ORIGINAL RESEARCH

Postoperative Evaluation of Nerve Function Following Coronal Incisions for Facial Fractures: A Clinical Study

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Abstract

Aim: The present study aimed to evaluate the postoperative nerve function following coronal incisions for facial fractures.

Materials and methods: The present study included 30 patients with craniomaxillofacial trauma treated using the bi-temporal/coronal or hemicoronal approach. A preoperative computed tomography (CT) scan of the face with 3D reconstruction was done for all the patients to determine the exact extent of the fractures. All the cases were undertaken with general anesthesia and endotracheal intubation. Under all aseptic conditions, a coronal incision was given, reflection of the flap was done and fracture segments were approached. Reduction and fixation were achieved at the sites and closure was done. Postoperatively, neurological deficits in the zygomaticotemporal, supraorbital, and frontal branches of the facial nerve were closely observed at 1-, 4-, 16-, 24-, and 52-weeks intervals.

Results: In all 30 patients, the duration of recovery varied between 16 weeks, 24 weeks, 32 weeks and 52 weeks but at the end of 32–52 weeks all the deficits subsided. There was a marked recovery between 16 and 24 weeks, with a complete resolution of 52 weeks. The study found a significant association between recovery time and nerve healing, highlighting the coronal approach's effectiveness in treating complex facial fractures while preserving nerve integrity.

Conclusion: In conclusion, the study found that while patients undergoing craniomaxillofacial reconstruction via the coronal approach initially experienced notable neurological deficits, full nerve function was ultimately restored over time, underscoring a strong correlation between nerve healing and favorable functional outcomes.

Clinical significance: The coronal approach not only delivers superior esthetic results but also safeguards neural integrity, minimizing the risk of nerve impairment often associated with traditional methods of fracture management. Coronal incisions provide superior access for precise anatomic reduction and preserve nerve integrity.

Keywords: Coronal incision, Craniomaxillofacial, Mid-face fractures, Nerve deficit, Temporal.

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Introduction

Maximum exposure of a facial skeleton, avoiding injury to facial structures and good cosmetic outcome, are the foremost concerns of Craniomaxillofacial surgery. Several tiny incisions positioned strategically over the face have been used for many years to heal facial fractures; nevertheless, these incisions leave several scars behind.[1]

Addressing severe cranio-maxillofacial injuries, especially those involving the mid-facial region, can be quite formidable. The coronal approach, as popularized by Teisser, facilitates optimal exposure of the fracture sites, thereby assisting in meticulous anatomic reduction, stabilization of the fractured segments, and achieving esthetically pleasing results at the incision location.[2,3]

The coronal approach, with its myriad of refinements, serves a multitude of purposes, including the treatment of severe cranio-maxillofacial trauma, the rectification of craniofacial deformities, the execution of craniotomies, and the performance of osteotomies in the upper and mid-facial regions. Additionally, it facilitates the harvesting of bone and facial grafts when necessary, grants enhanced access to the condylar regions, and is utilized for esthetic interventions such as forehead rejuvenation. The reason behind its enduring popularity is the visual benefit of a concealed scar in the hairline.[4]

The skin and subcutaneous tissue musculoaponeurotic layers can be separated from the pericranium due to the easy cleavage of the subgaleal fascia (musculoaponeurotic layer). The subgaleal

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fascia extends deep to the orbicularis oculi muscles on the anterior side, where it is continuous with the loose areolar layer. It is joined to the zygoma's frontal process laterally (Fig. 1).

The interval between the anterior concavity of the external auditory canal and the juncture at which the temporal branch intersects the zygomatic arch varies from 0.8 to 3.5 cm. This branch follows a deep trajectory, elegantly coursing either along its deep surface or nestled within the facial layer, advancing anteriorly and superiorly between the temporoparietal fascia and the confluence of the superficial temporalis fascia with the periosteum of the zygomatic arch.[5,6]

Focus on both sensory and motor impairments is required to uncover the extent of postoperative neural dysfunction associated with this specific surgical technique. Hence, a detailed analysis to enhance the understanding of the neurological outcomes and improve patient care following such intricate procedures is necessary. Therefore, the study was conducted to evaluate nerve deficits in patients undergoing craniomaxillofacial reconstruction through coronal incisions.

