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Endoscope-Assisted Reduction of Zygoma Arch Fractures

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Authors' contributions

This work was carried out in collaboration among all authors. The first author AMK, designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AMG and MHH managed the analyses of the study. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To compare the effectiveness of the endoscope-assisted approach with the open surgical technique for reduction of zygoma arch fractures.
Study design: Randomized controlled study.
Place and Duration of Study: Maxillofacial surgery unit, Otolaryngology department, Tanta University hospital, Tanta, Egypt, between April 2019 and October 2020.
Methodology: We included 18 patients (15 men, 3 women; age range 16-63 years) with fracture of zygoma arch. Ten cases were operated by the endoscope-assisted approach while the other 8 cases were operated by the open surgical technique. Operative time, intraoperative blood loss, adequacy of reduction and any complications were recorded and documented.
Results: The endoscope assisted group showed a statistically significant lower risk of complications with risk reduction rate of 67.5%. In other terms, the number needed to treat was 1.5, that is to say we must treat 1.5 patients with the endoscope-assisted method to prevent 1 adverse event that would have happened with the traditional open approach. Other outcome measures of operative time and blood loss showed no statistically significant difference (*P* value equals .25 and .52 respectively). The outcome of rate of inadequate reduction has quite wide 95% CI (-19.38 to 19.38) that reflects imprecision due to lack of events.

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Conclusion: The endoscope-assisted method showed statistically significant superiority in the domain of incidence of complications risk reduction (67.5%). No statistically significant difference was recorded in other outcome measures. Thus, the endoscope assisted approach for the zygoma arch fracture is in our opinion a better option than the traditional open incision approach.

Keywords: Arch; endoscope; fixation; fracture; reduction; zygoma.

1. INTRODUCTION

Trauma to the region of the face carries a high risk of morbidity and mortality due to the various vital structures in the region of the head and neck. Fractures of facial bones occur by different modalities including gunshots, personal assault, falling from heights ad most notably road traffic accidents. Currently, there is a trend towards the increase in the number of cases of facial trauma mostly due to the increase in road traffic accidents in Egypt [1].

Management of zygomatic fractures is usually carried out through standard facial incisions. These incisions though effective for exposure of fracture site, they are not without side-effects such as noticeable facial scars, alopecia, facial paralysis, infection and delayed wound healing [2].

Different studies across the world described different techniques for the use of the endoscope for the treatment of different maxillofacial fractures and they showed that it has the benefits of less operative time, complications rate and better exposure; yet it has a longer learning curve to master the endoscopic techniques [3,4,5].

2. MATERIALS AND METHODS

This randomized controlled study was carried out between April 2019 and October 2020 in the maxillofacial surgery unit of Otorhinolaryngology Department, Tanta University Hospital – Egypt. The study population were 18 patients sustaining zygoma arch fractures. A dedicated nurse used the SPSS software [IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.] to randomize the patients to the two study arms once they were admitted to the in-patient ward.

An informed consent was obtained from all patients participating in this research project or their parents in case of children below the age of medicolegal responsibility.

Inclusion criteria: patient with fracture of the zygoma arch.

Exclusion criteria:

1. Comminuted fractures
2. Multiple facial fractures

Participants in this study were informed of the possible risks which are:

1. Prolonged operating time
2. Inadequate exposure and fracture reduction which would necessitate converting to open approach and exclusion of the participant from the study

Participants in this study were informed of the possible benefits which are:

1. Avoidance of facial incisions
2. Lower rate of operative complications such as facial nerve injury, ectropion, visible scars and delayed wound healing

Any unexpected risks appearing during the research were cleared to participants and the ethical committee on time.

Adequate provision to maintain the privacy of the participants and confidentiality of data were undertaken. Every patient was given a secret code number and all personal data of the patients were kept secret and not published by any means.

Whenever the fracture could not be adequately reduced via the endoscopic approach, we planned to shift to the open standard approach and to exclude the patient from the study (no patients had inadequate reduction in both study arms and so we excluded none).

