DOI: 10.7860/JCDR/2015/14797.6296

Original Article

Surgery Section

Coronal/Hemicoronal Approach – A Gateway to Craniomaxillofacial Region

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ABSTRACT

Aims: The coronal incision with its various modifications provides the most versatile approach to various areas in the craniomaxillofacial region coupled with excellent exposure. The aesthetic advantage of a hidden scar in the hairline, accounts for its continued popularity. The aim of this study was to review the surgical anatomy, technique and problems of post-operative morbidity pertinent to coronal approach in various clinical situations such as craniofacial trauma, tumour resections and reconstructive craniofacial procedures.

Materials and Methods: In this study, ten patients who presented to Oral and maxillofacial surgery department with various craniofacial problems requiring the use of coronal and hemicoronal approach for treatment were evaluated over a period of two years. Five patients needed coronal approach and another five underwent the surgical procedures through hemicoronal approach. This was an observational study.

Results: It was observed that a well-planned and carefully designed coronal/hemicoronal incision with strict adherence to surgical principles posed minimal complication during surgery as well as post-operatively. None of the patients developed infection or heamatoma in the postoperative period. Sensory nerve deficits along the distribution of supraorbital nerve was observed in four patients of bicoronal approach and three patients of hemicoronal approach which completely resolved at the end of six months. Motor nerve weakness was observed in four patients in immediate postoperative period which gradually improved. But it persisted in one patient even after six months who had pathology of temporo-orbital region. All the patients had transient alopecia along the line of incision which improved at the end of six months. No other significant disadvantages or complications were noted.

Conclusion: This approach offers widest accessibility and visibility to the entire upper and middle one third of the face in less than twenty minutes as observed in our study. The postoperative complications are minimal, minor and outweigh the advantages for surgical treatment in any given clinical situation as observed in this study. This proves the brilliance of coronal approach in solving an array of surgical problems pertinent to craniomaxillofacial region with superior aesthetic outcomes.

Abbreviations: ZMC-Zygomatico maxillary complex, NOE-Nasoethmoidal complex, LF-Lefort, ORIF-open reduction internal fixation.

Keywords: Craniofacial exposure, Maxillofacial surgery, Zygomatic complex trauma

INTRODUCTION

The selection of a surgical approach is important in formulating a treatment plan for complex craniofacial problems. The surgical approach in this region is dependent on a number of factors, which include the degree of access, aesthetics and potential morbidity to critical structures of the face.

Although a variety of transoral and hidden incision are available providing adequate access to the face, but there are still areas of interest for maxillofacial surgeons, these incisions fail to address, particularly the upper mid-face and craniofacial regions.

In such complex situations, a viable alternative to these approaches is the coronal approach, initially described by Hartley and Kenyon in 1907 and later by Babcock in 1912 [1,2]. The coronal approach gained widespread popularity among the cranio maxillofacial surgeons, after Tessier, and later Henderson and Jackson used it for Le Fort II and III Osteotomies, reporting excellent access for these procedures [3,4].

Various indications for the coronal approach include severe craniomaxillofacial trauma, craniofacial deformities, craniotomy procedures, osteotomies of upper and middle one third of face, harvesting of bone and fascial grafts when indicated [5,6], for improved access to condylar regions [7], and also for forehead rejuvenation [8]. This study aims to prove that with minimal complications coronal/hemicoronal approach can be extensively used in the field of maxillofacial surgery. It's advantages in terms of exposure of surgical field for upper one third of face is far surpassed by any other approach.

MATERIALS AND METHODS

In this observational study, spanning between two to five years, ten patients who presented to the Department of Oral and Maxillofacial Surgery; Bapuji Dental college and hospital with various craniofacial problems requiring the use of coronal and hemicoronal approach for treatment were evaluated. An Institutional Ethical Committee approved the study and all patients provided written informed consent.

Indications for craniofacial exposure in our series of patients included six cases of complex craniofacial trauma, two cases of tumours of temporo-parietal region and one case each of mid-face deformity and residual fronto-nasal deformity. Pathologies, which extended into the cranium, pan facial trauma cases with full depth lacerations in nasoethmoidal and zygomatic regions were excluded.

