merenje uključuju zenicu (Pu), bočni ugao oka (La), sella-nasion (Sn) i ugao usta (Am). Za merenje referentnih linija koristili smo liniju koja povezuje desnu i levu zenicu (Pu) kao vodoravnu referentnu liniju (a) i liniju okomitu na vodoravnu referentnu liniju za medijalnu liniju lica (b)[24].

Facijalna asimetrija (FA) i centralna facijalna asimetrija (CFA)

Ukupna asimetrija lica (FA) temeljila se na zbiru svih mogućih razlika između srednjih tačaka šest vodoravnih linija, i to između sledećih parova tačaka: P1–P2, P3–P4, P5–P6, P7–P8, P9–P10 i P11–P12. Pozicija tačaka prikazana je na Figuri 1. Ovih šest linija označeno je kao Dl, D2, D3, D4, D5, odnosno D6. Sredina svake linije izračunata je formulom ((leva tačka - desna tačka) + 2) + desna tačka. Na savršeno simetričnom licu sve središnje tačke leže na istoj vertikalnoj liniji, a zbir svih mogućih srednjih razlika je nula. Pozicija tačaka, linija i sredina svake linije prikazana je na Figuri 1.

Centralna facijalna asimetrija (CFA) fokusira se na razlike između srednjih tačaka susednih linija, posebno u središtu lica. CFA odgovara zbiru razlika srednjih tačaka linija Dl i D2, D2 i D3, D3 i D4, D4 i D5 i D5 i D6[25].

Horizontalna angularna asimetrija lica

Ugao između vodoravne linije i linije kroz obostrane uglove usta meren je na fotografiji lica. U pilot studiji analizirane su tačke desni cheilion(chr)i levi cheilion(chl).

The analysis of the photos was performed with a resolution of 4128 x 2752 and a size of 32.5 M.

Another photographic technique was performed using a mobile phone (Samsung Galaxy Note 9) with the help of the Dental Shooting app (with a face frame). The analysis of the photos was performed with a resolution of 2548x3377 and a size of 24.6 M. After photographing, the analysis of the photos was performed using Adobe Photoshop CC 2019, Adobe Systems USA. Two evaluators positioned 20 points in three time-separated periods.

Written informed consent to use photographs for publication was obtained from the patient’s parents as the patient was a minor for publishing in scientific books and/or periodicals.

Asymmetry index (AI)

Absolute values of the asymmetry index (AI), calculated using the formula AI = ǀ (R-L) / (R + L) x 100%, were used to analyse the asymmetry in the frontal view photographs. Measurement landmarks included pupil (Pu), lateral angle of the eye (La), *sella-nasion* (Sn), and the angle of the mouth (Am). To measure the reference lines, we used a line connecting the right and left pupils (Pu) as the horizontal reference line (a) and a line perpendicular to the horizontal reference line for the medial line of the face (b)[24].

Facial asymmetry (FA) and central facial asymmetry (CFA)

The total facial asymmetry (FA) was based on the sum of all possible unnecessary differences between the midpoints of the six horizontal lines, between the following pairs of points: P1-P2, P3-P4, P5-P6, P7-P8, P9-P10, and P11-P12. The position of the points is shown in Figure 1. These six lines were marked as D1, D2, D3, D4, D5, and D6. The middle of each line was calculated using the formula ((Left point - Right point) + 2) + Right point. On a perfectly symmetrical face, all midpoints lie on the same vertical line, and the sum of all possible nonredundant differences is zero. The position of the points, the line, and the middle of each line are shown in Figure 1.

Central facial asymmetry (CFA) focuses on the differences between the midpoints of adjacent lines, especially in the centre of the face. CFA corresponds to the sum of the differences of the midpoints of the lines D1 and D2, D2 and D3, D3 and D4, D4 and D5, and D5 and D6[25].

Na osnovu veličine ugla, lica se razvrstavaju u sledeća tri tipa: paralelni tip obuhvata uglove veće od jednog stepena i manje od jednog stepena, levo dominantni tip sastoji se od uglova manjih od jednog stepena ili jednakih jednom stepenu, a desno dominantni uglovi veći su od jednog stepena ili jednaki jednom stepenu[26].