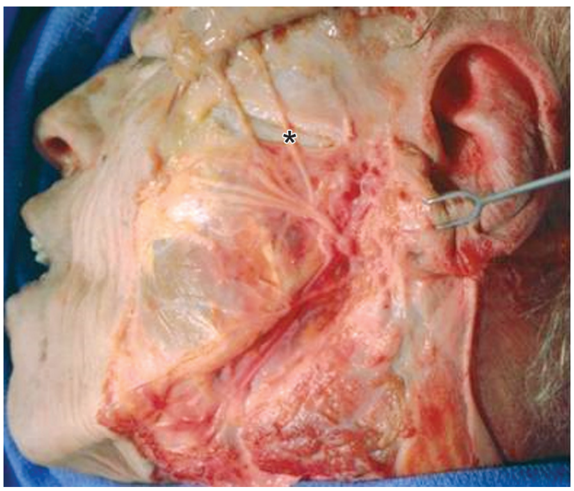


Fig. 1: Dissected specimen depicts the course of the facial nerve. The skin, subcutaneous layer, and temporalis fascia along with the superficial musculoaponeurotic system have been reflected to depict the facial nerve anatomy

Materials and Methods

The present study was conducted in the Department of Oral and Maxillofacial Surgery, Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha from January 2021 to March 2024. Ethical approval was obtained from the Institution. A sample size of 30 patients with craniomaxillofacial trauma recommended for operation using a bi-temporal/coronal or hemicoronal approach was included in the study. Valid informed consent was taken from each patient and their attendants before the surgical procedure.

The individuals who consented to participate, specifically those aged between 18 and 50 years, patients who were recommended surgical intervention via bi-temporal/coronal or hemicoronal approaches for intricate cranio-maxillofacial injuries involving the frontal bone, zygomatic arch, zygomatic complex, nasal bone, and supra-orbital region, patients medically fit for general anesthesia and who had obtained clearance from neurosurgeons for the procedure were included for the study.

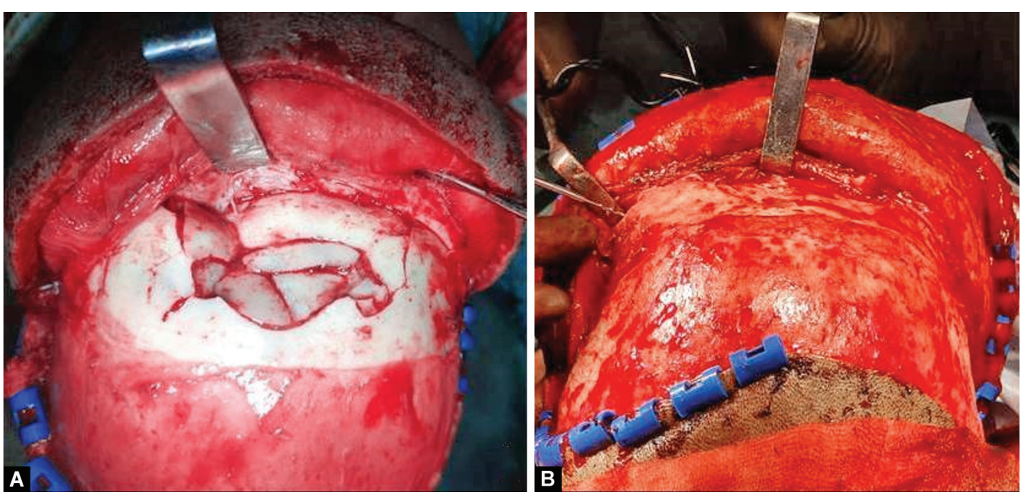
Patients unwilling to participate in the study, medically compromised patients, patients with preoperative facial nerve injury, and facial fracture reduction done using any other approaches were excluded from the study.

A preoperative computed tomography (CT) scan of the face with 3D reconstruction was done for all the patients to determine the exact extent of the fractures. All the surgeries were performed by the same team of surgeons. Before the surgery, full head shaving was done for all the patients. The 2 gms of Ceftriaxone every 12 hours followed by oral agent Amoxicillin/Clavulanate (Augmentin) 625 mg every 12 hours were administered pre and postoperatively.

Surgical Technique

All the cases were undertaken with general anesthesia and endotracheal intubation. Under all aseptic conditions, the scalp was exposed. A curvilinear incision line was marked, 3–4 cm from the hairline.

