BMC Surgery

RESEARCH Open Access

A modified approach for treating zygomatic arch fracture with plate fixation: a retrospective study

Zi-hua Tang[1], Yu Jiang[1], Hui Liu[1], Wei Tang[1] and Jin-long Chen[1*]

Abstract

Background Zygomatic complex fractures are prevalent among maxillofacial bone injuries due to the prominence of the zygomatic arch, which can significantly impact facial aesthetics and the ability to open the mouth. Although non-surgical interventions are available for mild cases, severe fractures necessitate surgical intervention. The surgical repair of zygomatic arch fractures poses a risk of injuring the temporal branch of the facial nerve (TBFN). This study aimed to develop a modern modification to reduce the probability of common complications.

Method We conducted a retrospective study involving 163 patients at the Department of Oral & Maxillofacial Surgery, West China Hospital of Stomatology, Sichuan University, spanning from March 2021 to June 2024. Our study introduced a novel modification of the temporal hairline approach for the treatment of these fractures.

Results Among the patients who underwent the modified approach ($n=38$), there were no instances of TBFN injuries. In contrast, the traditional approach ($n=125$) resulted in 17 cases of nerve-related complications.

Conclusion Our findings indicate that the modified temporal hairline approach offers distinct advantages in minimizing the risk of TBFN injury with minimally noticeable scarring, while ensuring that the fracture is securely repaired. This provides a new safe surgical approach option for the osteosynthesis of zygomatic arch fractures.

Keywords Zygomatic fractures, Maxillofacial injuries, Facial nerve injuries, Fracture fixation, internal, Minimal surgical procedure

Introduction

The zygomatic arch (ZA), a slender, cylindrical, and bridge-like structure, serves as the lateral buttress of the face and is pivotal for determining facial width and prominence, as well as for supporting the masticatory load. Despite its importance, it is particularly susceptible to fractures due to facial trauma [1, 2]. ZA fractures can lead to facial asymmetry, characterized by malar depression, and restricted jaw movement, potentially due to impingement of the coronoid process of the mandible.

Non-surgical treatment and surgical treatment remain controversial. However, surgical treatment is still the preferred option in more complex cases [3]. For a non-comminuted medially displaced ZA fracture ("M" shaped fracture), reduction can be effectively achieved through Gillies approach, Ginestet technique, or intra-oral approach [4, 5]. However, in cases of severely displaced arch fractures, comminuted fractures, or when closed reduction fails to provide adequate stabilization,

*Correspondence:
Jin-long Chen
jinlongchen@scu.edu.cn
[1]State Key Laboratory of Oral Diseases & National Center for Stomatology & National Clinical Research Center for Oral Diseases & Department of Oral and Maxillofacial Surgery, West China Hospital of Stomatology, Sichuan University, Chengdu 610041, China

open reduction and rigid internal fixation may be necessary, often accompanied by extensive dissection to ensure optimal outcomes [6–9].

The (hemi-)coronal approach, while effective, is associated with certain drawbacks, including a large surgical incision, extended operative time, potential alopecia, paresthesia within the surgical field, and the risk of temporal fossa depression, colloquially referred to as "skeletonization." [10, 11]. Additionally, there is a risk of injury to the temporal branch of the facial nerve (TBFN), which could lead to temporary or permanent paralysis of the frontalis muscle.

A local incision, made just above the fracture line, was developed to reduce the size of the incision and the associated complications of the coronal approach. However, the risk of temporary or permanent facial nerve palsy, a significant aesthetic and functional concern, persists. Consequently, there is a need for a superior approach to address zygomatic complex fractures.

Over the past 15 years, our center has adopted a temporal hairline approach to mitigate the aesthetic drawbacks of the local incision, with incision lengths typically ranging from 3 to 5 cm and discreetly positioned along the temporal hairline. Despite these improvements, the challenge of facial nerve paralysis persists due to the intricate and variable anatomy of the temporal branch of the facial nerve and its tortuous path. In this retrospective study, we introduce a novel modification of the temporal hairline approach, designed to provide an adequate surgical field for plate fixation while minimizing the risk of temporal branch of the facial nerve (TBFN) injury.