Pre-operative evaluation:

1. Full history taking with focus on age, sex, mode of trauma, and time elapsed since the onset of trauma
2. Clinical examination of the maxillofacial region

3. Exclusion of other traumatic health issues in other bodily organs
4. Laboratory investigation to assess general health status and fitness to undergo general anesthesia
5. Radiological assessment of their fracture pattern by means of computed tomography with or without 3D reconstruction.

2.1 Surgical Technique

All patients underwent endoscope-assisted or open reduction with/without internal fixation by the same surgeon, first author, under general anesthesia in a slight reverse Trendelenburg position with a preoperative dose of intravenous cefazolin (2 gm). During all interventions, care was taken to record the operative time in minutes, from the start of surgery to the end of surgery; amount of blood loss in milliliters (ml), by calculating the amount of blood in the suction collection jar and weighing sponges and gauze pads; and any complications that would arise intraoperatively.

2.1.1 Endoscope-assisted technique

A 2 cm scalp incision beyond the hairline above and anterior to the auricle was made as in Fig. (1). The incision was carried down to deep temporalis fascia then we introduced a 30-degree endoscope and continued blunt dissection downwards until the temporal line where the fascia divides into two layers superficial and deep. The deep temporal fascia was incised there and the superficial temporal fat pad adherent to the superficial layer of deep temporal fascia was then reflected carrying with it the middle temporal artery within the fat pad. After reflection of the superficial layer of the fascia along with the fat pad and even the temporalis muscle, if necessary, the periosteum over the zygoma was identified and incised and the arch was exposed anteriorly as in Fig. (2). In some cases, with free middle segment of zygoma arch, the middle segment was extracted, preplated in vitro and re-introduced in-vivo as in Fig. (3 and 4). Otherwise, reduction was done under endoscopic control and fixation was carried out by miniplates while the screws were placed through a percutaneous stab incision under endoscopic visualization as in Fig. (5).

2.1.2 Open surgical technique

Standard coronal incision was used to expose the fractured zygoma arch (Fig. 6) with subsequent open reduction and internal fixation (Fig. 7).

Fig. 1. Incision for endoscopic reduction of zygoma arch fracture

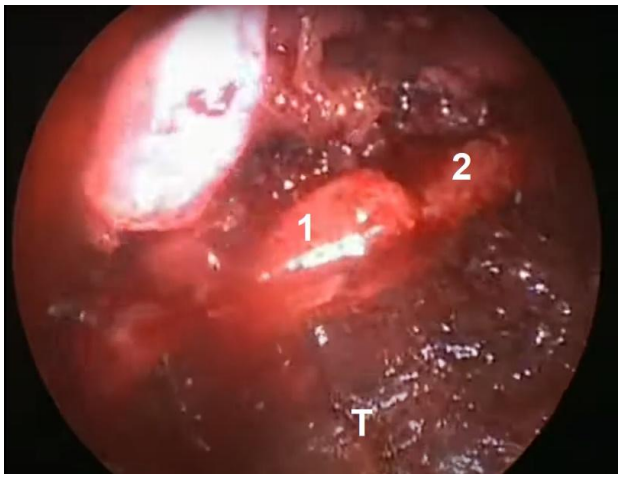

Fig. 2. Endoscopic view of left fracture zygoma arch. T, temporalis muscle; 1, temporal stable segment of zygoma arch; 2, fractured midsegment of the arch

Fig. 3. Preplating of fractured unstable midsegment of zygoma arch in vitro

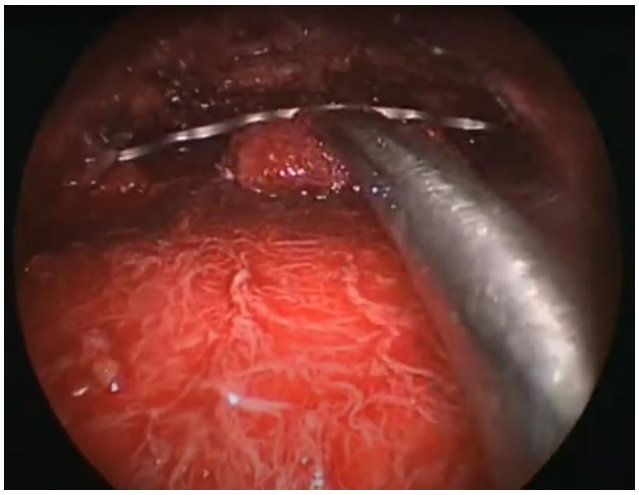

Fig. 4. Introduction of the fractured midsegment of the zygoma arch after preplating in vitro