Rezultati

U Tabeli 1. predstavljene su vrednosti indeksa asimetrije izračunatih na osnovu informacija o pozicijama 20 tačaka postavljenih od strane dva procenjivača u tri vremenski odvojene tačke, i to na dve fotografije snimljene mobilnim telefonom i foto-aparatom. Centralni indeks asimetrije (AI) izračunat je nivoima oka (AI gornji), nosa (AI srednji) i usana (AI donji), a srednja vrednost za ova tri pojedinačna indeksa korišćena je kao mera opšteg indeksa centralne asimetrije (AI prosečni). Pored toga, izračunati su i indeksi facijalne asimetrije (FA) i centralne facijalne asimetrije lica (CFA), te horizontalne angularne asimetrije lica. (Tabela 1.)

U Tabeli 2. prikazani su podaci o prosečnim vrednostima i pratećim standardnim devijacijama, izračunati na osnovu tri vremenski odvojene procene za svakog od dvaju procenjivača, koje su date zasebno za dve tehnike fotografisanja. Rezultati Man–Vitni testa prikazani u poslednjim dvema kolonama ukazuju na to da nisu postojale statistički značajne razlike u vrednostima izračunatih indeksa asimetrije (ps > .05) među procenjivačima i tako posredno svedoče o zadovoljavajuće visokom stepenu slaganja pozicioniranja tačaka na fotografijama.

Dodatnu potvrdu visokog stepena opšteg slaganja pozicioniranja tačaka postavljenih od strane dvaju procenjivača pružaju podaci prikazani u okviru Tabele 3. i na Grafikonu 1. Naime, vrednosti interklasnih koeficijenata korelacije, izračunatih putem metode dvosmernih nasumičnih efekata (engl. two-way random effects), za svaki od šest indeksa bile su iznad donje granice prihvatljivosti (ICCs > 0.70), pri čemu je vrednost ICC za FA indeks bila najniža (ICC = .74), za AI gornji .83, dok je za ostale indekse vrednost ICC bila iznad granice 0.90. Dodatno, stepen slaganja indeksa asimetrije, koji su analizirala dva procenjivača, prikazan je i putem Bland–Altmanovih dijagrama saglasnosti, na kojima se može primetiti da nijedna procena indeksa asimetrije ne odstupa značajno od okvira postavljenih putem devedesetpetoprocentnog intervala slaganja.

Horizontal angular asymmetry of the face

The angle between the horizontal line and the line through the bilateral corners of the mouth was measured in a photograph of the face.

In the pilot study, the points chr (right cheilion) and chl (left cheilion) were analyzed. Based on the size of the angle, faces were classified into the following three types: the parallel type included angles greater than ⩾1 degree and less than 1 degree, the left dominant type consisted of angles less than or equal to ⩾1 degree, and the right dominant angles were greater than one degree or equal to one degree[26].

The results

Table 1 presents the values of the asymmetry index calculated on the basis of information on the positions of 20 points set by two evaluators in three time-separated points on two photographs taken with a mobile phone and a camera. The central asymmetry index (AI) was calculated by the levels of the eye (AI upper), nose (AI middle), and lips (AI lower), and the mean value for these three individual indices were used as a measure of the general index of central asymmetry (AI average). In addition, the indices of facial asymmetry (FA) and central facial asymmetry (CFA), and horizontal angular facial asymmetry were calculated. (Table 1)

Table 2 shows data on average values and accompanying deviation standards calculated on the basis of three time-separated estimates for each of the two evaluators given separately for the two photography techniques. The results of the Mann-Whitney test presented in the last two columns indicate that there were no statistically significant differences between the evaluators in the values of the calculated asymmetry indices (ps >.05) and thus indirectly testify to a satisfactorily high degree of agreement of their point positioning in photographs.

Additional confirmation of the high degree of general agreement of the point positioning of the two evaluators is provided by the data shown in Table 3 and Graph 1. Namely, the values of interclass correlation coefficients, calculated using the two-way random effects method, for each of the six indices were above the lower limit of acceptability (ICCs >.70), with the ICC value for FA index being the lowest (ICC = .74), for AI upper .83, while for other indices the ICC

U nastavku su sprovedene dodatne analize, ali ovoga puta na nivou vrednosti pozicija tačaka, a ne indeksa asimetrije. Naime, analizirana je saglasnost pozicioniranja 20 pojedinačnih tačaka na dvema osama (x – horizontalnoj, y – vertikalnoj), kao i izračunatih vrednosti ugla.