Materials and methods

Study design

This retrospective study was conducted on patients who presented for treatment of ZA fracture at the Department of Oral & Maxillofacial Surgery, West China Hospital of Stomatology, Sichuan University, spanning a three-year period from March 2021 to June 2024. All patients were followed up for 12 weeks and were assessed at 1 week, 4 weeks, 8 weeks, and 12 weeks postoperatively. The study was conducted in accordance with the ethical protocol approved by the Ethics Committee of West China College of Stomatology, Sichuan University.

The inclusion criteria were as follows: (1) clinical and imaging diagnoses of zygomaticomaxillary complex or ZA fractures; (2) ZA fracture requiring surgical fixation; (3) no previous surgical treatment in maxillofacial region; (4) consent to the surgical treatment; (5) received plate fixation at ZA with a temporal hairline incision at the study host institution; (6) a minimum of 12 weeks postoperative follow-up.

The exclusion criteria were as follows: (1) patient lost to follow-up; (2) incomplete medical records, lacking key information such as sequelae or performance of a modified surgical procedure; (3) other temporal region surgeries performed during the postoperative follow-up period.

Patients were categorized into two groups: Group A, comprising individuals who received the modified temporal hairline approach, and Group B, consisting of those who underwent the traditional temporal hairline approach.

Surgical steps

Modified temporal hairline approach

Step 1: Marking the Reference line.

Mark a line that begins 0.5 cm below the tragus and extends to the most lateral end of the eyebrow (Figs. 1A and 2A).

Step 2: Incision line design.

The incision line should be positioned at the anterior edge of the temporal hairline, with a length of approximately 3–5 cm, depending on the distance between the hairline and the fracture line (Figs. 1A and 2A).

Step 3: Skin incision and undermining dissection.

Incise the skin and subcutaneous tissue to reach the surface of the temporoparietal fascia. Then, dissect towards the fracture line of the ZA, ensuring that the dissection plane is at the surface of the temporoparietal fascia (Figs. 1B and 2B). The superficial temporal artery, which lies on or within the temporoparietal fascia, should be identified and either ligated or protected when encountered.

Step 4: Fascia incision and bone exposure.

After the dissection passes below the reference line, palpate the upper edge of the ZA. Then, sharply incise the temporoparietal fascia and the superficial layer of the deep temporal fascia to reach the bone surface (Figs. 2C and 3). Reflect the periosteum to expose the fracture line of the ZA. This approach provides a sufficient surgical field for bone reduction and internal fixation.

Step 5: Closure.

Reapproximate the deep temporal fascia and temporoparietal fascia using slowly resorbing 4 – 0 sutures. Close the skin incision in a two-layered fashion (Fig. 2D).

Traditional temporal hairline approach

The skin incision should be made as previously described. Following this, the dissection should be carried out bluntly, proceeding directly to the fracture line. It is crucial to carefully identify the TBFN during this process. Once located, the nerve should be gently retracted superiorly and posteriorly to ensure its protection and to facilitate access to the fracture site.

Complication evaluation

Complications studied included TBFN palsy, temporal depression, hematoma and infection. TBFN palsy was