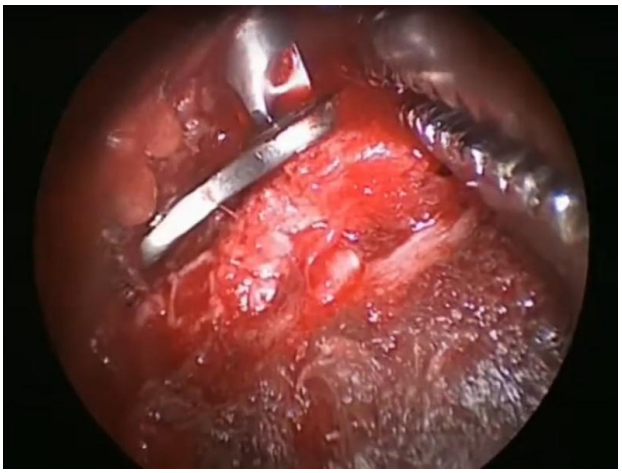

Fig. 5. Fixation of the plate to the posterior stable segment of the zygoma arch

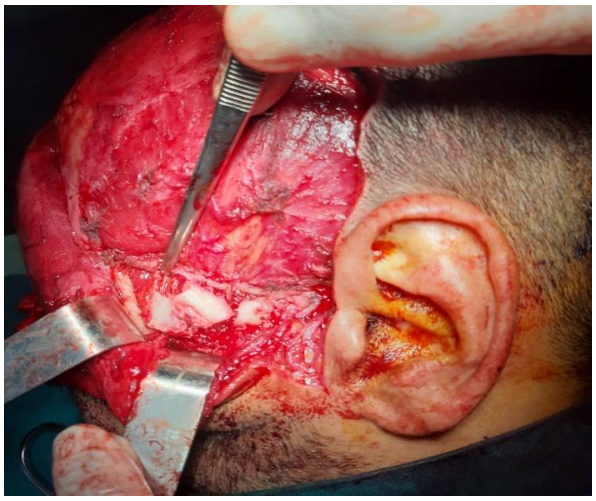

Fig. 6. Fracture of left zygoma arch exposed via standard coronal incision

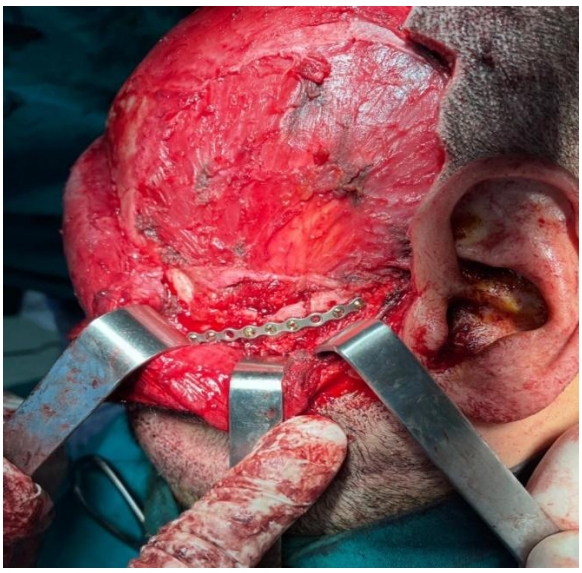

Fig. 7. Open reduction and internal fixation by long miniplate

2.1.3 Statistics

Comparison groups were considered independent (unpaired) since they are not necessarily matched by age and sex. Since data is symmetrically distributed, parametric tests were used for data analysis.

