Economic analysis of open approach versus conventional methods of zygoma fracture repair

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BACKGROUND: As resource allocations in health care are being increasingly guided by cost containment issues, surgical professionals must consider the costs associated with various procedures. The present study identifies the financial costs attributed to the two principal treatment options available for zygoma fractures: the Gillie's method and open reduction and internal fixation (ORIF).

METHODS: Patients were included if they sustained an isolated zygoma fracture and were treated within 10 days of injury using either ORIF or the Gillie's method. Those who suffered concomitant injuries or required orbital floor exploration and repair were excluded. The end point, which consisted of the total cost required to bring a patient to preinjury facial appearance and function, incorporated the cost of primary treatment and that of any secondary procedures required to correct unfavourable outcomes.

RESULTS: In total, 45 patients were included: 25 were treated with Gillie's method and 20 were treated with ORIF. The cost associated with the primary treatment of zygoma fractures was found to be higher for ORIF than Gillie's method, amounting to \$1,811 and \$715, respectively. However, when taking into account potential repair of unsatisfactory results, the final sum totalled \$1,930 and \$3,725, respectively. This difference was statistically significant.

CONCLUSION: To the authors' knowledge, this is the first study to objectively examine the cost of the Gillie's method and ORIF in the repair of zygoma fractures. Although the initial cost of ORIF is higher, the final cost of the Gillie's method is greater. Thus, surgeons should not allow higher initial costs to deter them from using more extensive and accurate techniques.

Key Words: Complications; Cost; Economic analysis; Gillie's repair; Open reduction internal fixation; Zygoma fractures

A wareness of treatment costs has become essential as resource allocation in health care is increasingly guided by financial concerns. Cost containment is increasingly impacting the decision-making process in the field of surgery.

Very few studies in craniomaxillofacial surgery have attempted to identify the cost-effectiveness of surgical procedures. Indeed, cost estimation has proven to be quite challenging because patient-dependent factors – such as subjective perception of the deformity, loss of income during recovery and interpretation of surgical risks – and not objective indications often greatly influence surgical decisions. This paucity is especially important given the trend, observed

Analyse économique de l'approche ouverte versus classique de réduction des fractures de l'os zygomatique

HISTORIQUE : Étant donné que l'allocation des ressources en soins de santé subit de plus en plus l'effet des contraintes budgétaires, les chirurgiens doivent tenir compte des coûts de leurs diverses interventions. La présente étude compare les coûts des deux principales options thérapeutiques offertes pour réduire les fractures de l'os zygomatique : la technique de Gillie's et la réduction ouverte avec fixation interne (ROFI).

MÉTHODES : Les patients étaient admis s'ils avaient subi une fracture isolée de l'os zygomatique traitée dans les dix jours suivant le traumatisme, soit par ROFI, soit par technique de Gillie's. Les sujets qui avaient subi d'autres blessures concomitantes et auraient nécessité une réparation du plancher orbital étaient exclus. Le paramètre primaire, soit ce qu'il en coûte au total pour redonner au visage du patient l'apparence et le fonctionnement qu'il avait avant la blessure, incluait le coût du traitement principal et celui de toutes les interventions secondaires nécessaires pour corriger les résultats défavorables.

RÉSULTATS : En tout, 45 patients ont été inclus : 25 ont été traités par la technique de Gillie's et 20, par ROFI. Le coût du traitement primaire des fractures de l'os zygomatique s'est révélé plus élevé avec la technique ROFI qu'avec la technique de Gillie's, soit 1 811 \$, contre 715 \$, respectivement. Par contre, en tenant compte de la correction d'éventuels résultats plus ou moins satisfaisants, la somme finale s'élevait respectivement à 1 930 \$ et 3 725 \$. Cette différence a été jugée statistiquement significative.