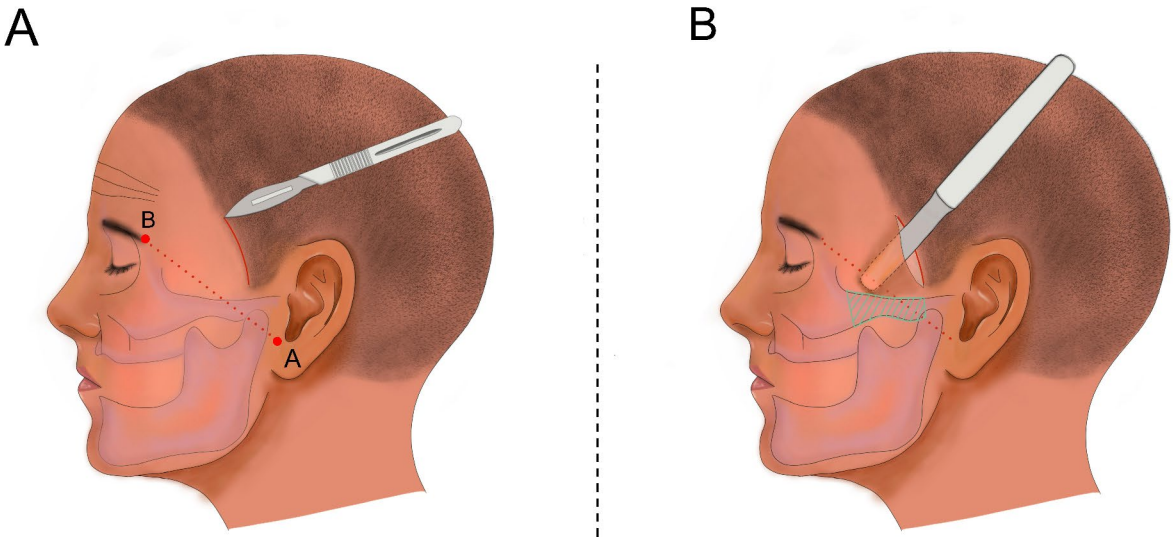

Fig. 1 (**A**) Modified Pitanguy's line indicated by red dotted line (Point A: 0.5 cm inferior to the tragus; Point B: most lateral end of the eyebrow); Incision line indicated by red solid line. (**B**) The accessible area is demonstrated by a light green shade. Periosteal elevator showing the undermining dissection in supra-temporoparoetal plane surpassed the reference line

identified by the loss of forehead creases, an inability to frown, and complaints of impaired vision when attempting to look upward. If these symptoms subsided and resolved during the follow-up period, the condition was categorized as temporary facial nerve paralysis; otherwise, it was considered to have resulted in permanent sequelae.

Statistical analysis

Descriptive statistics were utilized to delineate the characteristics of the data. For the analysis of categorical variables, chi-square tests and Fisher's exact tests were employed, with statistical analyses conducted using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

Results

A total of 167 patients met the study's inclusion criteria, with 4 patients being excluded. The remaining 163 participants were categorized into two groups: Group A, consisting of 38 patients who underwent the modified temporal hairline approach, and Group B, comprising 125 patients who received the traditional temporal hairline approach. The age of the patients ranged from 5 to 71 years old.

To facilitate statistical analysis, patients' ages were categorized into three subgroups: 0–14, 15–64, and over 65 years old. Upon conducting the analysis, it was found that the age group distribution between Group A and Group B was not correlated with the choice of surgical approach. This finding indicates that age is not a significant factor influencing the selection of the surgical method ($P = 0.211$). Similarly, sex also showed no significant association with the choice of surgical approach ($P = 0.142$) (Table 1).

All patients achieved facial symmetry postoperatively, and the reduction of ZA fractures was confirmed through the use of cone-beam computed tomography. In total, 16 cases experienced temporary TBFN palsy, while the remaining patients exhibited clear forehead wrinkles, suggesting no damage to the TBFN. All 16 cases (100%) were in Group B, with none in Group A. This suggests that the modified surgical approach significantly outperforms the traditional method in preventing TBFN injury, which is statistically significant ($P = 0.024$). There were no instances of permanent TBFN injury in either group. Furthermore, Group B recorded one case (100%) of temporal depression. During the follow-up period, neither group experienced any cases of hematoma or infection (Table 2).

Discussion

ZA fracture is a common type of traumatic injury that significantly impacts both facial appearance (due to the loss of zygomatic projection) and the physical and mental health of patients [12, 13]. Isolated ZA fractures account for approximately 10% of all ZA fractures and predominantly affect young and middle-aged men [1]. The primary causes of these fractures include blunt trauma from falls, sports injuries, and traffic accidents [14–16]. These injuries can lead to nerve palsies, such as those involving the infraorbital nerve and the temporal branch of the facial nerve (TBFN), as well as sequelae like facial asymmetry and skeletonization [13].