The traditional coronal incision starts at the root of the helix and continues coronally to the contralateral helix, the skull's vertex. In the present study cases, the initial scalp incision for the coronal approach spanned from one superior temporal line to the other (Fig. 2), whereas in the hemicoronal approach, it concluded just before the midline.



Figs 2A and B: (A) Exposure of the fracture site at the frontal bone; (B) The coronal flap has been used for reflection of the frontal bone fracture in the patient

The use of Raney's clips, electrocautery, and sutures was advocated for hemostasis. For cases demanding a zygomatic arch exposure, the incision was continued in the preauricular area.

The flap was raised, and the periosteum was preserved by making an initial incision down to the subaponeurotic areolar tissue. Subsequent subperiosteal dissection and periosteum incision exposed the nasoethmoid, nasofrontal and frontozygomatic areas, approximately 3 cm above the supraorbital rim.

Dissection along the temporal fascia continued with a 45° incision through the superficial fascia layer, the frontal branch of the facial nerve was carefully avoided as the cartilaginous auditory canal was reached. Inferior dissection revealed the zygomatic arch, frontal bone, nasal bone, and parts of the orbital margins, parietal, and temporal bones. In the hemicoronal approach, the incision was stopped just before the midline, with lateral dissection following the temporalis fascia, approximately 2 cm above the zygomatic arch (Fig. 3).

The dissection proceeded inferiorly until it reached the periosteum of the zygomatic arch, after which it unites anteriorly with the supraorbital periosteal incision. Laterally, when the zygomatic arch was encountered, a subperiosteal incision was made, reflecting the flap inferiorly.[7] When addressing other fracture sites, an intra-oral vestibular incision was placed. Anatomical and functional reduction with fixation was done at the fracture sites. Layer-by-layer suturing was done and staplers were used to close the skin layer (Fig. 4).

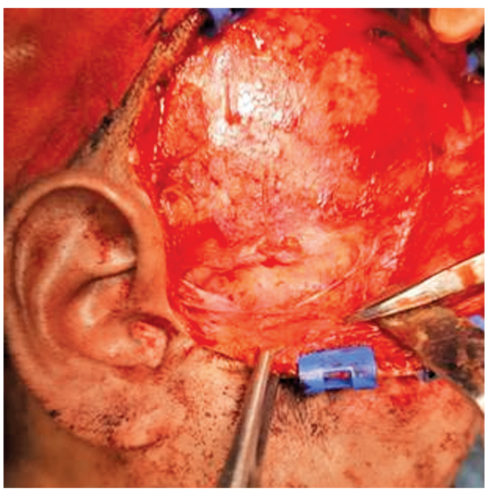


Fig. 3: Exposure of the white glistening layer of temporal fascia after layer-by-layer dissection using hemicoronal flap

Evaluation of nerve functioning was then done at 1 week, 4 weeks, 16 weeks 24 weeks, and 52 weeks, respectively using the following criteria.

The motor nerves such as the zygomaticotemporal branch were evaluated by checking for complete eye closure, the frontal branch was evaluated by checking for the raising of eyebrows and forehead wrinkling while sensory nerves such as the supraorbital branch were evaluated by checking for the absence of paresthesia or anesthesia over the scalp, forehead, and upper eyelid region.

The method of grading was based on the overall evaluation of nerve function using muscle power for motor nerves and for sensory nerves the sensations were measured as present or absent during the subsequent weeks of evaluation.