CONCLUSION : À la connaissance des auteurs, il s'agit de la première étude à se pencher objectivement sur le coût de la technique de Gillie's et de la technique ROFI pour la réduction des fractures de l'os zygomatique. Bien que le coût initial de la ROFI soit plus élevé, le coût final de la technique de Gillie's lui est supérieur. Ainsi, les chirurgiens ne doivent pas considérer les coûts initiaux plus élevés comme un obstacle à l'utilisation de techniques plus coûteuses et précises.

over the past three decades, toward more aggressive treatment of facial fractures. Techniques of more extensive fracture exposure, reduction and fixation result in increased operating time, equipment requirements and, thus, higher costs of initial treatment (1,2). Is this increased expenditure justifiable in the realm of today's increasingly cost-conscious health care system?

The wide disparity that exists in the choice of operative techniques for the repair of zygoma fractures stems partially from a similar dilemma. The two main treatment options are the Gillie's method and open reduction and internal fixation (ORIF). The former approach involves a transtemporal reduction of the zygoma without any significant cutaneous incisions

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Figure 1) Incidence of causes of orbitozygomatic complex fractures. MVA Motor vehicle accident

to directly visualize the fracture sites, or any rigid fixation. The latter exposes all fracture sites to allow for visual confirmation of proper realignment as well as rigid fixation using titanium hardware. While ORIF is anatomically more accurate and generally results in a lower rate of potential secondary reconstructive procedures, the Gillie's method is simple, fast and believed by its proponents to be less expensive.

To adequately assess the cost-effectiveness of each operative technique, it is imperative to identify not only the expenses associated with the primary surgery, but also those resulting from all additional procedures required to attain an equivalent end point, which ideally constitutes the pretraumatic facial appearance and function.

The objective of the present study was to identify, from a health care system perspective, the costs required to bring patients who sustained zygoma fractures to the same preinjury facial appearance, using either the Gillie's method or ORIF as the primary surgical technique. The analysis included costs of the primary surgery and any further secondary reconstructive procedures. These included correction of facial asymmetry and lower lid malposition (scleral show, ectropion). We hypothesize that the cost of the Gillie's method is higher due to an elevated incidence of secondary surgeries is necessary for these patients to acquire a similar preinjury appearance and function.

METHODS

Design

This was a cost-identification analysis performed via a retrospective review of the medical records of 153 patients who underwent zygoma fracture repair at the McGill University Health Centre (Montreal, Quebec) between 1996 and 2002. The perspective chosen was that of the Quebec health care system.

Inclusion criteria

Patients were selected if they sustained an isolated zygoma fracture, based on the preoperative computed tomography scan, and were treated within 10 days of injury using either ORIF or the Gillie's method. ORIF was defined as reduction and rigid miniplate fixation of at least one of the zygoma but-tresses. Gillie's repair was defined as open reduction of the zygoma by a temporally inserted elevator, without any direct

visualization of the alignment at the fracture sites or any fixation. Patients who suffered any concomitant injuries or required orbital floor exploration and repair were excluded, so as to minimize confounding costs.

End points

Demographic data were collected. The principal end point of the study was the cost required to bring a patient who sustained a zygoma fracture to preinjury facial appearance, using either ORIF or Gillie's as the initial treatment method.

Mean duration of each surgery as well as types and quantities of necessary equipment were calculated from the operating room records. Mean length of postoperative stay in the hospital was calculated from hospital discharge summaries.

Direct fixed and variable costs calculated included cost of primary treatment, potential cost of treatment for unsatisfactory outcomes, and total treatment costs for both ORIF and Gillie's groups.

Cost of primary treatment was subdivided into costs of operating room (OR) personnel (surgeon, anesthesiologist, assistants), OR equipment and length of stay in the hospital (same day surgery, floor admission) required for the treatment of a zygoma fracture. These data were obtained from the Régie de l'assurance maladie du Québec Coding Documents, surgical product catalogues and the McGill University Health Centre Finance Office, respectively. Costs for the treatment of unsatisfactory outcomes, including correction of zygoma asymmetry using osteotomies (3) and correction of lid malpositioning using lateral canthoplasty, were similarly estimated. These costs were averaged using the medical records of three patients who underwent zygoma asymmetry correction and 30 patients who underwent ectropion correction.