The study included nine males and one female patient with an age range of 19 to 60 years, for whom detailed case history and thorough clinical examination supplemented with radiographs/CT scans were carried out to assess the severity and extent of trauma and pathology. Five patients each underwent procedures using coronal and hemicoronal approach. The coronal incision, along with trans-oral and infra-orbital incision was used in four patients.

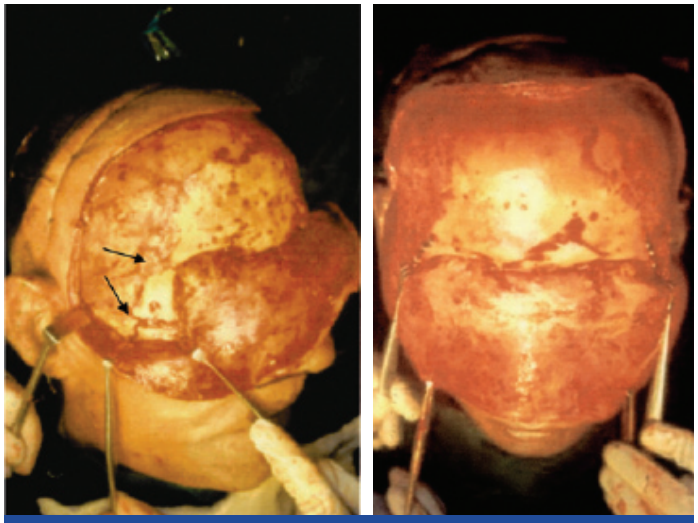
Hemicoronal approach was employed in two cases of comminuted zygomatic complex fractures [Table/Fig-1], frontal and nasoethmoidal deformities [Table/Fig-2], two with tumours among which one was a case of actinomycetoma involving left orbit and temporal region [Table/Fig-3] and the other with a malignant xanthogranuloma of left temporal region. Another case presented with mid-facial deformity

(unilateral malar hypoplasia) requiring malar advancement and augmentation [Table/Fig-4].

The positioning of anaesthetic tubing for intubation should be in such a manner as to provide optimal access to entire head, face and oral cavity. In our cases, three patients were intubated nasally, two orally, three with trans-mylohoid method. The remaining two patients required a tracheostomy as part of anaesthesia.

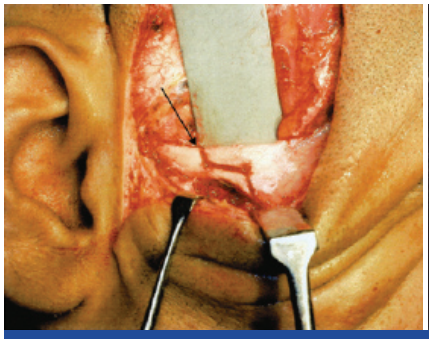
The incision is marked 2 to 3 cm posterior to the hairline extending into the pre-auricular incision. In hemicoronal approach, the superior end of the incision line was slightly curved anteriorly for ease of reflection and increased accesibility and terminates at the mid-line. Running blocking sutures were placed 1 cm behind the incision line for the purpose of haemostasis. A local anaesthetic with adrenaline was infiltrated along the incision line to facilitate dissection and minimize blood loss. The incision was given parallel to hair follicles through the skin, galea into the loose areolar plane leaving the periosteum intact. The dissection was carried supra-periosteally and the flap was gradually turned forwards until 3 to 4 cm above the supra-orbital ridges. At this level, the periosteumis incised and dissection was carried out sub-periosteally to expose the supra-orbital and naso-frontal areas.