For numeric data, the t- test was used and the effect size and precision was then scrutinized by assessing the associated 95% confidence interval [6]. whenever the *P* value calculated by t test was found significant at α = 0.05, the *P* value was recalculated using the Mann Whitney U test to assess if the *P* value was still significant since the sample sizes of our study groups are small and the t test may produce an artificially low *P* value in such situations. In such cases where two tests were used to calculate the *P* value, the rate of α inflation was assessed by calculating the family wise error rate ,FWE≤1–(1– α)^n which was found to be 0.097 (9.7%) ,where α = 0.05 and n = 2, which is not large enough to bias the results plus whenever the second *P* value is found to be non-significant unlike the *P* value calculated by the t test, then a Bonferroni correction was made to the α level which became 0.025 and the two *P* values were re-compared against the corrected α level to determine statistical significance

3. RESULTS

A total of 18 patients underwent repair of the zygoma arch fracture over 19 months of the study period, including 15 males and 3 females. With age range between 16-63 years old. The average follow-up period for all patients was (2.8+\-1.1 months). Ten patients were operated by the endoscope-assisted approach while the other 8 patients were operated by the open approach. In 13 patients the mode of trauma was due to road traffic accidents; in the other 5 patients, the fractures were due to personal assault. All data of the two comparison groups are shown in Table 1.

3.1 Operative Time

The outcome of operative time showed statistically non-significant difference (*P* = .25).

3.2 Operative Blood Loss

The outcome of operative blood loss showed statistically non-significant difference (*P* = .52).

3.3 Adequacy of Reduction

This was determined by intraoperative inspection and palpation as well as postoperative comparison of preoperative and postoperative computed tomography scans. The outcome of rate of inadequate reduction showed statistically non-significant difference (*P* = 1) with quite wide 95% CI that reflects imprecision due to lack of events.

Table 1. Fracture zygoma arch outcomes matrix

Fracture zygoma arch outcomes	Endoscope group (n=10)	Open surgery group (n=8)	Comparison
Operative time (minutes) Mean+\-SD	132.5+\-6.77	139.37+-16.99	t = 1.17 *P* = .25^t 95% CI = -19.27 to 5.53
Blood loss (ml) Mean+\-SD	156.5 +\- 17.8	151.25+-16.2	t = 0.64 *P* = .52^t 95% CI = -11.96 to 22.46
Inadequate reduction	0/10	0/8	*P* = 1^f RD = zero 95% CI = -19.38 to 19.38
Complications	2/10	7/8	**P* = .015^f RD = 67.5% 95% CI = 33.74 to 101.26 NNT = 1.5

The asterisk denotes significant results, t denotes P value was calculated using the t test, f denotes P value was calculated using the fisher exact test, u denotes P value calculated using the Mann Whitney U test

3.4 Rate of Complications

In the open surgery technique group, one patient had postoperative temporal hallowing which was treated by hyaluronic acid injection 6 months later; another patient had incisional alopecia, but the patient refused to undergo corrective procedures for it. The endoscope-assisted group patients had no complications and thus showed a statistically significant lower risk of complications (P = .015) with risk reduction rate of 67.5%. In other terms, the NNT was 1.5, that is to say we must treat 1.5 patients with the endoscope assisted method to prevent 1 adverse event that would have happened with the traditional open approach.

4. DISCUSSION

According to our study results the endoscope assisted group showed statistically significant lower rate of complications with 67.5% risk reduction. Other outcome measure showed no statistically significant differences between the endoscope assisted and the traditional open approach. Different studies similar to ours are shown in (Table 2) for comparison.

According to Chen and colleagues [7], 15 patients with fracture zygoma (two had isolated fracture of zygoma arch and 13 had displaced fracture zygomaticomaxillary complex) were treated with the endoscope assisted approach using a 30-degree endoscope introduced through a temporal hairline incision to expose the frontozygomatic suture by sub-galeal plane dissection. Successful reduction was accomplished and radiologically documented in all the patients as in our study with no complications except for temporary paresis of the temporal branch of the facial nerve that recovered within 2 months in two patients and one case of very mild hollowing in the temporal region that was not even perceived by the patient and required no intervention.

Chen Lee and colleagues [8] studied a patient who had a comminuted fracture of the right zygoma arch. Postoperative successful reduction was confirmed by zygoma arch view plain x-ray and computed tomography with no complications except for temporary paresis of frontal branch of facial nerve that resolved without intervention after 6 weeks.

