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Tytuł pracy: „Zastosowanie osteogenezy dystrakcyjnej w leczeniu wad poprzecznych szczęki przy pomocy urządzeń mocowanych do kości szczęk.”

Streszczenie

Chirurgiczna asysta podczas rozszerzania szczęki jest często stosowaną procedurą stosowaną w leczeniu wad poprzecznych szczęki u pacjentów po zakończonym skoku wzrostowym. Wśród badaczy wciąż nie ma zgodności co do najskuteczniejszego sposobu rozszerzania szczęki.

Praca ta ma na celu zbadanie wpływu osteodystrakcji przezpodniebiennej przy zastosowaniu urządzeń montowanych na kości szczęki, na szkielet twarzoczaszki, a w szczególności kości szczęki i jamę nosową; zastosowanie nowoczesnych metod obrazowania i przetwarzania danych pogłębia analizę zmian zachodzących podczas leczenia tą metodą; a także. ocena zmian szkieletu twarzoczaszki po leczeniu zwężeń szczęki za pomocą chirurgicznie wspomaganego rozszerzenia przy użyciu urządzeń montowanych na kości.

Analizie poddano zmiany zachodzące w płaszczyźnie czołowej i tylno-przedniej oraz zmiany zachodzące w pojemności jamy nosowej i górnych drogach oddechowych. Uzyskane dane analizowano pod względem wieku, płci i występowania poszczególnych zmian w połączeniu z wadą twarzowo-zgryzową.

Grupa objęta badaniem liczyła 79 pacjentów (36 kobiet, 43 mężczyzn) w wieku od 12 do 23 lat. Średni wiek pacjentów wynosił 16,86 ± 2,65 lat. Do grupy badanej kwalifikowano pacjentów ze zwężeniem szczęki większym niż 4 mm, u których planowano dalsze leczenie ortognatyczne, posiadających pełną dokumentację diagnostyczną (na każdym etapie leczenia wykonane zdjęcie TK, dokumentacja fotograficzna, modele gipsowe) oraz niewykazujących patologii ze strony jamy nosowej, górnych dróg oddechowych czy alergii.

Pacjentów określono pod względem występującej wady szczęki (19 pacjentów ze zwężeniem szczęki i 60 pacjentów z hipoplazją szczęki), wady szkieletowej przednio-tylnej (20 pacjentów z wadą klasy I, 13 pacjentów z wadą klasy II, 46 pacjentów z wadą klasy III), wady szczęki i szkieletową (hipoplazja szczęki; hipoplazja szczęki, II klasa szkieletowa; hipoplazja szczęki, zgryz otwarty, II klasa szkieletowa; hipoplazja szczęki, III klasa szkieletowa; hipoplazja szczęki, zgryz otwarty, III klasa szkieletowa; zwężenie szczęki; zwężenie szczęki, II klasa szkieletowa; zwężenie szczęki, III klasa szkieletowa).

Leczenie polegało na wykonaniu pełnej osteotomii Le Fort I z uwolnieniem wszystkich wzmocnień kostnych i złożeniu urządzenia do osteodytrakcji montowanym na kości szczęki. Osteodystrakcję prowadzono według protokołu: okres latencji trwający 5–7 dni, okres osteodystrakcji (dwa obroty urządzenia dziennie, jeden obrót to około 0,25 mm) trwający 14,7 ± 8,6 dni,okres konsolidacji trwający od 3 do 6 miesięcy.

Na podstawie badań tomograficznych przeprowadzonych u pacjentów przed i po leczeniu (po okresie konsolidacji) oceniano zmiany kątów i odcinków opisujących wysokość szczęki w odcinku przednim i tylnym oraz szerokść szczęki na poziomie poszczególnych zębów oraz wysokość podniebienia. Pomiary wykonywano także na obrazach graficznych odpowiadających zdjęciom cefalometrycznym w projekcji tylno-przedniej i bocznej przekonwertowanych z obrazów tomografii komputerowej. Na zdjęciach tomografii komputerowej, przy pomocy programu Dolphin Imaging, oceniano zmiany pojemności górnych dróg oddechowych oraz jamy nosowej. Wykonano również pomiary na modelach gipsowych przed i po leczeniu.