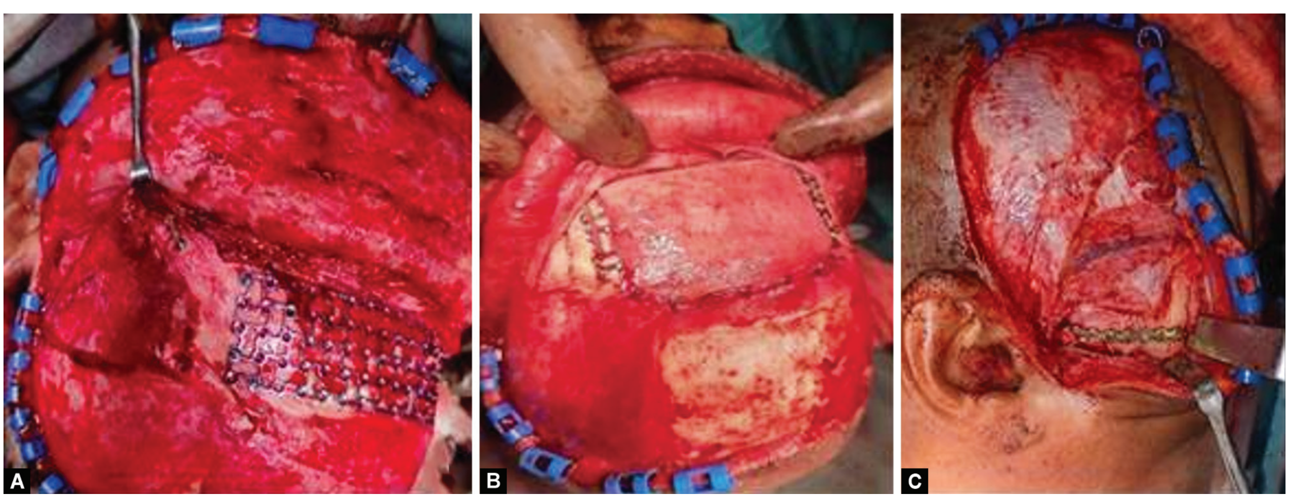
Statistical Analysis

Clinical data coding, tabulation, and visualization were performed using Microsoft Excel (Microsoft Office 365 suite). Statistical analysis was conducted using R statistical programming language v4.4.1 on R Studio desktop environment v2024.4.2.764. Fisher's exact *t*-tests were conducted due to the low sample numbers not fulfilling the chi-squared expected value assumption. A significance level (α) of 0.05 was considered for the analysis.

Results

A total of 30 male patients (15 cases were of bicoronal and 15 were of hemicoronal approach) who underwent craniomaxillofacial fracture reduction with a mean age of 33.2 years were included in the study.

Table 1 describes the deficit present and absent, along with percentages for each nerve for all points of follow-up. When considering the zygomaticotemporal nerve, most participants 5 (71.4%) exhibited neurological deficit 1-week postsurgery. This number remained constant over 4 weeks post-op, following



Figs 4A to C: (A) Reduction and fixation was done using titanium mesh and screws; (B) Pericranial flap closure; (C) Fixation of the zygomatic arch fracture using a hemicoronal approach

Table 1: Number of patients with and without neurological deficit using coronal/bi-temporal approach during 1-, 4-, 16-, 24-, and 52-weeks postsurgery

	Weeks					
Neurological deficits	*2*	*4*	*16*	*24*	*52*	*p-value*
Zygomaticotemporal nerve (*n* = 7)						
Deficit present (%)	5 (71.4)	5 (71.4)	4 (57.1)	2 (28.6)	0 (0)	<0.05
Deficit absent (%)	2 (28.5)	2 (28.5)	3 (42.9)	5 (71.4)	7 (100)	
Supraorbital nerve (*n* = 30)						
Deficit present (%)	13 (43.3)	11 (36.7)	8 (26.7)	3 (10.0)	0 (0)	<0.001
Deficit absent (%)	17 (56.7)	19 (63.3)	22 (73.3)	27 (90.0)	30 (100)	
Frontal branch of facial nerve (*n* = 30)						
Deficit present (%)	23 (76.7)	23 (76.7)	18 (60.0)	5 (16.7)	0 (0)	<0.001
Deficit absent (%)	7 (23.3)	7 (23.3)	12 (40.0)	25 (83.3)	30 (100)	

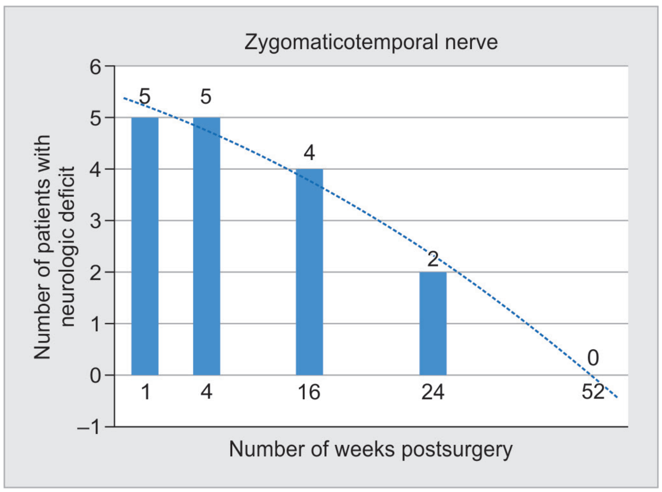


Fig. 5: Number of patients with zygomaticotemporal neurological deficit during 1-, 4-, 16-, 24-, and 52-weeks postsurgery