Czerwinski and Chen Lee [9] in a clinical series of 25 cases used a retractor mounted endoscope also through an extended preauricular approach. The authors emphasized on maintaining the integrity of the deep temporal fascia to avoid hollowing of the temporal region postoperatively. The mean operative time for isolated zygoma arch fractures was 120 minutes with temporary palsy of frontal branch of facial nerve in 8 cases that resolved spontaneously, which we think happened that much because the authors did their dissection superficial to the deep temporal fascia close to temporal branch of facial nerve. Similar to our study, no patient had inadequate reduction or needed revision surgery.

Chung Hoon and colleagues [10] studied one patient with right zygomaticomaxillary complex fracture. The author preferred not to disrupt the temporal pad of fat to avoid later temporal hollowing. The authors had successful reduction without complications as in our study but they did not mention the operative time or blood loss.

Kobayashi and colleagues [11] studied 8 patients with zygoma fractures. The authors reported that the endoscope-assisted method slightly decreased the operative time in comparison to the routine approaches but without reporting the actual numbers and statistics (selective reporting bias).

Osman and colleagues [12] studied 8 patients with zygoma arch fractures for which the endoscopic approach was used. The authors advised using a mini-adaption plate that is prebent over a 3d-printed model of the zygoma arch that was acquired by mirroring from the normal non-fracture side. The mean operative time was 180 minutes which is longer than our results for the same outcome which could be accounted for by the familiarity of our study surgeon with the endoscopic surgery in other fields which helps accelerate the learning curve and decrease the operative time. In this study similar to ours, no patient suffered postoperative complications in the 1-year follow-up period of the study.

Su Shin Lee and colleagues [13] studied 42 patients for whom the endoscopic approach was used to treat their zygoma arch fractures. In the first 17 patients the optical cavity was created by dissection in the plane directly over the deep temporal fascia, yet two patients sustained postoperative facial weakness thus in the next 25 patients this plane was modified to be below the deep temporal fascia to completely avoid the temporal branch of the facial nerve. This way the

Table 2. Studies on endoscope-assisted repair of zygoma arch fractures

Study/outcome	Operative time (min) (mean +-SD)	Blood loss (ml) (mean +-SD)	Complications Rate (%)	Inadequate reduction rate (%)
Our study	132.5+\-6.77	156.5 +\- 17.8	2/10	0/10
Czerwinski [9]	120	-	8/25	0/10
Kobayashi [11]	[K]	-	0/8	0/8
Osman [12]	180		0/8	0/8
Su Shin Lee [13]	216[s]	74.2[s]	2/42	0/42
Xie [14]	-	-	0/7	0/7

k reported as slightly less than open approach. s values are not for the endoscopic approach solely but is the total operative time including repair of other facial buttresses with open approaches

authors had no case of postoperative facial weakness. This is why we also preferred to carry out our dissection below the deep temporal fascia away from the temporal branch of facial nerve. The average operative time was 216 min (including repair of other buttresses of the fractured zygoma not only the pure endoscopic approach which justifies the much longer operative time mean in this study compared to ours) and similarly the average blood loss was74.2 ml.

Xie and colleagues [14] studied 7 patients with isolated zygoma arch fracture in whom they used the endoscopic approach. The authors reported a unique way to avoid injury to the temporal branch of facial nerve. The superficial temporal vessels were chosen as a landmark because they run in the same fascial plane of the temporal branch of the facial nerve. No patient suffered postoperative complications with this technique and all patients had satisfactory reduction of their fractures as in our study.

5. CONCLUSION

For the fracture zygoma arch, the endoscope-assisted method showed statistically significant superiority in the domain of incidence of complications risk reduction (67.5%). No statistically significant difference was recorded in other outcome measures. Thus, the endoscope-assisted approach for the zygoma arch fracture is in our opinion a better option than the traditional open incision approach.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

All authors hereby declare that all procedures have been examined and approved by the Tanta University of Medicine research ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. The ethical approval was issued on 13th of March 2019 with the reference number of (MED19/0648-2019000293).

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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