Na podstawie uzyskanych danych stwierdzono, że zastosowanie podniebiennej osteogenezy dystrakcyjnej do rozszerzenia szczęki jest skuteczną metodą leczenia wad szkieletu twarzowej części czaszki.Leczenie metodą poprzecznej osteogenezy dystrakcyjnej podniebienia powoduje zwiększenie pojemności jamy nosowej, przez co następuje powiększenie pojemności całych górnych dróg oddechowych. U pacjentów młodych najłatwiej uzyskać poprawę objętości jamy nosowej za pomocą osteodystrakcji poprzecznej szczęki z wykorzystaniem urządzenia montowanego na kości. Stwierdzono, że najlepsze efekty leczenia osiąga się u pacjentów z wadą szkieletową klasy III powikłanej hipoplazją szczęki. Natomiast pacjenci z hipoplazją szczęki oraz pacjenci z wadą klasy II wymagają silniejszego powiększenia jamy nosowej. Na podstawie poczynionych obserwacji stwierdzono, że podczas leczenia szczęka wykonuje największy ruch w płaszczyźnie strzałkowej ku dołowi w odcinku przednim, nieco mniejszy w odcinku tylnym. Podczas leczenia z wykorzystaniem urządzenia montowanego na kości szczęka wykonuje również ruch w płaszczyźnie strzałkowej zgodny z ruchem wskazówek zegara, nieznacznie cofając się. Poszerzenie szczęki w płaszczyźnie czołowej w odcinku kłowym ma największy wpływ na ruch szczęki w płaszczyźnie strzałkowej.

Dystrakcja poprzeczna za pomocą urządzenia montowanego na kości powoduje największe powiększenie w tylnej części szczęki, jednak powiększenie w odcinku przednim (kłowym) wpływa najistotniej na powiększenie dna jamy nosowej. Stosowany dystraktor jest łatwy w użyciu i pozwala na utrzymanie prawidłowej higieny jamy ustnej i może pozostawać długo w jamie ustnej jako element stabilizujący.

Abstract

Surgically assisted maxillary expansion is a procedure used frequently to treat transverse maxillary defects in patients who completed a growth spurt. However, there is still lack of consensus regarding the most effective method of maxillary expansion.

This paper aims to study the effects of transpalatal osteodistraction using appliances anchored on the maxillary bone on the facial skeleton, and especially on the maxillary bones and nasal cavity.

The paper aimed to evaluate changes in the facial skeleton after treatment of maxillary narrowing with surgically assisted expansion using bone-anchored appliances. Additionally, changes in the frontal and posterior-anterior planes were studied. Changes in the volume of the nasal cavity and upper respiratory tract were also examined. Data obtained were analysed with regard to the age, sex and presence of individual changes combined with a faciodental defect.

The study group included 79 patients aged 12 to 23 years. The mean age of patients was 16.86 ± 2.65. There were 36 females, and 43 males. The study group included patients with maxillary narrowing of more than 4 millimetres, patients in whom further orthognathic treatment was scheduled, with complete diagnostic documentation; CT scans at all stages of treatment, photographic documentation, gypsum models performed at all stages of treatment and patients without any abnormalities in the nasal cavity, upper respiratory tract, without any hypersensitivities or allergies.

Patients were divided into groups depending on a maxillary defect present: a group with maxillary narrowing of 19 patients and a group with maxillary hypoplasia of 60 patients. Then, patients were divided into groups depending on an anterior-posterior skeletal class defect: class I – 20 patients, class II – 13 patients, and class III – 46 patients. Then, patients were divided depending on a maxillary defect and skeletal defect, as follows: maxillary hypoplasia, class II maxillary hypoplasia, maxillary hypoplasia open bite class II, maxillary hypoplasia class III, maxillary hypoplasia open bite class III, maxillary narrowing, maxillary narrowing class II, maxillary narrowing class III.