Non-surgical treatments, such as the Ginestet technique and the Gillies approach, can achieve satisfactory

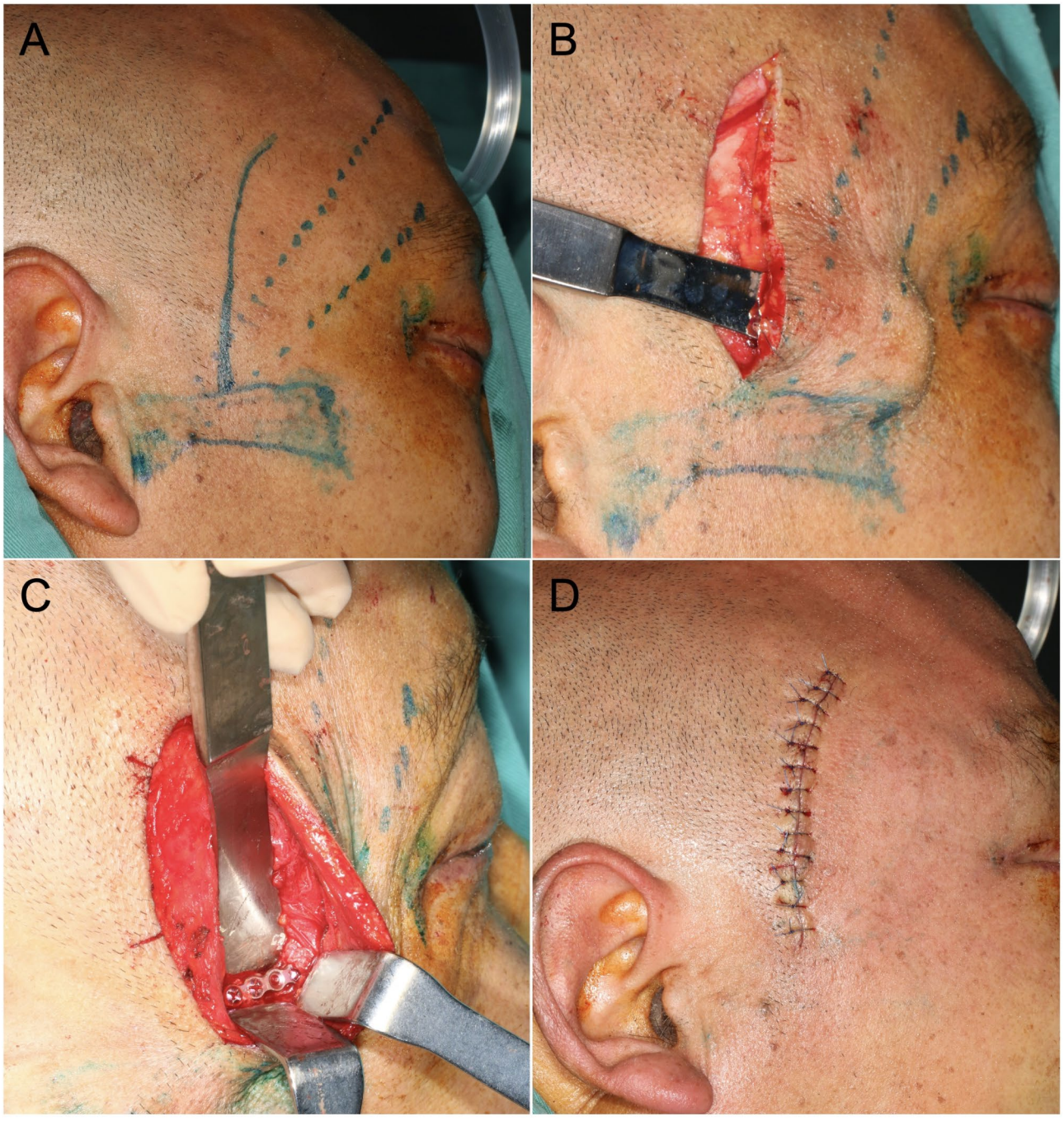

Fig. 2 Intraoperative photos of the modified temporal hairline approach. (**A**) Incision line and reference lines. (**B**) Undermining dissection in supra-temporoparoetal plane surpassed the reference line. (**C**) Plate fixation of zygomatic arch fracture. (**D**) Wound closure

reduction results in some cases of zygomatic arch fractures while avoiding common complications like nerve damage and scarring [4, 17, 18]. However, for comminuted fractures, open surgical treatment remains the only viable option. Despite the potential risk of nerve palsy, surgical intervention offers accurate reduction and better restoration of facial appearance.

