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The impact of cranioplasty on the patients' quality of life

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ABSTRACT

Objective: To evaluate the quality of life in patients with moderate or large cranial bone defects before and after late cranioplasty.**Methods:** Authors performed a prospective clinical trial including all consecutive patients that filled inclusion criteria during a period of 1 year. All patients answered the quality of life SF-36 questionnaire in 5 different times. Besides authors gathered information about the primary trauma and demographic characteristics.**Results:** A total of 70 consecutive patients were admitted to the hospital during the study period, and 62 were included in the project. Cranioplasty statistically improved patients' quality of life in all 8 domains after a 24 months follow-up.**Conclusion:** Cranioplasty has a significant impact over the quality of life in brain trauma victims who survived the primary trauma and harbor a large cranial bone defect.

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1. Introduction

When a neurosurgeon faces a victim of severe head trauma all efforts are focused on saving the patient's life, and, in many cases, the treatment of intracranial hypertension requires an urgent decompressive craniotomy. Under the scope of severe head trauma, survival is considered a satisfactory endpoint from a medical point of view, especially if the patient does not have a motor or cognitive impairment at the time of hospital discharge. However, many patients are discharged from the hospital harboring a skull defect, because cranial reconstruction may not be performed during the same hospitalization.

Cranioplasty (CP) is a neurosurgical procedure aimed to repair the skull defect following craniectomy. Historically, skull defect reconstruction has been indicated for protection and cosmetic reasons (Junior et al., 2018; El-ghani, 2019).

However, recent studies have postulated that performing cranioplasty has a therapeutic role in improving the patient's functional and neurological outcome after decompressive craniectomy (Sahoo et al., 2018), helping the individual's rehabilitation from different

points of view. It has been shown that CP promotes an increased cerebral blood flow, change in cerebrospinal fluid hydrodynamics and reduction in epileptic seizures (De Cola et al., 2018). Additionally, promising results following this procedure in both motor and cognitive outcomes have been reported (Posti et al., 2018).

Even though a large number of articles have been published about the neurological (motor and cognitive) improvements after CP and about the physiological events responsible for this event, no previous article analyzed the impact of CP on social aspects and patient's self-esteem. Skull defect affects social and family interaction, making the patients isolated and ashamed of their appearance. They are also socially seen as neurologically and intellectually impaired (Lee et al., 1995; Schmidek, 2006; Cranioplasty, 1984). Moreover, cranial bone defects (especially those located on areas not covered by hair) are visually uncomfortable, and may produce psychological disturbances, low self-esteem, social embarrassment and isolation and also postpone return to labor activities (Islam et al., 2010).

Current medical literature had already analyzed the impact of large craniectomies on the patient's quality of life, although no scientific article concerning the impact of cranioplasty over the theme has been published.

The objective of this article is to evaluate the impact of late cranioplasty on the quality of life in patients with large skull defects.

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2. Material and methods

A prospective clinical trial was conducted from March 2013 through March 2016. The patient inclusion period was from March 2013 to March 2014, and all patients were followed for 2 years after surgery. The study was conducted at the Cristo Redentor Hospital – POA, which is a tertiary hospital of high complexity, specialized in head and spinal trauma located in the southernmost state of Brazil (Rio Grande do Sul State). The study was approved by the hospital's ethics committee in research.

Authors included patients harboring a cranial defect with a minimum diameter of 12,5 cm who underwent late cranioplasty. Patients under 18 years old, or who presented a neurological deficit that restricted proper completion of the questionnaires or who did not agree to be part of the study were excluded.

Quality of life was analyzed using the SF-36 (Medical Outcomes Study 36 – Item Short – Form Health Survey) five times: once before cranioplasty and four times after the surgery (respectively in the 3rd, 6th, 12th and 24th months).

Brazilian-Portuguese version of the SF-36 Health Survey was validated to the Brazilian population by Ciconelli et al. (1999). The questionnaire consists of 36 questions and expresses 8 domains and 2 summary scores (Hikosaka et al., 2011). The eight domains are: functional capacity, physical aspects, pain, general health, vitality, social aspects, emotional aspects and mental health. Each one presents a final score from 0 to 100 in which 0 corresponds to the worst quality of life and 100 to the best. The assessment scales related to physical and emotional aspects are approached not only through the types of limitations, but also by the amount of work and how much these limitations encumber professional routine and other daily activities (Ware et al., 1998).