Treatment included complete le Fort I osteotomy with releasing all bone reinforcement points and midline osteotomy followed by placement of an osteodistraction appliance anchored on the maxillary bone. Osteodistraction was conducted according to the following protocol: latency period of 5–7 days, osteodistraction period of two rotations daily (one rotation was approx. 0.25 mm), and consolidation period of 3 to 6 months.

Changes in angles and sections were examined in patients based on tomography scans before and after treatment. Measurements were made on anterior-posterior and lateral cephalograms converted from digital tomography scans. Changes in the volume of the upper respiratory tract and changes in the volume of the nasal cavity from digital tomography scans were assessed using the Dolphin Imaging USA software. Moreover, measurements on gypsum models before and after treatment were performed.

Then, material was subject to a statistical analysis. The effects of changes in angles and distances on changes in transverse dimensions measured on gypsum models, on tomography scans converted into posterior-anterior cephalograms were analysed.

The analysis of changes in transverse dimensions measured on gypsum models using linear regression demonstrated mutual relationships with maxillary expansion at all dental levels. The distance between the apices of canine roots (3–3) increased by more than 6 mm, between the first premolars (4–4) by more than 7 mm, whereas between the first molars by more than 5 mm. All changes were mutually related to one another and were statistically significant ($p < 0.05$). As a result of treatment the distance between palatal cusps of the first maxillary molars increased by 4.0 ± 7.0 mm, distance measured on the zygomatic alveolar crests changed by 2.5 ± 6.9 mm, whereas the width of the nasal base increased by 2.2 ± 3.6 mm, the angle measured between the first maxillary molars with the apex near the anterior nasal spine changed by 0.5° ± 7.8°, the angle measured between these teeth with the apex in the Nasion point increased by 2.4° ± 2.4°. The regression analysis demonstrated a relationship between the expansion at the level of zygomatic alveolar crests and a change between buccal cusps of the first molars ($p < 0.05$). There were changes due to treatment between the width of the nasal base and the mean change was 4.0 ± 3.9 mm, change in the width between buccal cusps of the first maxillary molars from 50.9 ± 8.3 mm to 55.0 ± 8.3 mm after the procedure.

An analysis of computed tomography scans in the frontal plane demonstrated that a relationship between a change in the width of the nasal base with regard to a change in the distance between the edges of the maxillary palatal lamina is statistically significant ($p < 0.05$).

It was revealed that a relationship between values of a change in the width of the nasal base and the width between the first maxillary molars was statistically significant ($p < 0.05$), and it demonstrates positive effects of the expansion of the nasal cavity bottom with regard to the expansion at the level of the first maxillary molars, where the mean change was 2.1 ± 3.6 mm.

It was revealed that a relationship between a change in the width of the maxillary palatal laminas and the width between the first maxillary molars was statistically significant ($p < 0.05$), and it demonstrates positive effects of the expansion with regard to the expansion at the level of the first maxillary molars. The width between palatal laminas changed by 4.9 ± 3.9 mm on average, whereas between the palatal cusps of the first maxillary molars by 4.8 ± 3.9 mm on average. Results of the analysis of skeletal changes on computed tomography scans converted into two-dimensional lateral cephalograms revealed a change in the maxillary angle resulting in a change in the mandibular angle. Maxillary movement resulting in mandibular dislocation was observed. The SNB angle is reduced when the SNA angle increases. Additionally, it was observed that the anterior distance N-ANS increases when the posterior distance S-PNS increases. Results of the analysis of changes in transverse dimensions measured on models and computed tomography scans with regard to anterior-posterior changes in angles and distances on lateral cephalograms demonstrate that during maxillary expansion at the level of canines a mean change is 4.8 ± 3.9 mm and it correlates with a change in the SNA angle by –0.6 ± 4.1 on average. Additionally, a change in the angle between the cranial base and the occlusal plane was 0.4° ± 2.6° on average. The analysis of changes in the maxillary transverse dimensions with regard to changes in the sections measured on computed tomography scans converted into two-dimensional lateral cephalograms demonstrates a change in the angle describing the maxillary movement towards the bottom in its posterior section depending on a change in the angle between the first maxillary molars. This relation is demonstrated by a change in the S-N-PNS angle that was 1.2° ± 3.7° on average. A change in the angle between the first maxillary molars and the anterior nasal spine was 0.45 ± 7.7. All relationships mentioned above were statistically significant ($p < 0.05$).