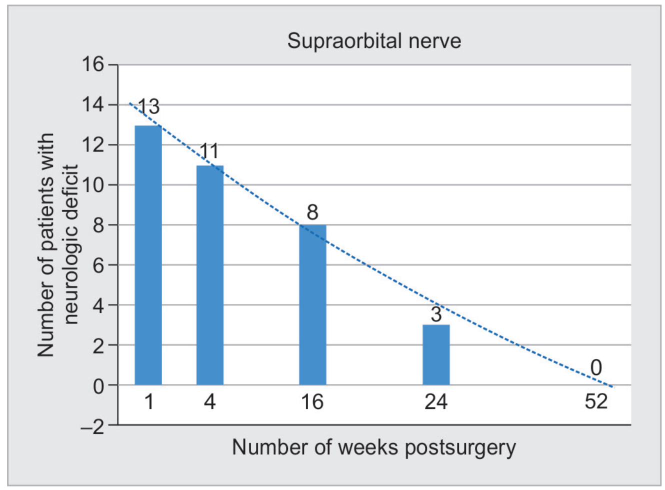


Fig. 6: Number of patients with a supraorbital neurological deficit during 1-, 4-, 16-, 24-, and 52-weeks postsurgery

which improvement was observed in nerve function over 16-, and 24-week, up to the 52-week mark by which point no participants reported the presence of neurological deficit (Fig. 5).

A similar pattern was observed for the supraorbital nerve, which reported the minimum number of neurological deficit cases 1-week post-op 13 (43.3%) among the three nerves included in this study. Neurological deficit cases reduced gradually over the 4-, 16-, and 24-week mark, up to the 52-week mark by which point, similar to zygomaticotemporal nerve, no participants reported the presence of neurological deficit (Fig. 6). Fisher's exact *t*-test reported a value of $p < 0.001$ which again suggests the likelihood of a highly statistically significant association between postsurgery time and the presence of neurological deficit in the supraorbital nerve.

Complete recovery was also observed in the frontal branch of the facial nerve, for which no cases reported the presence of neurological deficit by 52 weeks postsurgery. Similar to the zygomaticotemporal nerve, initial recovery was slow during the first 4 weeks post-op—the majority of cases reported the presence of a neurological deficit in this nerve. Following this, a sharp drop in number of neurological deficit cases was observed between weeks 16 and 24—suggesting faster recovery during this phase (Fig. 7). A highly significant value of $p < 0.001$ suggests the likely presence of an association between postsurgery time and the presence of a neurological defect in the frontal branch of the facial nerve as well.

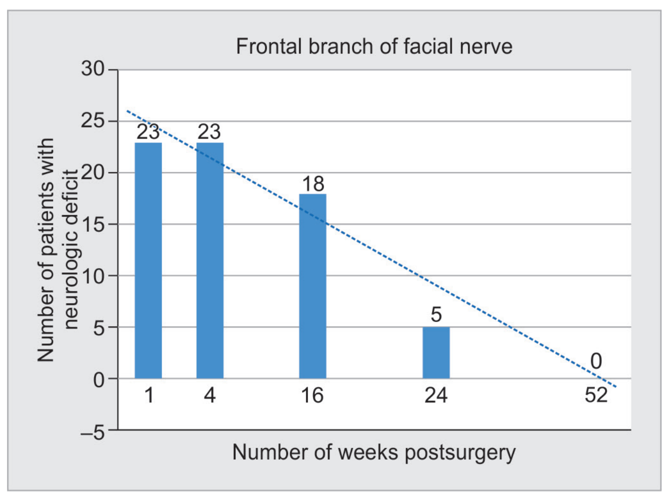


Fig. 7: Number of patients with frontal branch of facial nerve deficit during 1-, 4-, 16-, 24-, and 52-weeks postsurgery

Figures 8 to 10 showed the number of patients without nerve deficit during 1-, 4-, 16-, and 24-weeks postsurgery.