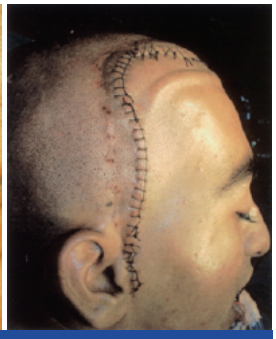
The supra-orbital neuro-vascular bundle was then identified and released from its foramen by removing a small wedge of bone above



[Table/Fig-1]: Complete exposure zygomatic complex fractures
[Table/Fig-2]: Exposure of bilateral fronto-zygomatic region including nasoethmoidal region

[Table/Fig-3]: Actinomycetoma of left orbital and temporal region





[Table/Fig-4]: Exposure during malar osteotomy **[Table/Fig-5]:** Closure of wound

the bundle, converting the supra-orbital foramen to a notch. This facilitates further retraction of the flap and minimizes parasthesia of forehead. Following complete release of the neuro-vascular bundles, the flap was further dissected infero-medially to expose the entire naso-ethmoidal and orbital regions. Laterally, the dissection may be continued subperiosteally beyond the fronto-zygomatic suture to expose the malar complex including the arch. The lateral dissection includes the outer layer of deep temporal fascia along with superficial temporal fascia from a point 2 cm above the zygomatic arch taking the temporal branch of facial nerve along with it. With the nerve safe within the flap dissection was further carried inferiorly to the periosteum of the arch. The periosteum was safely incised and subperiosteal reflection is done to expose the arch, body of zygoma and lateral orbital rim.

Following the craniofacial exposure, the necessary procedure was carried out and haemostasis achieved. The wound was closed in layers using 3.0 vicryl for deeper layers and 3.0 silk for skin [Table/Fig-5]. A surgical vacuum drain was introduced prior to closure to facilitate the drainage of postoperative oedema and a pressure dressing is placed. All our patients received antibiotics and analgesics postoperatively. Pressure dressing was given and suction drains were removed after 48 hours postoperatively when the contents were less than 15ml. Postoperatively, patients were evaluated on a daily basis for one week, followed by weekly intervals for one month and then at monthly intervals for the next six months for the following clinical parameters as summarized in [Table/Fig-6].

OBSERVATION AND RESULTS

The hemicoronal and coronal incision with pre-auricular extension was used in all our cases with an equal distribution [Table/Fig-7]. The exposure was considered adequate by the operating surgeons in all the cases. The average time from incision to reflection of the flap used for the management of complex craniofacial trauma was about 12.5 minutes. For the correction of naso-frontal deformity, it was about 14 minutes. Average time for the reflection of hemicoronal flap was about 11 minutes in cases of trauma, 20 minutes in cases of pathology and 7 minutes for mid-face deformity [Table/Fig-8].

In our series of cases, the supra-orbital nerves were found to be exiting through the supra-orbital foramen in eight cases wherein it was osteotomized and released; through the supra-orbital notch in one case and involved by pathology in one case. The supra-trochlear nerve exited through the notch in all cases except in one

Serial no.	Complications	No. of cases	2 weeks	4 weeks	6 weeks	3 months	6 months
1.	Haematoma	None	-	-	-	-	-
2.	Infections	None	-	-	-	-	-
3.	Sensory deficits	7	7	4	3	1	0
4.	Motor deficits	4	4	2	1	1	1
5.	Scarring	All patients acceptable	Acceptable	Acceptable	Acceptable	Inconspicuous	Inconspicuous
6.	Pruritis	6	6	1	1	1	0
7.	Alopecia	10	10	10	10	0	0

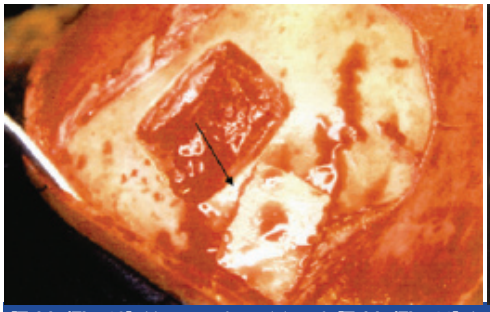
[Table/Fig-6]: Postoperative complications

Additional acess	Hemicoronal preauricular extension	Bicoronal Preauricular extension
Buccal sulcus	4	1
Infraorbital	1	1
Infraorbital and buccal sulcus	-	3
Total	5	5

[Table/Fig-7]: Isolated and combination incisions

Serial No.	Coronal		Hemicoronal	
	Time (min)	Exposure	Time (min)	Exposure
1	12	Adequate	10	Adequate
2	12	Adequate	12	Adequate
3	13	Adequate	20	Adequate
4	13	Adequate	20	Adequate
5	14	Adequate	7	Adequate

[Table/Fig-8]: Exposure time



[Table/Fig-10]: Harvest of cranial graft **[Table/Fig-11]:** Late post op with minimal scar

the condition persisted but with considerable improvement at the end of sixth week [Table/Fig-6].