During maxillary expansion the angle of molar inclination increases, and it results in the maxillary movement towards the bottom in its posterior section. Statistical significance was demonstrated ($p < 0.05$). A linear regression analysis of a change in the distance of the posterior maxillary section S-PNS correlates with a change in the distance between canines measured on computed tomography scans in the frontal plane. The posterior maxillary section S-PNS increased by 0.9 ± 3.1 mm. The expansion between the canines was 4.8 ± 3.9 mm on average. A linear regression analysis of a change in the N-ANS distance and change in the distance between points on the zygomatic alveolar crests demonstrated statistical significance ($p < 0.05$). A change in the N-ANS distance was 0.67 ± 3.3 mm on average. On the other hand, a change in the distance between the points on the zygomatic alveolar crests was

2.5 ± 6.8 mm on average. Changes in the volume of the nasal cavity depending on variable distances and angles were analysed. The volume of the nasal cavity changed by 2.9 cm^3 on average in the study material. All correlations did not demonstrate statistical significance, and it reveals that changes in the studied parameters had hardly any effect on the changes in the volume of the nasal cavity. A change in the volume of the nasal cavity depending on variable distances between individual teeth measured on models was analysed. Despite lack of statistical significance it was possible to observe that the volume of the nasal cavity increased with the increase in the difference of the distance between canine cusps. The analysis of results for a single variance analysis of the effects of a skeletal defect on changes in angles, sections and volume of the upper respiratory tract did not demonstrate any statistical significance. The volume of the upper respiratory tract increased by 5.4 ± 5.1 cm^3 on average. Results of the change in the occlusal plane angle with regard to the cranial base depending on a skeletal defect indicate that the greatest changes in the angle were observed in a group with class III defects. Results of a quantitative analysis of a change in the ANB angle depending on a skeletal defect demonstrated statistical significance ($p < 0.05$). The ANB angle changed after treatment and there was a difference between defects, namely the angle was significantly smaller in class II, and significantly higher in class III when compared to class I. A degree of a change in the SNA angle describing the maxillary movement anteriorly with regard to a skeletal defect confirmed it was statistically significant ($p < 0.05$). The greatest difference was observed in the class II group, namely the maxilla was the most prominent in this defect, whereas in class III defect it was observed to a significantly lower degree. A change in the maxillary angle SNA by –0.6 ± 1.0° resulted in a change in the mandibular angle SNB by –0.1 ± 2.7°.Analysis results demonstrated the greatest changes in a group with skeletal class III defects. On the other hand, results of an analysis of changes in the width of the nasal base with regard to a skeletal class demonstrated that the greatest changes were observed in the class III defect group. Therefore it can be assumed that class III patients demonstrate more narrow maxillae or require larger expansion due to a larger mandible. Results of the analysis regarding changes in the palatal height depending on a skeletal defect demonstrated that changes were the greatest in a group with a class III defect. Therefore it should be assumed that patients with a class III defect have narrower and higher maxillae or require greater expansion. This effect may lead to lowering of the palatal roof due to a larger mandible. Results of the analysis of changes in the nasal cavity volume with regard to a skeletal defect indicate that the range of changes in the nasal cavity volume is the smallest in a group with a class II defect. All types of defects were associated with a similar maximum range of changes regarding the increase in the nasal cavity volume.