For a zygomaticotemporal and frontal branch of the face—initial recovery is slow (no change in one month). It can be stated that the supraorbital nerve was the fastest to begin recovery. The biggest

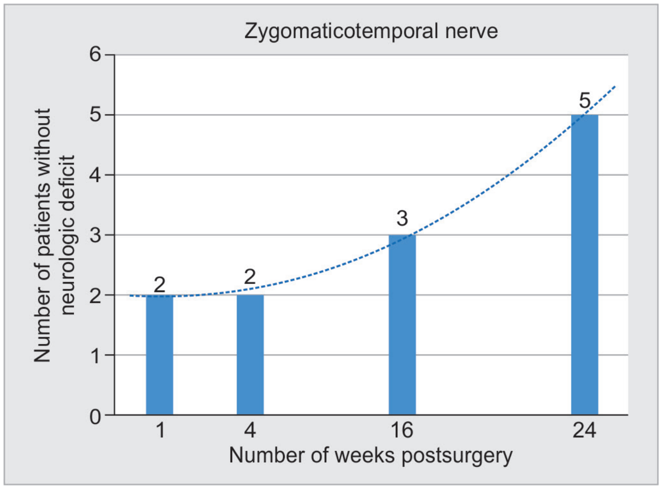


Fig. 8: Number of patients without zygomaticotemporal nerve deficit during 1-, 4-, 16-, and 24-weeks postsurgery

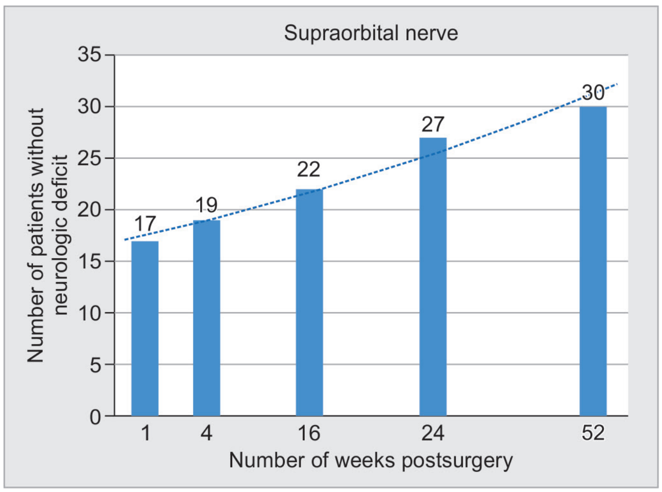


Fig. 9: Number of patients without supraorbital nerve deficit during 1, 4, 16, 24, and 52 weeks postsurgery

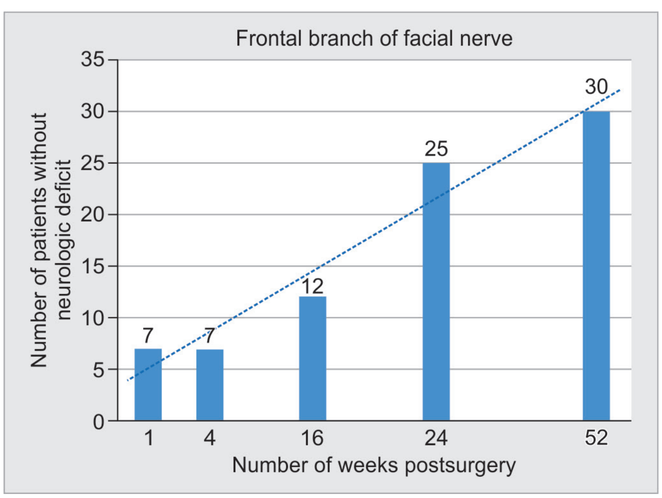


Fig. 10: Number of patients without a frontal branch of facial nerve deficit during 1, 4, 16, 24, and 52 weeks postsurgery

jump in deficit numbers is usually seen between weeks 16 and 24—suggesting most healing occurs during a 4–6-month period.

Discussion

The coronal approach, once the domain of neurosurgeons for accessing the neurocranium, has seen a surge in popularity within craniomaxillofacial surgery in the 21st century. This technique provides unrivaled access to the craniofacial skeleton, encompassing the orbit and nasal bones, all without necessitating facial incisions. Similarly, Rajmohan et al.[8] demonstrated that hemicoronal and bicoronal approaches provided sufficient surgical site exposure, enhanced by intraoral and infra-orbital incisions, with average flap reflection times of 12.8 and 13.8 minutes, respectively, justifying the time investment for improved accessibility and visibility. Hence, by utilizing a coronal flap, surgeons can easily navigate the frontal, temporal, and zygomatic regions, facilitating the seamless reconstruction of the orbit, zygoma, frontal area, and nasoorbitoethmoid (NOE) complex.