The course and depth of the TBFN have long been a mystery in the field of ZA surgeries, with numerous studies conducted in an attempt to reach a consensus. The golden key to locating the TBFN was introduced by Pitanguy et al. [19] in 1966. The Pitanguy line is defined as a line that starts 0.5 cm below the tragus and extends towards a point 1.5 cm above the lateral end of the eyebrow, connecting these two points. This line roughly

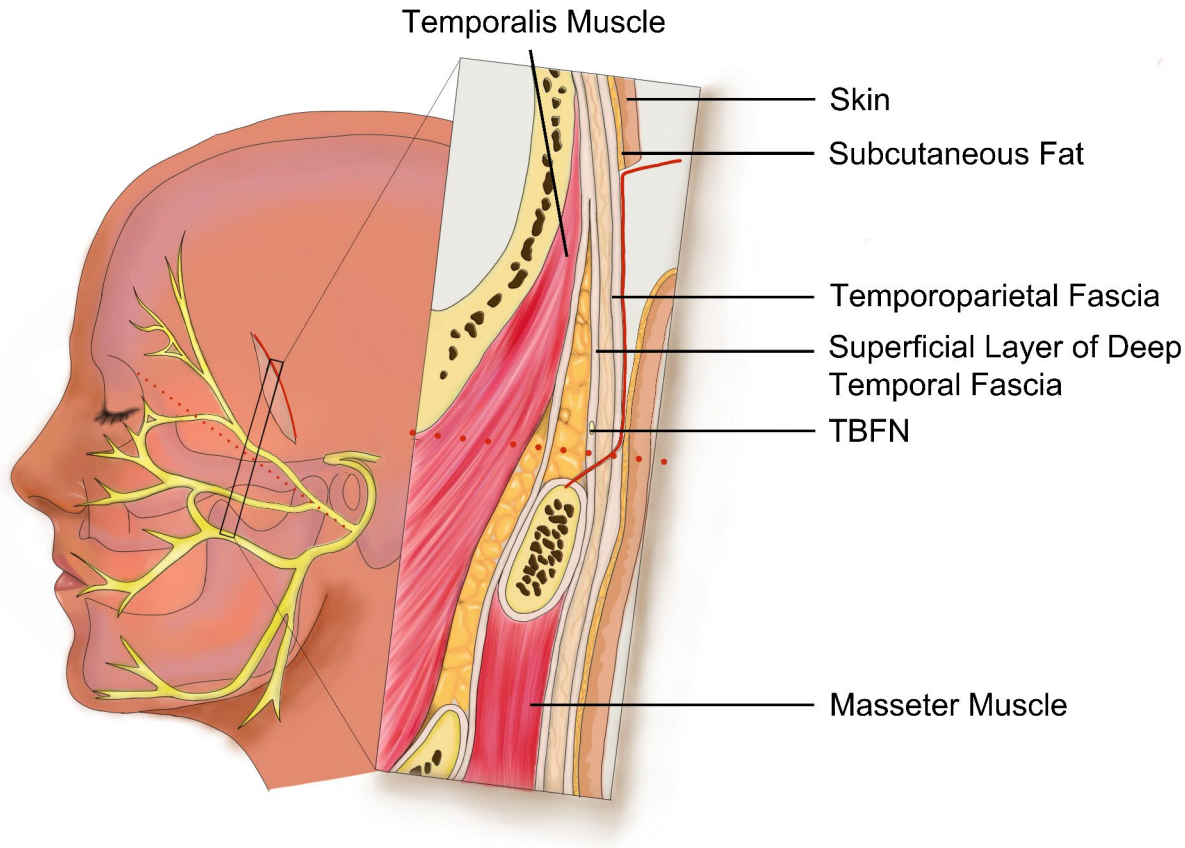

Fig. 3 Illustration of the modified temporal hairline approach. Red solid line indicating the dissection plane; red dotted line indicating the projection of the modified Pitanguy's line