U Tabeli 4. prikazane su prosečne vrednosti pozicioniranja ovih tačaka postavljenih od strane dvaju procenjivača u slučaju fotografije dobijene putem foto-aparata, kao i vrednosti razmaka, odnosno razlike u prosečnim procenama, te rezultati statističkog testiranja značajnosti ovih razlika. Od ukupno 41 analiziranog parametra, samo je na jednom parametru (Snb_L_x) detektovana statistički značajna razlika (U = 0.00, p = .04); kod preostalih 40 parametara ova razlika nije bila statistički značajna (p ≥ .05).

U slučaju kada su procenjivane fotografije dobijene putem mobilnog telefona, nijedna razlika nije bila statistički značajna. (Tabela 5)

value was above the limit of .90. In addition, the degree of agreement of the asymmetry index of the two evaluators is shown by Bland-Altman agreement diagrams on which it can be observed that no estimate of the asymmetry index deviates significantly from the limits set by the 95% agreement interval.

Additional analyses were performed below, but this time at point position values rather than asymmetry indices. Namely, the agreement of the positioning of 20 individual points on two axes (x - horizontal and y - vertical) and the calculated values of the angle was analyzed.

Table 4 shows the average values of the positioning of these points for two evaluators in the case of a photograph obtained with a camera, as well as the spacing values, i.e., differences in average estimates, and the results of statistical testing of the significance of these differences. Out of a total of 41 analyzed parameters, only one (Snb_L_x) had a statistically significant difference detected (U = 0.00, p = .04), while on the remaining 40 this difference was not statistically significant (p ≥.05).

When it comes to evaluating the photographs obtained via mobile phone, no difference was statistically significant. (Table 5)

Tabela 1. Veličine indeksa asimetrije na osnovu tačaka koje su postavila dva procenjivača u tri navrata na fotografijama načinjenim fotoaparatom i mobilnim telefonom

Table 1. Asymmetry index values based on points set by two evaluators on three occasions in photographs taken with a camera and mobile phone

Procenjivač Evaluator	Tehnika Technique	Mjerenje Measurement	AI gornji AI upper	AI srednji AI middle	AI donji AI lower	AI prosečni AI average	FA	CFA
A	Aparat Camera	1	6.59	4.88	4.94	5.47	39.31	20.14
A	Aparat Camera	2	4.57	5.13	4.75	4.82	40.16	20.62
A	Aparat Camera	3	4.82	5.28	4.64	4.91	39.68	20.43
A	Telefon Phone	1	1.86	2.64	3.38	2.63	36.36	18.61
A	Telefon Phone	2	1.40	2.47	3.19	2.35	36.71	18.88
A	Telefon Phone	3	2.48	2.73	3.18	2.80	35.83	18.41
B	Aparat Camera	1	5.04	4.94	4.70	4.89	39.18	20.13
B	Aparat Camera	2	5.11	5.57	5.40	5.36	47.50	22.14
B	Aparat Camera	3	6.75	5.14	5.05	5.65	39.36	20.32
B	Telefon Phone	1	1.66	2.80	3.99	2.82	36.48	18.76
B	Telefon Phone	2	4.04	2.62	3.40	3.35	36.39	18.71
B	Telefon Phone	3	2.37	2.46	3.50	2.78	36.41	18.72

Legenda: A - procenjivač, B- procenjivač, AI -index asimetrije, FA- facijalna asimetrija, CFA- centralna facijalna asimetrija
Legend: A - estimator, B - estimator, AI - asymmetry index, FA - facial asymmetry, CFA - central facial asymmetry

Tabela 2. Razlike u procenama asimetrije između dva procenjivača
Table 2. The differences in asymmetry estimates between the two evaluators

Tehnika Technique	Indeks Index	Procenjivač A Evaluator A		Procenjivač B Evaluator B		Značajnost razlika DifferenceSignificance	
		M	SD	M	SD	U	p
Aparat Camera	AI gornji AI upper	5.33	1.10	5.63	0.97	2.00	.28
	AI srednji AI middle	5.10	0.20	5.22	0.32	3.00	.51
	AI donji AI lower	4.78	0.15	5.05	0.35	2.00	.28
	AI prosečni AI average	5.07	0.35	5.30	0.38	3.00	.51
	FA	39.72	0.43	42.02	4.75	4.00	.83
	CFA	20.40	0.24	20.87	1.11	4.00	.83
Telefon Phone	AI gornji AI upper	1.91	0.54	2.69	1.22	3.00	.51
	AI srednji AI middle	2.61	0.13	2.63	0.17	4.00	.83
	AI donji AI lower	3.25	0.11	3.63	0.32	0.00	.05
	AI prosječni AI awerage	2.59	0.22	2.98	0.32	1.00	.13
	FA	36.30	0.44	36.43	0.05	3.00	.51
	CFA	18.64	0.24	18.73	0.03	3.00	.51