(c) **Drains –** In all the patients, drains were removed at 48-72 hours postoperatively. The average collection at 24 hours was around 35 ml. and gradually reduced to 20 ml by the end of 48 hours.

Serial no.	Diagnosis	Intubation	Incision	Exposure time (mins)	Supraorbital nerve	Graft	Intra-op
1.	Lf. ZMC + orbital blowout supraorbital rim	Nasal	Bicoronal & Intraorbital	12	Bilateral foramen	Parietal left outer table 1x1 cm	-
2.	Rt. ZMC + Rt LF II symphysis	Tracheostomy	Coronal & infraoribital buccal sulcus	12	Bilateral foramen	Parietal outer table 2x2 cm	-
3.	Lf. LF III nasal bone	Tracheostomy	Bicoronal & bilateral infraorbital incisions	13	Bilateral foramen	-	-
4.	Communited Lf. ZMC Rt arch	Transmylohyoid	Lf. Hemicoronal	10	Lf. foramen	-	-
5.	Communited Rf. ZMC	Transmylohyoid	Rt. Hemicoronal	12	Rt. foramen	-	-
6.	Rt. LF II Lf. LF III NOE complex #	Transmylohyoid	Coronal	13	Bilateral notch	-	-
7.	Residual frontonasal encephalocele	Oral	Coronal	14	Bilateral foramen	Parietal outer table 2.5 x2 cm	-
8.	Actinomyeloma Lt. Temporoparietal region	Oral	Hemicoronal	20	Involved by pathology	-	-
9.	Malignant xanthogranuloma	Nasal	Hemicoronal	20	Foramen	-	-
10.	Dentofacial deformity	Nasal	Hemicoronal buccal sulcus	7	Foramen	Temporalis fascia 2.5x1.5 cm	-

[Table/Fig-9]: Summary

case where it was not discernible due to the involvement of overlying pathology [Table/Fig-9].

Autogenous calvarial bone grafts [Table/Fig-10] of approximately 3x1.5 cm in size were harvested for reconstruction of orbital floor in two cases and augmentation of fronto-nasal area in one case. Temporalis fascia graft was harvested in one case for lining the lateral orbital wall after malar osteotomy. No intraoperative complications mentioned in literature were observed in our cases.

Postoperative results

The following observations were studied in the postoperative period.

(a) **Sensory nerve deficits –** Neuro sensory deficits was encountered bilaterally in four patients along the distribution of supra-orbital nerve where a bicoronal approach was used. One patient had additional neurosensory deficit along the distribution of auriculo-temporal nerve unilaterally. Three patients had neuro-sensory deficits along the distribution of supra orbital and supra-trochlear nerve unilaterally in cases where hemi-coronal approach was used. However, all patients had return of sensory functions between a period of four weeks to six months [Table/Fig-6].

(b) **Motor nerve deficits –** Postoperative frontalis muscle weakness was observed in three patients of hemicoronal approach and bilaterally in one patient in bicoronal approach. Complete recovery was seen at the end of three weeks. In one patient

(d) **Haematoma and Infection –** None of the patients developed Haematoma or infection at the postoperative site.

(e) **Scars-** Scars along the incision line on an average were approximately 3 mm in width and well accepted by patients. Most of the incision lines were well concealed within the hairline. The pre-auricular scar was almost imperceptible within one month. None of the patients in our series exhibited hypertrophic scarring at the incision site [Table/Fig-11].

(f) **Alopecia –** Transient alopecia was seen for 2 mm around the scar, which persisted for 3-4 months. Focal areas of decreased hair density were observed in two patients in the initial post-operative period which gradually improved after 5 weeks [Table/Fig-6].