Total treatment costs were calculated by the summation of primary treatment costs and the cost of reconstruction of the unsatisfactory outcomes, multiplied by their incidence. The incidence of each such outcome was calculated from a subgroup of 12 patients in each surgical group, who were objectively assessed using methods described elsewhere (4). Thus, the total cost was a summation of the primary and secondary treatment costs required to return patients in each group to their preinjury facial appearance.

Statistical analysis

Statistical analysis was performed using independent variable Student's *t* test and χ^2 test. Significance level was chosen as 0.05.

RESULTS

In total, 45 patients fulfilled the selection criteria; of these, 25 were treated using the Gillie's method and 20 using ORIF. Thirty-one patients were male and 14 were female. There were no statistically significant differences in demographic characteristics between the groups. In descending order, the most frequent causes of fractures were assault, sport-related injuries, falls and motor vehicle accidents (Figure 1).

Mean costs of primary treatment are presented in Table 1. Most patients in the ORIF group underwent a two-point fixation. Differences in the costs of each component were significantly different. On average, there were three nurses in the OR at any time. All patients (100%) in the ORIF group were admitted to the hospital postoperatively, compared with 84% of those in the Gillie's group. Total cost of stay in the hospital

| TABLE 1 | | |
|------------------------|---------------|--------------------|
| Component analysis and | costs of each | surgical technique |

| | ORIF | | Gillie's method | | |
|---------------------------|---|----------|--|----------|-----------------------|
| Variable | Quantity | Cost, \$ | Quantity | Cost, \$ | Р |
| Surgery | | | | | |
| Duration, min | 135±35 | - | 71±16 | _ | _ |
| Surgeon | - | 140 | - | 56 | 2.8×10 ⁻¹⁰ |
| Anesthesia | - | 193 | - | 116 | 4.7×10 ⁻⁸ |
| Nursing (\$26.13/h/nurse) | - | 176 | - | 93 | 2.8×10 ⁻¹⁰ |
| Operating equipment | | | | | |
| Miniplates (Synthes, USA) | Orbital rim plate; Zmb L plate | 211 | - | 0 | - |
| Screws (Synthes, USA) | 11 mm \times 4 mm | 330 | - | 0 | _ |
| Sutures (Ethicon, USA) | $1 \times 4-0$ chromic gut; $1 \times 5-0$ nylon | 4 | 1×4 -0 chromic gut 1 × 5-0 nylon | 4 | - |
| Hospital stay | | | | | |
| Admission | 1.7 days (100%) | 757 | 1.1 days (81%) | 489 | |
| Same day surgery | _ | 0 | (19%) | 52 | |
| Total mean | - | 757 | - | 406 | 8.3×10 ⁻⁴ |
| Total | - | 1,811 | - | 715 | 1.2×10 ⁻¹⁴ |

ORIF Open reduction and internal fixation

was calculated by adding the costs of percentages of patients admitted to the hospital and those undergoing same day surgery.

Rates of unsatisfactory outcomes are presented in Table 2. Components and mean costs of secondary procedures required to correct these outcomes are found in Table 3. Using presented unsatisfactory outcome rates, the total costs required to bring patients to preinjury facial appearance amounted to \$1,930 and \$3,725 for the ORIF and Gillie's groups, respectively. This difference was statistically significant.

DISCUSSION

Cost analysis is especially important in the field of craniomaxillofacial surgery, where aggressive operative techniques are increasingly replacing more conservative treatments. However, the need for longer operating times and specialized equipment adds to the cost of these techniques. Thus, despite the augmented accuracy of the newer surgical options, many surgeons still favour the more conservative treatment methods. It is imperative, however, to also consider the costs of secondary surgeries required to repair the unfavourable results that potentially arise following the primary surgeries. Indeed, the cost of treating an injury should represent the sum of all expenses disbursed to achieve a patient's same end point facial appearance, and not simply the cost of the initial surgery. Treatment of zygoma fractures exemplifies this concept.

The present analysis has shown, as expected, that the primary treatment of zygoma fractures is more costly using ORIF (\$1,811) than the Gillie's method (\$715). The cost of specialized titanium miniplate and screw systems accounted for the majority of this cost difference (\$549), followed by the cost of hospital stay (\$351). Patients treated using ORIF were admitted to the hospital more frequently than those treated with the Gillie's method (100% versus 84%, respectively) and stayed in the hospital for a longer duration (1.7 days versus 1.1 days, respectively).