Legenda: AI -indeks asimetrije, FA- facijalna asimetrija, CFA- centralna facijalna asimetrija
Legend: AI−asymmetry index, FA - facial asymmetry, CFA−central facial asymmetry

Tabela 3. Interklasni koeficijenti korelacije (ICC) za indekse asimetrije
Table 3. Interclass correlation coefficients (ICC) for asymmetry indices

Tačka Point	ICC	95% CI	Prosečna razlika (SD) Average difference (SD)	95% granice slaganja 95% agreement limit
AI gornji AI upper	.826	-.105 – .975	-0.54 (1.53)	-3.54 – 2.46
AI srednji AI middle	.993	.954 – .999	-0.07 (0.25)	-0.56 – 0.42
AI donji AI lower	.931	.311 – .991	-0.33 (0.32)	-0.96 – 0.31
AI prosječniAI average	.947	.679 – .992	-0.31 (0.57)	-1.43 – 0.80
FA	.740	-.588 – .963	-1.21 (3.02)	-7.13 – 4.71
CFA	.922	.536 – .989	-0.28 (0.63)	-1.53 – 0.96

Legenda: AI -indeks asimetrije, FA- facijalna asimetrija, CFA- centralna facijalna asimetrija
Legend: AI−index asymmetry, FA−facial asymmetry, CFA−central facial asymmetry

Tabela 4. Razlike u pozicioniranju tačaka između dva procenjivača (tehnika 1)
Table 4. Differences in point positioning between two evaluators (technique 1)

Tačka Point	Procenjivač A Evaluator A		Procenjivač B Evaluator B		Značajnost razlike Difference significance		
	M	SD	M	SD		U	p
Lab_D_x	21.82	0.04	21.82	0.11	-0.01	4.00	.83
Lab_D_y	18.01	0.03	18.04	0.04	-0.03	2.00	.27
Lab_L_x	30.64	0.04	30.56	0.07	0.08	0.50	.08
Lab_L_y	17.96	0.04	17.65	0.48	0.31	1.50	.18
Snb_D_x	20.10	0.01	20.12	0.03	-0.01	3.50	.65
Snb_D_y	22.04	0.01	22.04	0.03	0.00	4.00	.82
Snb_L_x	32.20	0.01	32.12	0.04	0.08	0.00	.04
Snb_L_y	22.04	0.02	22.05	0.03	-0.01	3.50	.66
Amb_D_x	20.72	0.01	20.73	0.03	-0.01	3.50	.66
Amb_D_y	24.08	0.03	24.06	0.02	0.02	2.00	.28
Amb_L_x	31.67	0.02	31.61	0.01	0.06	0.00	.05
Amb_L_y	24.08	0.03	24.06	0.02	0.02	2.00	.28
P1_x	21.97	0.14	21.82	0.12	0.15	2.00	.28
P1_y	18.10	0.13	18.23	0.41	-0.13	3.50	.66
P2_x	30.69	0.19	30.60	0.09	0.10	3.00	.51
P2_y	18.64	1.13	17.93	0.04	0.71	2.50	.38
P3_x	24.94	0.16	24.79	0.04	0.15	0.00	.05
P3_y	18.31	0.12	18.22	0.03	0.09	2.00	.26
P4_x	27.93	0.19	27.81	0.03	0.11	3.00	.51
P4_y	18.26	0.12	18.17	0.03	0.09	1.00	.13
P5_x	19.57	0.13	19.53	0.01	0.03	4.00	.82
P5_y	19.23	0.25	19.35	0.05	-0.12	3.00	.51
P6_x	32.82	0.23	32.65	0.02	0.17	0.00	.05
P6_y	19.22	0.21	19.11	0.19	0.11	2.00	.28
P7_x	24.84	0.16	24.69	0.03	0.15	0.50	.08
P7_y	21.41	0.10	21.39	0.03	0.02	4.00	.83
P8_x	28.34	0.21	28.21	0.02	0.14	0.50	.08
P8_y	21.40	0.07	21.39	0.03	0.01	3.50	.66
P9_x	20.59	0.15	20.49	0.02	0.11	3.00	.51
P9_y	23.63	0.20	23.46	0.12	0.17	1.00	.13
P10_x	31.95	0.31	31.78	0.06	0.18	2.00	.28
P10_y	23.63	0.16	23.50	0.15	0.13	2.00	.28
P11_x	24.46	0.15	24.36	0.04	0.10	2.00	.27
P11_y	24.19	0.19	24.11	0.02	0.08	3.00	.51
P12_x	28.62	0.23	27.14	2.31	1.48	2.00	.28
P12_y	24.15	0.19	24.08	0.04	0.07	4.00	.82
Chr_x	24.50	0.18	24.28	0.04	0.22	2.50	.38
Chr_y	24.20	0.18	24.08	0.02	0.12	1.50	.18
Chl_x	28.65	0.22	28.47	0.03	0.18	0.00	.05
Chl_y	24.17	0.18	24.05	0.02	0.12	1.50	.18
Degree	0.47	0.10	0.41	0.34	0.06	3.00	.51