The present study technique allows for precise reduction and fixation, promoting rapid functional recovery. Its standout feature is the combination of superior surgical exposure and protection of the facial nerve, while still delivering cosmetically favorable results. Similar results found in Dunaway and Trott[9] reported 25 cases employing a novel extended bicoronal approach coupled with masseter myotomy for condylar fractures, achieving satisfactory reduction and fixation, minimal complications, and esthetically pleasing scars, thereby endorsing this technique for its surgical efficacy. The ability to minimize visible scarring while achieving excellent structural outcomes makes the coronal approach a highly commendable option in craniofacial reconstruction, harmonizing both functionality and esthetics with finesse.

Traditionally, patients with significant comminuted fractures and misalignment of the facial skeleton were treated with small local incisions, where bone fragments were wired into place, the jaws were immobilized with arch bars, and sometimes immediate bone grafts were applied to restore the facial buttresses. In some instances, the coronal approach affords extensive exposure and direct access to calvarial bone grafts, empowering the surgeon to meticulously reconstruct the fragmented visage using undamaged bone that resembles the original shape and texture. Substantial areas of compromised bone can be readily substituted with intact calvarial segments, which can then be accurately stabilized within the generously exposed surgical field.[10] demonstrated that, in a cohort of seven cases, six achieved excellent reductions and one good reduction, while three underwent esthetic correction of trauma-induced contour defects using iliac bone autografts and titanium mesh alloplastic, with transient facial nerve deficits resolving by the twelfth postoperative week. As, this method enables the reconstruction of all fractures or absent bony elements under direct visualization, presenting considerable advantages over traditional techniques for reduction and fixation in the treatment of upper and middle facial fractures.

To avoid damaging the nerves around the orbit, a precise surgical approach is necessary. Care must be used while releasing the supraorbital nerve from the bone canal of the supraorbital notch to prevent damage to the nerves and paraesthesia, which can cause tingling or numbness in the scalp and forehead.[11] To protect the supratrochlear nerve, which innervates the top eyelid and lower forehead, the dissection must be kept in the subperiosteal plane along the medial orbit. This important plane reduces the possibility of nerve injury. It is situated between the periosteum and the bone.[12]

In the present study, an incision is diligently placed along the superficial temporal line, guaranteeing that both the periosteum and temporalis fascia are incorporated into the principal flap. Similarly "Sikkerimath et al." in their study evaluated 40 patients with craniomaxillofacial trauma requiring fracture fixation or reconstruction, revealing postoperative paraesthesia in 11 cases and highlighting the bicoronal flap's advantages despite potential complications. Hence, caution is essential when dissecting along the deep temporal fascia and elevating the superficial temporal fascia to avert any damage to the frontal branch of the facial nerve. Another similar study by Matic and Kim.[11–14] showed that Coronal incisions are vital in traumatic, reconstructive, and cosmetic procedures for lateral facial skeleton access and the study concluded that suprafascial dissection minimizes frontal nerve injury, with 27 patients undergoing 54 dissections without any nerve damage.

Zhang et al.[15] highlighted that while coronal incisions provide excellent anatomical exposure, they pose risks like scarring, prolonged surgery, nerve palsy, and infections, warranting cautious, limited use to avoid complications. Therefore, this approach demands meticulous consideration, weighing the risk-benefit ratio carefully. While offering unparalleled exposure for anatomical accuracy, its potential complications—scarring, infection, nerve palsy—necessitate prudence in its application to ensure the benefits outweigh the inherent risks.

The dissection is executed in a posterior-to-anterior direction to navigate along the galeotemporal plane and liberate this point of galeotemporal fusion. After surgery, traction injuries typically cause some weakening in the frontal branch, which will primarily heal with time.[13,14] Overall, precise dissection techniques and proper flap design are key to minimizing complications and preserving nerve function during surgery in this delicate region.

The study's limitations encompass its single-center design, a restricted study population, and the absence of comparative groups with alternative incisional techniques. Further studies should be conducted on larger sample sizes with multi-centric designs and different incision techniques.

Conclusion

The present study concluded that while patients undergoing craniomaxillofacial reconstruction via the coronal approach initially experienced notable neurological deficits, full nerve function was ultimately restored over time, underscoring a strong correlation between nerve healing and favorable functional outcomes.

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