(g) **Trismus–** Trismus was difficult to assess as most of the patients required IMF prior to definitive management. Temporary limitations in movements during pre-operative phase was attributed to trauma at the time of presentation, which gradually improved during the postoperative period.

(h) **Ptosis and Epiphora–** This complication was not observed in any of our patients except in one case where unilateral epiphora on the right side was attributed to naso-orbito-ethmoidal complex fracture, which persisted even after six months.

(i) **Temporal fossa depression –** Two patients with temporo-parietal region requiring tumour debulking along with underlying temporalis muscle had temporal fossa depression

postoperatively. Both patients however did not complain about the temporal hollowing as it became less prominent and partially concealed by hair growth after a period of six months.

DISCUSSION

The coronal approach traditionally used by the neurosurgeons to gain access to the neurocranium has in the 21st century has gained popularity in the realm of craniomaxillofacial surgery for exposure of the craniofacial skeleton including the orbit and nasal bones. Since the coronal flap provides access to the frontal, temporal and zygomatic regions, the reconstruction of orbit, zygoma, frontal and NOE regions is accomplished without the need for any facial incisions.

Ten patients, who reported to our department with a variety of clinical presentations requiring the use of hemicoronal or coronal approaches for access and treatment was included in the study. Shumrick et al., presented the role of extended access or internal approaches for the management of facial trauma and concluded that it would virtually be possible to expose the entire facial skeleton with subperiosteal dissection providing wide exposure with camouflage or internal mucosal incisions. This improved exposure allowed for accurate fracture reduction taking full advantage of various plating systems that are now an integral part of maxillofacial trauma [9]. Other studies on treatment of zygomatic complex fractures suggest that this approach facilitates accurate reduction and fixation of all the fractures fragments accurately [10,11].

In our study, hemicoronal and bicoronal approaches provided adequate exposure to the surgical site in all cases. Exposure was further enhanced by the intraoral buccal sulcus incisions and an infra-orbital incision in a case of complex craniofacial trauma for exploration and reconstruction of orbital floor with calvarial grafts. The time taken to reflect the flap in bicoronal approach averaged 12.8 and 13.8 min for a hemicoronal flap. The exposure provided was considered adequate in all the cases with the benefits of accessibility and visibility far outweighing the time consumed for reflection of flap.

Webster et al., in 111 human skulls studied the variations in supraorbital/supratrochlear anatomy and found that supra orbital bundle reached the forehead through supraorbital foramen on both sides in 50% of the specimens, by supra orbital foramen on one side and notch on the other side in 25% of cases and bilateral supraorbital notches in 25% of specimens. The supratrochlear bundle emerged from the orbit via the notch in almost all the specimens [12]. In our cases, the supraorbital foramen required to be osteotomized, the nerve released in eight cases, and the supratrochlear nerve emerged through a notch in all the cases.

Jackson et al., discussed their experience with various harvesting procedures of skull bone grafts in 307 patients over a period of 6 years. They reported minor complications (e.g. Haematoma, seroma, scalp wound, dural tears, dehiscence, arachnoid bleed and scalp infection) with advantages of a non-visible scar, no obvious secondary deformity, abundance of graft material, decreased postoperative morbidity and greater graft survival volume as compared to that of endochondral bone [13]. Harsha et al., used autogenous calvarial bone grafts for reconstructive procedures involving alveolar clefts, Le fort I osteotomies, mid face onlay grafts, mandibular continuity defects and concluded that morbidity associated with donor site was minimal with good incorporation of all the grafts at the recipient sites [14]. Calvarial grafts from the parietal region was harvested in three of our cases for orbital floor reconstruction in two cases and for frontonasal augmentation in one case, with no complications observed in any of our patients. Frodel et al., in the anatomical and technical considerations and morbidity of coronal approach have stated that permanent sensory deficits are relatively common and difficult to quantify. Scalp anaesthesia and paraesthesia though unavoidable was circumvented by subperiosteal, supraperiosteal dissection with careful attention to delicate dissection of the supraorbital neurovascular bundle [15].