Tabela 5. Razlike u pozicioniranju tačaka između dva procenjivača (tehnika 2)
Table 5. Differences in point positioning between two evaluators (technique 2)

Tačka Point	Procenjivač A EvaluatorA		Procenjivač B Evaluator B		Značajnost razlike Difference significance		
	M	SD	M	SD	Razmak	U	p
Lab_D_x	9.94	0.03	9.90	0.15	0.05	3.50	.66
Lab_D_y	19.69	0.01	19.73	0.02	-0.04	0.00	.05
Lab_L_x	19.15	0.03	19.12	0.06	0.03	2.00	.27
Lab_L_y	19.83	0.04	19.87	0.03	-0.03	2.00	.27
Snb_D_x	8.81	0.02	8.76	0.04	0.05	0.50	.08
Snb_D_y	24.03	0.01	23.99	0.04	0.05	1.00	.10
Snb_L_x	20.16	0.01	20.16	0.00	0.00	3.00	.32
Snb_L_y	24.04	0.01	23.96	0.05	0.08	0.00	.05
Amb_D_x	9.45	0.01	9.43	0.03	0.01	3.50	.64
Amb_D_y	26.12	0.01	26.11	0.05	0.01	3.00	.50
Amb_L_x	19.47	0.01	19.46	0.02	0.02	2.00	.20
Amb_L_y	26.12	0.00	26.11	0.03	0.01	4.50	1.00
P1_x	9.92	0.06	9.83	0.03	0.09	0.50	.08
P1_y	19.66	0.08	19.68	0.02	-0.02	4.00	.83
P2_x	19.10	0.06	19.14	0.07	-0.04	2.00	.28
P2_y	19.80	0.03	19.80	0.04	0.00	4.50	1.00
P3_x	12.97	0.02	12.98	0.02	0.00	4.00	.82
P3_y	19.97	0.04	19.97	0.01	0.00	4.50	1.00
P4_x	16.10	0.02	16.09	0.03	0.01	3.00	.50
P4_y	19.98	0.01	19.98	0.05	0.00	3.50	.65
P5_x	8.17	0.04	8.16	0.01	0.02	3.00	.51
P5_y	20.98	0.27	21.06	0.05	-0.09	3.00	.51
P6_x	20.81	0.04	20.80	0.02	0.01	3.00	.51
P6_y	20.97	0.39	21.04	0.02	-0.07	3.00	.51
P7_x	12.65	0.02	12.66	0.01	-0.01	2.50	.37
P7_y	23.18	0.11	23.31	0.02	-0.13	1.50	.18
P8_x	16.48	0.15	16.45	0.02	0.03	4.50	1.00
P8_y	23.10	0.17	23.27	0.06	-0.17	2.00	.28
P9_x	9.14	0.04	9.13	0.04	0.01	3.00	.51
P9_y	25.39	0.09	25.38	0.04	0.01	4.00	.83
P10_x	19.76	0.03	19.71	0.03	0.04	1.00	.13
P10_y	25.40	0.10	25.44	0.03	-0.05	3.00	.51
P11_x	12.23	0.01	12.21	0.03	0.03	1.00	.10
P11_y	26.12	0.02	26.11	0.02	0.01	2.00	.27
P12_x	16.75	0.02	16.72	0.01	0.03	0.00	.05
P12_y	26.13	0.03	26.09	0.04	0.05	1.50	.18
Chr_x	12.32	0.03	12.29	0.05	0.03	0.00	.05
Chr_y	26.10	0.02	26.10	0.01	0	3.00	.49
Chl_x	16.76	0.01	16.73	0.04	0.03	2.00	.27
Chl_y	21.13	0.01	26.12	0.02	-4.99	0.00	.05
Ugao Degree	0.11	0.02	0.13	0.05	-0.02	2.50	.35