Correction of zygoma asymmetry was the most expensive of secondary reconstructive procedures, costing \$6,021. The

| TABLE | Ξ2 | | |
|-------|-----|-------|--|
| Datas | ofo | omnli | |

Rates of complications

| Complication | ORIF (%) | Gillie's method (%) | |
|--------------------|----------|---------------------|--|
| Zygoma asymmetry | 0 | 50 | |
| Enophthalmos | 0 | 0 | |
| Lid malpositioning | 33 | 0 | |

ORIF Open reduction and internal fixation

length of operating time required for osteotomy and adequate fixation of the malunited fracture, along with the required surgical equipment, accounted for this substantial sum. Frequently, more than one secondary reconstructive procedure is necessary (5). The mean cost of lid malpositioning correction was \$314. There were no incidences of enophthalmos in our study population, most likely because we selected patients who suffered from moderately displaced zygoma fractures without significant orbital floor involvement (6). Enophthalmos was thus excluded as a potential source of costly complication repair.

Given the incidence of each unfavourable result, the total cost required to bring patients who sustained a zygoma fracture and were treated primarily using ORIF or Gillie's repair to an equivalent end point of facial appearance were \$1,930 and \$3,275, respectively. Although the Gillie's procedure is initially less expensive, it is intrinsically more inaccurate and thus becomes more costly once repair of complications is factored in.

Several strategies can be employed to decrease the costs of initial ORIF. First, increasing the proportion of outpatientbased surgeries would significantly reduce the high expenses associated with hospital admissions. Proper discharge instructions and regular follow-ups should make this a safe practice. Second, use of the transconjunctival approach to the infraorbital rim significantly decreases the incidence of lower lid sequelae. Third, discriminate use of rigid fixation at points where stability is really necessary would evidently reduce the costs of plating equipment.

TABLE 3 Complication component analysis and costs

| | OZC osteotomy and bone graft | | Lid malpositioning | | |
|---------------------------|------------------------------|----------|---------------------------|----------|--|
| Variable | Quantity | Cost, \$ | Quantity | Cost, \$ | |
| Surgery | | | | | |
| Duration, min | 420 | - | 58 | - | |
| Surgeon | | 960 | | 198 | |
| Anesthesia | | 925 | Local | 0 | |
| Nursing (\$26.13/h/nurse) | 3 nurses per OR | 549 | 2 nurses per OR | 52 | |
| Operating equipment | | | | | |
| Miniplates (Synthes, USA) | | 367 | _ | 0 | |
| Screws (Synthes, USA) | | 530 | - | 0 | |
| Sutures (Ethicon, USA) | | 20 | 1×4-0 vicryl, 1×5-0 nylon | 8 | |
| Hospital stay | | | | | |
| Admission | 6 days (100%) | 2,670 | 0% | - | |
| Same day surgery | 0% | - | 100% | 52 | |
| Total mean | 6 days | 2,670 | 0 days | 52 | |
| Total | - | 6,021 | - | 314 | |

OR Operating room; OZC Orbitozygomatic complex

CONCLUSIONS

The present study demonstrates that the cost of the Gillie's method of zygoma fracture repair is greater than ORIF due to the cost of potential secondary reconstructive procedures required to correct its complications. However, we do not know whether all the patients would have chosen to undergo these additional procedures. The decision of a patient to undergo surgery is complex and involves the consideration of various factors, including subjective perception of the deformity, loss of income during recovery and interpretation of surgical risks. Nevertheless, we feel confident in stating that from an economic perspective, initially higher expenses should not discourage the use of more extensive techniques for the repair of facial trauma.

NOTE: This project has been presented at the American Society of Plastic Surgeons (ASPS) Annual Meeting, Philadelphia, USA, October 2004; the Canadian Society of Plastic Surgeons (CSPS) Annual Meeting, Hamilton, Ontario, June 2004.

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