Table 1 Basic profiles of patients

		Group A (*N* = 38)	Group B (*N* = 125)	*P*-value[a]
Age	0–14	2	8	0.211
	15–64	32	113	
	65-	4	4	
Sex	Male	30	83	0.142
	Female	8	42	

[a]*P*-values from Chi-square test and Fisher's exact test

Table 2 Complications

	Group A (*N* = 38)	Group B (*N* = 125)	*P*-value[a]
TBFN temporary palsy	0	16	0.024
TBFN permanent palsy	0	0	-
Temporal depression	0	1	-
Hematoma	0	0	-
Infection	0	0	-
Malunion and Non-union	0	0	-

[a]*P*-values from Chi-square test and Fisher's exact test

indicates the path of the frontal branch of the facial nerve across the face, making it a valuable reference in surgeries involving the temporal and facial regions. The superficial temporal artery (STA) was also mentioned as a guide to trace the course of TBFN. Correia and Zani [20] indicated that the TBFN is typically located beneath the STA and within the areolar plane. They also identified a triangular danger zone bounded by lines extending from the earlobe to the lateral end of the eyebrow and the highest point of the forehead. This finding was corroborated by Zani, Fadul, Rocha, et al. in 2003, after examining 150 adult cadavers [21]. Ishikawa [22] after dissecting 30 facial halves, claimed that most branches of the facial nerve are situated below the Pitanguy line and proposed a danger area between a line connecting the bony lateral canthus (LC) to the superior border of the zygomatic arch and another line perpendicular to the first at the LC. Gosain et al. [23] conducted a study to measure the distance from the antihelix-tragal landmark to the points where each ramus of the temporal branch of the facial nerve (TBFN) crossed the lower and upper aspects of the ZA. They concluded that though the anterior division of TBFN generally correlated with the Pitanguy line, there can be a variation of 10 to 20 mm anterior or posterior to this line.

Based on the findings of prior anatomical studies, we have chosen to utilize a modified Pitanguy line as a reference to assist in identifying the skin projection of the

TBFN. Acknowledging the variability in the number of rami of the TBFN, we have adjusted the line slightly downward to minimize the risk of nerve injury during surgical procedures.

As evidenced by parotidectomies [24] and confirmed through anatomical studies [25–29], TBFN crosses over ZA in the plane beneath the temporoparietal fascia. Thus, in the area above the reference, the dissection should remain in the plane superficial to the temporoparietal fascia. And when surpassed the reference line, it would be safe to proceed to deeper planes to access ZA. In Group A, where the modified technique was employed, there were no instances of TBFN injury. This outcome is in stark contrast to the 16 cases of TBFN injuries reported in Group B, which utilized the traditional approach. The high incidence of temporary palsies of the TBFN in Group B indicates that nerve stretching or compression is a significant contributor to complications associated with the conventional surgical approach.

Furthermore, the temporal hairline approach offers surgeons adequate visual exposure of the fracture area, which is sufficient for precise plate fixation. This approach steers clear of the extensive dissection associated with the coronal approach, aligning with the contemporary preference for minimally invasive surgical techniques.

An additional benefit of the modified approach is its effectiveness in managing scar visibility. In our study, incisions were made along the hairline, which were effectively concealed by hair after recovery, resulting in minimal to no visible facial scarring. This concealing effect is particularly pronounced in female patients and male patients with longer hair. This modified approach is particularly advantageous for patients with a receding hairline or baldness, as it avoids the aesthetic limitations associated with the coronal approach. We have also observed that the temporal hairline is highly individualized, varying from one patient to another. In some cases, the distance between the hairline and the surgical area may be greater than in others, which can increase the difficulty of surgical exposure.