Tabela 6. ICC za tačke
Table 6. ICC for point

Tačka Point	ICC	95% CI
Lab_D_x	1.00	1.00 – 1.00
Lab_D_y	.999	.992 – 1.00
Lab_L_x	1.00	.999 – 1.00
Lab_L_y	.977	.863 – .997
Snb_D_x	1.00	1.00 – 1.00
Snb_D_y	1.00	.997 – 1.00
Snb_L_x	1.00	1.00 – 1.00
Snb_L_y	.999	.994 – 1.00
Amb_D_x	1.00	1.00 – 1.00
Amb_D_y	1.00	.998 – 1.00
Amb_L_x	1.00	1.00 – 1.00
Amb_L_y	1.00	.999 – 1.00
P1_x	1.00	.998 – 1.00
P1_y	.967	.784 – .995
P2_x	1.00	.999 – 1.00
P2_y	.795	-.199 – .971
P3_x	1.00	.999 – 1.00
P3_y	.997	.980 – 1.00
P4_x	1.00	.999 – 1.00
P4_y	.997	.982 – 1.00
P5_x	1.00	1.00 – 1.00
P5_y	.981	.886 – .997
P6_x	1.00	.999 – 1.00
P6_y	.975	.815 – .996
P7_x	1.00	.999 – 1.00
P7_y	.996	.974 – .999
P8_x	1.00	.999 – 1.00
P8_y	.992	.954 – .999
P9_x	1.00	.999 – 1.00
P9_y	.993	.954 – .999
P10_x	1.00	.998 – 1.00
P10_y	.993	.954 – .999
P11_x	1.00	1.00 – 1.00
P11_y	.997	.984 – 1.00
P12_x	.979	.871 – .997
P12_y	.997	.983 – 1.00
Chr_x	1.00	.998 – 1.00
Chr_y	.996	.978 – .999
Chl_x	1.00	.998 – 1.00
Chl_y	.996	.975 – .999
Ugao Degree	.456	-.550 – .930

Diskusija

Metodološki pristup pilot studije oslanja se na sprovedena istraživanja[27]. Velika zastupljenost heterogenosti rezultata posledica je nedostatka standarda, kao i metoda koje se koriste za facijalnu analizu. Različiti formati fotografija, tačnost mernog sistema, kao i odabir digitalnog markera za markiranje tačaka prilikom merenja, mogu uticati na rezultate[11,28].

U pilot studiji rezultati svedoče o relativno visokom stepenu slaganja pozicioniranja tačaka, koji su pružila dva procenjivača. Kod čak 22 parametra registrovano je apsolutno podudaranje procena (*ICC*s = 1.00), dok je kod još 17 parametara ova vrednost bila izuzetno visoka (*ICC*s > .96). Jedino je u slučaju P2_y registrovana nešto niža, ali i dalje veoma zadovoljavajuća stopa saglasnosti (ICC = .80); jedina realno niska vrednost pak dobijena je za parametar ugla (ICC = .46).

Od ukupno 41 analiziranog parametra, samo je na jednom (Snb_L_x) detektovana statistički značajna razlika (U = 0.00, p = .04), dok na preostalih 40 parametara ova razlika nije bila statistički značajna (p ≥ .05). U slučaju u kome su procenjivane fotografije dobijene putem mobilnog telefona, nijedna razlika nije bila statistički značajna. Pametni telefon omogućava brzo određivanje parametara lica pacijenta i analizu dobijenih podataka, uz poboljšanja u interakciji i saradnji sa pacijentom[5].