Abubaker OA in his series of coronal incisions for craniomaxillofacial injuries had total return of neurosensory function within 6 weeks in the supraorbital region and 6 months in pre-auricular region [5]. In our cases, neurosensory deficits along the distribution of the supraorbital, supratrochlear and auriculotemporal nerves were transitory with return of sensory functions within a range of 4 weeks to 6 months.

Temporary motor nerve deficits were reported in the literature with recovery periods varying from 2 months to 1 year. Anatomic cadaveric studies have revealed that the greatest risk for damage of temporal branch of facial nerve is in the area bordered by a line drawn from the tragus to a point just above and behind the highest forehead crease and a line drawn from the earlobe to the lateral edge of the eyebrow [5,16]. Transient motor nerve deficits in the form of frontal muscles weakness in our patients had complete recovery by the end of 6 weeks except in one patient where it persisted but improved markedly at the end of 6 months.

Haematoma, an uncommon complication reported in literature could occur due to lack of drainage, postoperative seizures, repeated episodes of hypertension, presence of skeletal and pull out fixation wires [5,13,15,17]. None of the patients in our series developed Haematoma under the coronal flap which could be attributed to meticulous closure of incision sites after adequate homeostasis, placement of drains supplemented with pressure dressings. Infection though sparingly reported in literature has been mostly limited to localized stitch abscess, which resolved after suture removal [15]. None of our cases had infection in the postoperative phase, due to strict adherence to aseptic meticulous surgical technique with the use of prophylactic antibiotics and adequate suction drainage. Scarring of incision sites though unavoidable have not been of concern to the patient. It can be minimized by meticulous 2 layer closure with particular attention to proper approximation and eversion. Pre auricular scars in small children were avoided by placement of inferior aspect of incision posterior to the ear, which allows arch exposure by retraction of the cartilaginous auricular framework [15]. Patients prone to the male pattern baldness are identified preoperatively both by examination and pertinent questioning in the family history. In such patients, the incision was repositioned occipitally without fear of compromising access to the surgical site [18]. Further modifications in the coronal incision such as placement of incision behind the ear [19,20] and the use of a zig-zag incision [21] instead of a straight incision within the hairline have the advantage of further camouflage of the scar although it has certain minor disadvantages [22]. None of our patients complained about the scars, which was well concealed within the hairline providing for a good cosmetic result.

Alopecia around the incision site could result from either direct injury to hair follicles, excessive wound tension or prolonged tissue ischemia secondary to application of raney clips [15,23,24]. Transient alopecia observed in our cases (2 mm around the incision scars) persisted only for 3-4 months. Minimal hair loss in our patients could be due to carefully planned incisions made parallel to the hair follicles with selective coagulation of bleeding areas of scalp flap and a tension free closure at the incision site.

Trismus following the use of coronal flaps is uncommon. The probable reason could be tracking of blood between muscles and fascia or direct injury to the temporalis muscle fibres resulting in fibrosis and contracture causing restriction of movement of muscle and eventually disease atrophy [25,26]. Trismus in our patients was mainly related to initial trauma, which resolved spontaneously in the postoperative period without requiring active intervention.

Ptosis, Epiphora and Corneal abrasion have been reported in literature [5,15,17,27]. Postoperative ptosis could be a result of extensive exploration of orbit for correction of enophthalmos, trauma

to the levator apparatus and surgical correction of craniostenotic syndromes [28]. Epiphora was observed in one patient, which was a result of initial injury rather the approach itself.

CONCLUSION

Coronal approach with its preauricular extension in combination with intra oral approaches was found to be superior to traditional approaches in the treatment of traumatic, oncologic and reconstructive procedures. In addition to providing an excellent craniofacial exposure, hemicoronal and coronal approaches allow for the harvesting of cranial bone through the same incision when immediate bone grafting was indicated, eliminating the need for a second surgical site to obtain the graft. The bicoronal and hemicoronal approach turns out to be a highly indispensable and versatile approach, owing to its application in wide array of surgical procedures of craniomaxillofacial region, truly making it a 'Craniomaxillofacial Gateway' for maxillofacial surgeons.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **May 05, 2015**
Date of Peer Review: **Jun 15, 2015**
Date of Acceptance: **Jul 09, 2015**
Date of Publishing: **Aug 01, 2015**