Although the study has demonstrated encouraging outcomes with the modified approach, it is important to recognize that this method cannot wholly supplant the coronal approach. In cases of old or comminuted ZA fractures where extensive exposure is necessary for optimal reduction and internal fixation, the coronal approach remains the preferred option. Furthermore, it is essential to undertake a multicenter clinical trial with a significant sample size to confirm the safety and therapeutic efficacy of the modified technique.

Conclusion

In conclusion, the modified temporal hairline approach offers several distinct advantages: it provides superior protection for the temporal branch of the facial nerve, ample visual exposure for precise surgical manipulation, and results in minimally noticeable scarring. Therefore, we advocate for this technique as a suitable and effective option for the treatment of zygomatic arch fractures that necessitate fixation.

Abbreviations

TBFN The temporal branch of the facial nerve
ZA The zygomatic arch

Acknowledgements

Not applicable.

Author contributions

Z. T.: Methodology, Formal analysis, Writing-Original draft preparation, Revision of the manuscript. Y. J.: Visualization, Revision of the manuscript. H. L.: Resources, Data curation, Revision of the manuscript. W. T.: Investigation, Revision of the manuscript. J. C.: Conceptualization, validation, supervision, project administration, Revision of the manuscript.

Funding

The authors have no financial interests concerning the content of this article. This work was supported by Natural Science Foundation of Sichuan Province (2025ZNSFSC0765).

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This retrospective review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the Helsinki Declaration. The study was approved by the Ethics Committee of West China College of Stomatology, Sichuan University (WCHSIRB-D-2024-466). Written informed consent was obtained from all patients. Specifically, for patients under the age of 16, consent to participate was obtained from their parents or legal guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 12 January 2025 / Accepted: 17 February 2025
Published online: 24 February 2025

References

1. Brucoli M, Boffano P, Broccardo E, Benech A, Corre P, Bertin H, et al. The European zygomatic fracture research project: the epidemiological results from a multicenter European collaboration. J Cranio-Maxillofac Surg. 2019;47:616–21.
2. Kostakis G, Stathopoulos P, Dais P, Gkinis G, Igoumenakis D, Mezitis M, et al. An epidemiologic analysis of 1,142 maxillofacial fractures and concomitant injuries. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114:69–73.
3. Salentijn EG, Boverhoff J, Heymans MW, van den Bergh B, Forouzanfar T. The clinical and radiographical characteristics of zygomatic complex fractures: a comparison between the surgically and non-surgically treated patients. J Cranio-Maxillofac Surg. 2014;42:492–7.