U antropometrijskom istraživanju koje su sproveli, autori su dokazali da stereofotogrametrija i njen protokol za lokaciju orijentira daju vrlo dobru pouzdanost za seriju 2D i 3D linearnih i ugaonih merenja. Rezultati pokazuju da je ICCs 0,88, 0,99 i 0,97 i 0,98 i 0,92[29]. Za dalja istraživanja treba koristiti poboljšanu šemu klasifikacije za antropometriju i poboljšanu nomenklaturu za kraniofacijalne orijentire, koji omogućavaju jasno razlikovanje kako za meka, tako i za tvrda tkiva. Posebnu važnost imaju za fotogrametriju lica, gde su orijentiri mekih tkiva loše definisani i često se pogrešno predstavljaju kao kraniometrijski analozi. Korišćenjem nove notacije obezbeđuje se standardizovani niz kraniometrijskih (lobanja) i kapulometrijskih (lice mekog tkiva) orijentacija, koje omogućavaju izbegavanje trenutnih zabuna[30].

Discussion

The methodological approach of the pilot study relies on the conducted research[27]. The high prevalence of heterogeneity of results is due to the lack of standards and the methods used for facial analysis. Different photograph formats, the accuracy of the measuring system, the choice of a digital marker to mark the points when measuring can affect the results[11,28].

In the pilot study, the results suggest a relatively high degree of agreement of the point positioning provided by the two evaluators. Absolute matching of estimates was registered on 22 parameters (ICCs = 1.00), while on another 17 this value was high (ICCs >.96). Only in the case of P2_y, a slightly lower agreement rate was registered (ICC = .80), but still satisfactory, while the only exceedingly low value was obtained for the angle parameter (ICC = .46).

Out of a total of 41 analyzed parameters, only one (Snb_L_x) had a statistically significant difference detected (U = 0.00, p = .04), while on the remaining 40 this difference was not statistically significant (p ≥.05). In the case of the evaluated photographs obtained via mobile phone, no difference was statistically significant. The mobile phone will enable fast determination of the patient's face parameters and analysis of the obtained data, with improvements in interaction and cooperation with the patient[5]. In an anthropometric study they conducted, the authors proved that stereo-photogrammetry and their landmark location protocol provide very good reliability for a series of 2D and 3D linear and angular measurements. The results show ICCs 0.88, 0.99 and 0.97, and 0.98 and 0.92[29]. For further research, an improved classification scheme for anthropometry and an improved nomenclature for craniofacial landmark should be used to allow a clear distinction to be made for both soft and hard tissues. They are of special importance for facial photogrammetry, where soft tissue landmarks are poorly defined and are often misrepresented as craniometric analogs.

Using the new notation, a standardized set of craniometric (skull) and cephalometric (soft tissue face) orientations is provided, which makes it possible to avoid current confusion[30]. In routine cases of orthognathic surgery, cephalometry and 2-D photogrammetry are common and less expensive tools that can have the potential to analyze and predict the resulting profile.

U rutinskim slučajevima ortognatske hirurgije, cefalometrija i 2D fotogrametrija uobičajeni su i jeftiniji alati, koji mogu imati potencijal za analizu i predviđanje rezultirajućeg profila. 2D fotogrametrija je jednostavna i isplativa tehnika i može se koristiti za procenu promena mekog tkiva nakon ortognatske operacije[31].

Istraživanje iz 2018. godine prikazalo je komparaciju analize lica na 2D slikama lica sa analizom na 3D rekonstruisanim modelima ljudskih lica korišćenjem tehnologije skeniranja lica. 3D rekonstruisani modeli lica bolje ilustruju klinička standardna mjerenja u odnosu analiza na 2D fotografijama. Kvalitativno, Wilcoxon test je pokazao da su posmatrači za subjektivnu procenu analize lica izazili uvjerenost u 3D rekontsrukciju modela lica kao i u 2D fotografije[32].