Statistically significant changes that are visible are associated with the anterior maxillary movement in class II defects, as in class III defects jaws are usually retracted and hypoplastic.

Changes that are visible but are not statistically significant included changes in the width and height of the maxilla in class III defects. It is also a result of the need for significant maxillary expansion due to maxillary deformation and adjustment to the mandible which is usually larger.

Results of a single factor analysis of variance regarding types of maxillary defects that correlated with changes in angles, sections and volume of the upper respiratory tract demonstrate that a greater change in the angle of the maxillary base is visible in defects with maxillary hypoplasia. The angle formed by the planes between the S-N and PNS-ANS points, namely the angle of maxillary inclination to the cranial base changed by $0.08° \pm 1.8°$ on average. The analysis of variance of changes in the maxillary anterior height N-ANS depending on types of maxillary defects concluded that the anterior maxillary height demonstrated the highest variability in a group with maxillary narrowing compared to a group with hypoplasia. The N-ANS section increased by 0.67 ± 3.3 mm on average. Results of a qualitative analysis for changes in the posterior maxillary height depending on types of maxillary defects demonstrated that the highest variability of the anterior maxillary height was observed for defects with maxillary narrowing. The N-ANS section increased by 0.9 ± 3.1 mm on average. Changes in the respiratory tract are visible in the analysis. Similar results of treatment were achieved in cases with maxillary narrowing and hypoplasia.

Results of the analysis of changes in the maxillary inclination angle to the cranial base depending on types of maxillary defects demonstrated that a greater change in the angle was observed in defects with maxillary hypoplasia.

The results of the analysis of the effects on changes in angles and sections depending on types of maxillary defects and skeletal defects demonstrated that an increase in the volume of the respiratory tract with regard to the diagnosis was greater in a group with defects with maxillary narrowing and class II defect. These are patients in whom it is necessary to expand the maxilla to the largest degree possible in order to provide complex treatment of a defect. The second group included maxillary narrowing with a class III defect. A degree of expansion, namely an increase in the volume of the respiratory tract, depends on the plan of final treatment. The volume of the upper respiratory tract increased by 5.4 ± 5.1 cm^3 on average.

The volume of the nasal cavity changed by 2.9 cm^3 on average, from 34.7 ± 5,7 cm^3 before treatment to 37.7 ± 5.6 cm^3 after treatment.All correlations with changes in the angles and sections did not demonstrate significance, and it reveals that changes in the studied parameters had hardly any effects on the changes in the volume of the nasal cavity. The majority of analyses presents a growing tendency, apart from the SNB angle, change in the width of the nasal base and changes in the palatal height.

Based on data obtained it was concluded that palatal distraction osteogenesis for maxillary expansion was an effective method to treat defects of the facial skeleton. Additionally, it was concluded that treatment with transverse palatal distraction osteogenesis results in the increase in the nasal cavity volume, therefore in the whole upper respiratory tract. In young patients increased volume of the nasal cavity is the most easily obtained with maxillary transverse osteodistraction with a bone-anchored appliance. It was concluded that the best therapeutic outcomes are observed in patients with skeletal class III complicated by maxillary hypoplasia. On the other hand, patients with maxillary hypoplasia and patients with class II defects require greater expansion of the nasal cavity. It was observed that during treatment the maxillary movement is the greatest in the sagittal plane towards the bottom in its anterior section, and slightly smaller in the posterior section. During treatment with a bone-anchored appliance the maxilla also moves clockwise in the sagittal plane, with slight retraction. An increase in the frontal plane in the canine section has the largest effect on the maxillary movement in the sagittal plane.

Transverse distraction with a bone-anchored appliance results in the greatest enlargement of the posterior section of the maxilla, but an increase in the anterior, namely canine, section has the largest effect on an increase in the nasal cavity bottom.

A distractor that was used is easy to use, helps maintain appropriate oral hygiene and may be left in the oral cavity as a stabilising structure.