CONCLUSION: Unilateral vertical mandibular distraction osteogenesis improves mandibular ramus height and chin point deviation, while also effectively leveling the maxillary occlusal height and cant angle for patients with HFM without the need for an intraoral orthodontic appliance. Future study will be aimed at assessing the long-term stability of these promising results.

Surgical Management through Skeletal Maturity in Craniofacial Microsomia

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PURPOSE: Due to the complex and diverse nature of craniofacial microsomia (CFM) and the variety of treatment options available, there is little consensus around an optimal management algorithm. This study examines treatment patterns for CFM over a 24-year period at a tertiary care center, with an emphasis on the controversial role of early mandibular distraction osteogenesis (MDO) as it relates to need for orthognathic surgery at skeletal maturity.

METHODS: A retrospective review of all CFM patients evaluated between January 1993 and March 2017 was conducted. A subset analysis was performed on subjects who had reached skeletal maturity to evaluate need for orthognathic surgery for correction of maxilla-mandibular asymmetries, specifically examining whether MDO had been previously performed.Demographic characteristics were assessed with descriptive statistics. Univariate analysis was conducted using chi-square and Fisher exact tests for categorical variables, and Mann-Whitney U test for continuous variables.

RESULTS: 179 patients were identified (55.9% male, mean follow-up age 11.3±5.6 years), with 148 having adequate data for analysis. 29.9% were Kaban-Pruzansky Grade I, 16.3% Grade IIa, 14.3% Grade IIb, and 17.0% Grade III. 122 subjects underwent a total of 543 procedures (mean 4±3 procedures per subject). The mean age at first intervention was 6.0±4.6 years, with ear reconstruction (30.1%) and mandibular distraction (20%) being the most frequent procedures. Higher Kaban-Pruzansky Grade was significantly associated with earlier age at first intervention (p=0.001). Other major interventions included costochondral rib grafting, fat grafting, cleft repair, and orthognathic surgery. 38 subjects (17 MDO, 21 non-MDO) who had reached skeletal maturity were included in the subset analysis. Cohorts were matched in Kaban-Pruzansky Grade (p=0.788). Need for orthognathic surgery did not differ significantly between the two cohorts (MDO=8; non-MDO =10; p=0.203).

CONCLUSION: Life-long management of CFM requires a multi-faceted treatment plan tailored to each patient’s evolving needs; careful sequencing and timing of operations is essential for optimal restoration of craniofacial form and function. CFM patients with more severe mandibular deformity are significantly younger at time of initial intervention. There appears to be similar orthognathic surgery rates at skeletal maturity between CFM subjects who underwent early-MDO and those who did not undergo early-MDO. Future studies and continuing experience can inform the best timing and technique of early-MDO for long-term retention of facial symmetry.

A Prospective Study of Forces in Craniofacial Distraction

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BACKGROUND: While much has been written about the variables “distance” and “rhythm” in craniofacial distraction osteogenesis (CMF DO), little is known about the forces involved. The purpose of this study is to study force magnitudes and force trends in CMF DO and associate these forces to operative outcomes.

METHODS: Seventeen patients undergoing distraction of the mandible or cranial vault with a semi-buried KLS-Martin (KLS-Martin, Tuttlingen, Germany) distractor, were included in this prospective study. Subjects’ distractors were activated each day by study personnel, using a digital
torque-measuring screwdriver. Torque measurements were then converted into generalizable force values and associated with patient outcomes.

RESULTS: Cranial vault distraction (CVDO) was performed on 7 subjects (41.2%), and mandibular distraction (MDO) on 10 subjects (58.8%). Across the entire cohort, the maximum force per activation was 27.02 ± 3.5 N, and the elastic force (the rise in force over a single activation) was 10.71 ± 4.1 N. Maximum force (CVDO: 52.92 ± 20.2 N vs. MDO: 12.98 ± 8.5 N; *p* < 0.0001), and elastic force (CVDO: 22.01 ± 15.6 N vs. MDO: 4.58 ± 8.2 N; *p* < 0.0001) were significantly higher in the CVDO sub-group than in the MDO cohort. On multivariate regression analysis, statistically significant associations were seen between maximum activation force and the following independent variables: active DO day number (beta-coefficient: 1.1; *p* < 0.001), DO rate (mm/day) (beta-coefficient: 8.9; *p* = 0.016), CVDO (relative to MDO) (beta-coefficient: 41.4; *p* < 0.001), and device failure (beta-coefficient: 10.3; *p* = 0.004).

CONCLUSION: In CMF DO, both the magnitude of, and the trend in forces are relatively predictable, and correlate significantly with easily discernable factors such as DO-modality (MDO vs. CVDO), DO rate, and other factors. Deviations from these predictable force magnitudes and trends are correlated with systems failures. A more thorough understanding of the normal and abnormal states, as they relate to force measurements, may allow for novel diagnostic and prognostic tools, and a better heuristic with which clinicians can optimize DO protocols for the patients.

Corrected Cephalometric Analysis and hybrid Osteogenesis Distraction System to Control the Distance and Vector with Le Fort III Osteotomy for Syndromic Craniosynostosis

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**BACKGROUND:** The purpose of this study was to confirm the utility of corrected cephalometric analysis to facilitate the planning of distraction osteogenesis with Le Fort III osteotomy for syndromic craniosynostosis, and to evaluate the stability and/or resultant change in facial features after at least 1 year of follow-up (range, 1–9 years).

**METHODS:** This prospective study involved 8 cases of Crouzon syndrome and 3 cases of Pfeiffer syndrome (types II and III) (age range, 4 years 6 months to 13 years 2 months) treated with primary Le Fort III maxillary distraction using corrected cephalogram analysis and a hybrid distraction system. Corrected cephalogram analysis involves superimposing a patient’s cephalogram onto that of a normal Japanese adult. Both cephalograms are then superimposed using the articulare for guidance to determine the distance and vector of distraction osteogenesis. The hybrid distraction system is composed of both a conventional external distraction device and a newly developed adjustable-angle internal distraction device. Postoperative control of the distraction vector is performed by pulling the midfaces using the external device, while control of distraction distance is done by pushing the midfaces with the internal device.

**RESULTS:** Midfaces were brought close to the planned position from the corrected cephalometric analysis in Crouzon syndrome. Midfaces were advanced by 19.8 ± 4.0 mm at Or and 29.4 ± 4.1 mm at point A, but accurate alignment to the planned vector was difficult. Meanwhile, midfaces were not brought close to the planned position from the corrected cephalometric analysis in Pfeiffer syndrome. Midfaces were advanced by 32.0 ± 2.1 mm at Or and 34.7 ± 5.0 mm at point A, but accurate alignment to the planned vector was more difficult for Pfeiffer than for Crouzon. Facial features changed little on follow-up, 1–9 years after removal of the distraction device.

**DISCUSSION:** Pfeiffer syndrome was more difficult than Crouzon syndrome to achieve results close to the planned position. This was because severe Pfeiffer syndrome requires advancement over a longer distance than Crouzon syndrome, and the nasal part of the soft tissue might be tighter in Pfeiffer syndrome than in Crouzon syndrome.

**CONCLUSION:** Using corrected cephalometric analysis, the distance and vector of distraction osteogenesis with Le Fort III osteotomy could be determined in patients with syndromic craniosynostosis. This distraction system offers the possibility of bringing facial bones to the planned position using controlling devices. However, final long-term growth remains unclear.