Merenja zabeležena 3D sistemom dovoljno su tačna i dovoljno pouzdana za kliničku upotrebu. Najveće razlike između direktnog i indirektnog (tj. 2D) merenja uzrokovane su fotografskim izobličenjem. Bilo bi očekivano da se 2D merenja neće usko porediti sa ručnim ili 3D merenjima, prilikom kojih tačke lokacije nisu u istoj ravni kao kalibracijski kvadrat. Jedna od potencijalnih upotreba 3D slike volumetrijska upoređivanja pomoću superponiranja slike –snažno zavisi od preciznosti identifikacije orijentira, kako je prikazano u istraživanju H. Ghoddousi et al.[28]. Nalazi autora Guyot et al. pokazali su da su fotogrametrijska merenja pouzdana. Nije pronađena statistička razlika u 10 od 14 merenja ($P > 0,05$). Ovo istraživanje pokazuje da je digitalna fotogrametrija korisno sredstvo, ali i da još uvek ne postoji pouzdana standardna tehnika fotografskog merenja[33]. Analiza koju su izvršili Bland i Altman pokazala je da su obe tehnike, direktna antropometrija i 2D fotogrametrija, slično valjane i da mogu zameniti jedna drugu. Mora se imati na umu da su udaljenosti dobijene direktnom antro-pometrijom obično kraće od udaljenosti dobijene direktnom antropometrijom, verovatno zbog pritiska na meko tkivo kada antropometar dodirne kožu[34]. Razvoj digitalnih aplikacija za ortodonciju tek treba u potpunosti istražiti i iskoristiti. Upotrebu 2D fotografije u analizi lica prikazali su autori Rao et al. Inovativan sistem pruža automatizovan i učinkovit pristup merenju orijentira na licu pomoću fotometrijskih tačaka na osnovu 2D slika. Sistem se može kombinovati sa tehnologijom proširene stvarnosti (AR) kako bi se postigla bolja vizualizacija i 3D rekreacija struktura[35].

2-D photogrammetry is simple, cost-effective, and can be used to assess soft tissue changes after orthognathic surgery[31].

A comparison of 3D scans and 2D photography to identify soft tissue landmarks on the face included a study of thirty Caucasians. Five soft tissue facial observers were identified twice from three observers in 2D and 3D images. The correlation coefficient within the observer (ICC) revealed a better agreement between the observer in 3D for issues related to face shape, lip pitch, and chin posture[32].

The measurements recorded by the 3D system are sufficiently accurate and reliable enough for clinical use. The largest differences between direct and indirect (i.e., 2D) measurements are caused by photographic distortion. It would be expected that 2D measurements would not be closely compared to manual or 3D measurements, where the location points are not in the same plane as the calibration square. One of the potential uses of 3D imaging, namely, volumetric comparisons using image superposition, strongly depends on the accuracy of landmark identification, as shown in the study by H. Ghoddousi et al.[28] Findings of Guyot et al. have shown that photogrammetric measurements are reliable. No statistical difference was found between 10 of 14 measurements ($P > 0.05$). This research shows that digital photogrammetry is a useful tool but there is no reliable standard photographic measurement technique yet[33]. Bland-Altman's analysis showed that both techniques, direct anthropometry and 2-D photogrammetry, are similarly valid and can replace each other. It must be borne in mind that the cephalometric distances obtained by direct anthropometry are usually shorter than the distances obtained by direct anthropometry, possibly due to the pressure on the soft tissue when the anthropometer touches the skin[34]. The development of digital applications for orthodontics has yet to be fully explored and exploited. The use of 2D photography in facial analysis was demonstrated by the authors Rao et al. The innovative system provides an automated and efficient approach to measuring face landmarks using photometric points based on 2D images. The system can be combined with augmented reality (AR) technology to achieve better visualization and 3D recreation of structures[35].

Zaključak

Prikazani rezultati svedoče o tome da različiti procenjivači u različitim vremenskim tačkama daju zadovoljavajući pouzdane, odnosno dosledne i međusobno saglasne procene pozicija tačaka važnih za razumevanje asimetrije lica. Iako su rezultati analize fotografija načinjenih mobilnim telefonom pouzdani, rezultati dobijeni analizom fotografija načinjenih foto aparatom su precizniji. Kako bi se ustanovila dijagnoza asimetrije lica i razvoja teledentistike, potrebno je sprovesti dodatna istraživanja, koja će obuhvatiti veći uzorak i različite modele telefona.

Zahvalnica: Autori se zahvaljuju Aleksić dr Bojani (procenjivaču B), bez čijeg napora u tačnom i preciznom prikupljanju podataka ova studija ne bi bila moguća.

Sukob interesa: Nema

Conclusion

The presented results indicate that different evaluators at different time points give satisfactorily reliable, mutually consistent estimates of the positions of points important for understanding facial asymmetry.The results obtained by the mobile phone are reliable but the camera is more accurate.From the above, it is necessary to do additional research that will include a larger sample and different phone models to establish the diagnosis of facial asymmetry and the development of teledentistry.

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Conflict of interest: Nil

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