4. Boffano P, Salentijn EG, Roccia F, Gallesio C, Karagozoglu KH, Forouzanfar T. Closed Management by Ginestet Hook Elevator of V-Shaped fractures of the Zygomatic Arch. J Craniofac Surg. 2014;25:1130.
5. Swanson E, Vercler C, Yaremchuk MJ, Gordon CR. Modified Gillies Approach for Zygomatic Arch Fracture reduction in the setting of Bicoronal exposure. J Craniofac Surg. 2012;23:859.
6. Fox AJ, Tatum SA. The coronal incision. Arch Facial Plast Surg. 2003. https://doi.org/10.1001/archfaci.5.3.259.
7. Zhang Q-B, Dong Y-J, Li Z-B, Zhao J-H. Coronal incision for treating zygomatic complex fractures. J Cranio-Maxillofac Surg. 2006;34:182–5.
8. Sullivan WG. Displaced Orbital roof fractures: presentation and treatment. Plast Reconstr Surg. 1991;87:657.
9. Zingg M, Laedrach K, Chen J, Chowdhury K, Vuillemin T, Sutter F, et al. Classification and treatment of zygomatic fractures: a review of 1,025 cases. J Oral Maxillofac Surg. 1992;50:778–90.
10. Frodel JL, Marentette LJ. The coronal approach. Anatomic and technical considerations and morbidity. Arch Otolaryngol Head Neck Surg. 1993;119:201–7.
11. Rajmohan S, Tauro D, Bagulkar B, Vyas A. Coronal/Hemicoronal Approach – A Gateway to Craniomaxillofacial Region. J Clin Diagn Res JCDR. 2015;9:PC01–5.
12. Monarchi G, Girotto R, De Feudis F, Racano C, Balercia P. Retrospective study over 15-years period on zygomathic arch fractures: a single Center experience. Indian J Otolaryngol Head Neck Surg off Publ Assoc Otolaryngol India. 2024;76:5359–63.
13. Boffano P, Roccia F, Gallesio C, Karagozoglu KH, Forouzanfar T. Infraorbital nerve posttraumatic deficit and displaced zygomatic fractures: a double-center study. J Craniofac Surg. 2013;24:2044–6.
14. Iqbal A, Frequency. Etiology and presenting complaints Associated with Zygomatic Complex fractures. Pak J Med Health Sci. 2022.
15. Ruslin M, Boffano P, ten Brincke YJD, Forouzanfar T, Brand HS. Sport-Related Maxillo-Facial fractures. J Craniofac Surg. 2016;27:e91–94.
16. Ruslin M, Brucoli M, Boffano P, Benech A, Dediol E, Uglešić V, et al. Motor vehicle accidents-related maxillofacial injuries: a multicentre and prospective study. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019;128:199–204.
17. Bergeron JM, Raggio BS. Zygomatic Arch Fracture. StatPearls. Treasure Island. (FL): StatPearls Publishing; 2025.
18. Siy R, Meaike JD, Hollier LH. Zygomatic Arch reduction (Gillies Approach). In: Anh Tran T, Panthaki ZJ, Hoballah JJ, Thaller SR, editors. Operative dictations in Plastic and reconstructive surgery. Cham: Springer International Publishing; 2017. pp. 269–71.
19. Pitanguy I, Ramos AS. The Frontal Branch of the facial nerve: the importance of its variations in Face Lifting. Plast Reconstr Surg. 1966;38:352.
20. Correia P, de Zani C. Surgical anatomy of the facial nerve, as related to ancillary operations in rhytidoplasty. Plast Reconstr Surg. 1973;52:549–52.
21. Zani R, Fadul RJ, Dias Da Rocha MA, Santos RA, Alves MCA, Ferreira LM. Facial nerve in Rhytidoplasty: anatomic study of its trajectory in the overlying skin and the most common sites of Injury. Ann Plast Surg. 2003;51:236.
22. Ishikawa Y. An anatomical study on the distribution of the temporal branch of the facial nerve. J Cranio-Maxillo-fac Surg off Publ Eur Assoc Cranio-Maxillo-fac Surg. 1990;18:287–92.
23. Gosain AK, Sewall SR, Yousif NJ. The temporal branch of the facial nerve: how reliably can we predict its path? Plast Reconstr Surg. 1997;99:1224.
24. Baker DC, Conley J. Avoiding facial nerve injuries in rhytidectomy. Anatomical variations and pitfalls. Plast Reconstr Surg. 1979;64:781–95.
25. Campiglio GL, Candiani P. Anatomical study on the temporal fascial layers and their relationships with the facial nerve. Aesthetic Plast Surg. 1997;21:69–74.
26. Schwember G, Rodríguez A. Anatomic surgical dissection of the extraparotid portion of the facial nerve. Plast Reconstr Surg. 1988;81:183–8.
27. Stuzin JM, Wagstrom L, Kawamoto HK, Wolfe SA. Anatomy of the frontal branch of the facial nerve: the significance of the temporal fat pad. Plast Reconstr Surg. 1989;83:265–71.
28. Rudolph R. Depth of the facial nerve in face lift dissections. Plast Reconstr Surg. 1990;85:537–44.
29. Trussler AP, Stephan P, Hatef D, Schaverien M, Meade R, Barton FE. The Frontal Branch of the facial nerve across the Zygomatic Arch: anatomical relevance of the High-SMAS technique. Plast Reconstr Surg. 2010;125:1221.

Publisher's note