



Evolution of craniofacial surgery

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Modern craniofacial surgery was established by the work of Dr. Paul Tessier and others, dating back to the 1960s, which applied concepts including autogenous bone grafts, transcranial and subcranial approaches for correcting deformities of craniofacial synostosis, as well as the surgical management of Treacher Collins syndrome and craniofacial clefts. Subsequently, techniques involving extensive exposure and complete correction of craniofacial trauma were followed by the development of rigid fixation using titanium plates and screws [1]. This method enabled effective restorations of the shape of craniofacial structures with stable results. The application of rigid fixation opened the door for new ideas about bone treatment in the craniofacial area. In particular, it became possible for surgeons to perform more aggressive osteotomy and movement with less postoperative patient management (e.g., intermaxillary fixation). This improved the quality and safety of surgical procedures. Microsurgical free tissue transfer was added to the armamentarium of treating orofacial tumors. This involved soft tissue coverage and filling defects, as well as skeletal tissue support. Free tissue transfer has enabled stable reconstruction, encouraging more extensive resection of tumor tissue and consequently improving survival.

The treatment of craniofacial deformities necessitates the consideration of both reconstructive and aesthetic purposes, which are equally important issues. In my early practice of wide exposure and complete rigid fixation for patients with complex cra-

niofacial fractures, some patients developed a skeletal appearance of the face with subcutaneous tissue atrophy and palpable hardware, constituting a significant secondary deformity. Today, I would employ a different treatment strategy for patients with the same condition. Over the years, the field has evolved to a considerable extent, with advances such as endoscopic and other minimally invasive procedures, distraction osteogenesis, three-dimensional (3D) imaging, computer-assisted treatment, virtual surgical planning, and 3D printing. These gradual innovations led to new treatment concepts for craniofacial deformities. Skeletal distraction with new bone generation has addressed the problems of limited bone advancement using the traditional methods [2]. This includes Le Fort III osteotomy and gradual advancement for patients with multiple craniosynostosis, hypoplastic ramus in hemifacial microsomia, micrognathia, wide alveolar cleft, and contracted dentoalveolar arch, to name a few conditions. The development and application of 3D imaging have had significant impacts on the medical field, and I consider 3D imaging to be equally important as the discovery of antibiotics in the earlier era of medicine. The most commonly used imaging modality is computed tomography, although other methods including magnetic resonance imaging, photographs, laser imaging, and ultrasonography are also applied in the clinical settings. These 3D imaging modalities are now actively used in preoperative evaluations, treatment planning, virtual surgery, and postoperative assessments [3]. They are used to evaluate the skeletal tissue as well as soft tissues (e.g., muscle, brain, cerebrospinal fluid, and eyeball), as well as for research purposes.

Orthognathic surgery has become one of the major fields of practice at the Craniofacial Center of Chang Gung Memorial Hospital, and 3D imaging, surgical simulation, and 3D printing are routinely applied [4,5]. Compared with the traditional two-

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dimensional cephalometry and the dental cast and face bow transfer method, modern 3D modalities offer multiple advantages in terms of yaw rotation, ramus inclination, midline, roll rotation, genioplasty, and pitch rotation. The yaw rotation of the mandible is a particular benefit of the 3D system, since it was possible only to a limited extent in the traditional method, and it avoids bony collision and achieves cheek symmetry. Consequently, the accuracy of the procedure is higher and outcomes are more satisfactory [6]. With the support of 3D imaging, intraoperative navigation of the maxillomandibular complex could be applied to the planned position. 3D printing is used to produce physical models, occlusal splints, osteotomy guides, positioning guides, and interosseous spacers between bone segments. Custom-made fixation plates could also be made using 3D printing after virtual surgery planning.

Researchers are exploring further advances that could be usefully incorporated into our practice in the near future. In particular, we are expecting contributions from tissue engineering technology, new biomaterials, molecular medicine, machine learning, virtual reality, augmented reality, and artificial intelligence in the field of craniofacial surgery. In this regard, I am particularly enthusiastic about advances in bone and cartilage engineering.

At the same time, we must also acknowledge changes in disease and practice patterns in the craniofacial field, parallel with those encountered in other medical specialties. Each center around the world should recognize these changes and adjust accordingly. For instance, the incidence of cleft lip and palate has declined over the years in Taiwan, most likely due to prenatal diagnoses. The number of surgical interventions for each patient with cleft lip and palate has dramatically decreased due to advances in surgical techniques. These reductions occurred mainly for secondary deformities such as oronasal fistula and velopharyngeal insufficiency, as well as for intermediate revisions of the lip and nose. Patients with cleft lip and palate do not require surgical interventions during the growth period except for alveolar bone grafting at 9 years of age. Improvements in the quality of care have reduced the physical and psychological burden of cleft care [7]. At the same time, practice patterns at Craniofacial Center of Chang Gung Memorial Hospital have changed to involve an increasing number of orthognathic surgery procedures. Orthognathic surgery is performed to correct dental malocclusion, facial asymmetry, and a dissatisfactory facial appearance, with the main purpose of improving patients' quality of life.

The aim of the Asian Pacific Craniofacial Association is to provide a platform where members and participants can share their knowledge and learn from each other (Fig. 1). *Archives of*



Fig. 1. Photograph with Prof. Kiyonori Harii and members of Korean Cleft Palate-Craniofacial Association at PRS Korea 2016 in Seoul, Korea.

Craniofacial Surgery provides a stage to showcase our research and clinical experience. It is my pleasure to see the establishment of a close connection between these two parties.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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REFERENCES

- Chandawarkar A, Birgfeld CB, Yaremchuk MJ, Tufaro AP, Hopper RA, Susarla SM. Pioneers in modern craniofacial surgery: assessing the academic impact of Drs. Joseph Gruss and Paul Manson. *Plast Reconstr Surg* 2020;145:814e-817e.
- Gibson TL, Grayson BH, McCarthy JG, Shetye PR. Proptosis correction in pre-adolescent patients with syndromic craniosynostosis by Le Fort III distraction osteogenesis. *J Craniofac Surg* 2018;29:1535-41.
- Lin HH, Lo LJ. Three-dimensional computer-assisted surgical simulation and intraoperative navigation in orthognathic surgery: a literature review. *J Formos Med Assoc* 2015;114:300-7.
- Ho CT, Lin HH, Lo LJ. Intraoral scanning and setting up the digital final occlusion in three-dimensional planning of orthognathic surgery: its comparison with the dental model approach. *Plast Reconstr Surg* 2019;143:1027e-1036e.
- Lin HH, Lonic D, Lo LJ. 3D printing in orthognathic surgery: a literature review. *J Formos Med Assoc* 2018;117:547-58.

6. Denadai R, Chou PY, Su YY, Lin HH, Ho CT, Lo LJ. The impacts of orthognathic surgery on the facial appearance and age perception of patients presenting skeletal class III deformity: an outcome study using the FACE-Q report and surgical professional-based panel assessment. *Plast Reconstr Surg* 2020; 145:1035-46.
7. Denadai R, Lo LJ. Toward reducing the surgical burden of care: modern longitudinal life-changing concept in cleft care. *J Formos Med Assoc* 2020;119:1013-5.