Additionally, data about reconstruction topography, trauma mechanism and primary Computed Tomography scan (CT scan) findings were collected.

2.1. Patient data collection

SF-36 questionnaire was self-applied and patients were placed in a calm, silent and well illuminated room. Before the patient started to answer, the questionnaire was explained by one of the authors, all doubts were promptly clarified, and the patients were informed that no further help or intervention were allowed in order to not interfere with the responses.

2.2. Surgical procedure

Patients underwent the standard approach of cranioplasty surgery. Skull defect was repaired using a Polymethylmethacrylate plaque (powder impregnated with erythromycin 0.5 g and colistin 3.00 million IU), molded during surgery. Authors did not use customized prosthesis.

2.3. Statistic analysis

Statistic analysis was performed using Statistical Package for the Social Sciences (SPSS) software. Numerical variables are presented as mean and standard deviation. Comparison among three or more means was calculated by ANOVA test with Bonferroni post-roc.

2.4. Ethical aspects

The project was approved on its ethical and methodological aspects by an Ethical Committee in Research. All included patients agreed to participate in the study and signed the free and informed consent form.

3. Results

A total of 70 patients underwent cranioplasty during the study period, but eight patients were excluded (see Fig. 1): four presented sensorial aphasia and were not able to respond the questionnaire adequately; two patients were lost during postsurgical follow-up and two patients were excluded because the cranial defect was small. Population analyzed then comprised 62 patients, with a mean age of 40 years-old and a Caucasian male predominance (77%).

Intraparenchymal brain contusion was the most common CT scan finding at hospital admission, followed by traumatic subarachnoid hemorrhage and subdural hematoma. The main etiology for craniectomy was severe head trauma (81%) and malignant stroke (9,6%). Stratifying the head trauma group, traffic accident was responsible for 58% of cases followed by head aggression in 22,6% (Table 1).

Cranioplasty promoted a positive and statistically significant impact in all domains evaluated by the SF-36 in the end of follow-up ($p < 0.001$). The first domain to improve is the general health state (at the third month after surgery). Two domains (vitality and social aspects) show an important improvement at the 6th month of follow-up. All other five domains (labor capacity, physical activities, pain, emotional aspects and mental health) increase at the 12th postsurgical month (Table 2).

4. Discussion

Quality of life is impaired in patients that suffered mild, moderate or severe head trauma (Paoli et al., 2008; Vieira et al., 2013; Shiraz et al., 2014). Kaske et al. identified difference in all 8 domains of SF-36 in a 2 year follow-up of patients that suffered severe head trauma, when compared to a non-trauma control group (Kaske et al., 2014). Additionally, a study that analyzed the consequences on daily activities and psychological state 18 months after head trauma (Holtslag et al., 2007), showed that any head trauma (mild or severe) has a negative impact on daily life aspects, worsening patient's quality of life.

According to our results, general health status statistically increases in the first 3 months after cranioplasty; followed by vitality and social aspects, which improves at the 6th month of follow-up. These results suggest that once the patients felt healthier, they regained vitality and self-confidence, diminishing depressive symptoms. A better self esteem results in a better social interaction and the patients may even feel confident to return to their labor activities.

Most patients present an important neurologic rehabilitation in the first months after hospital discharge. The improvement is higher during the first six months, and continues to increase, in a less abrupt pattern, until the end of the first year. After 12 months, patient's recovery velocity decreases until it reaches a plateau and stabilizes; by the end of the second year the patient condition is believed to be definitive. Therefore, further improvements in the neurological status are supposed to be secondary to a therapy provided to the patient, since the natural recovery period has finished.

The mean time between primary head trauma and cranioplasty in our sample was 25 months, a period in which the neurologic maximal recovery from trauma is expected to be achieved and stable. Therefore, the authors believe that the improvement in the patients' quality of life is secondary to the repair of the skull defect, once this intervention promoted such an important impact in our sample even two years after the brain injury.

Quality of life is a complex item to be analyzed since it varies according to cultural and educational patterns, between different global regions and even inside the same country. Different locations

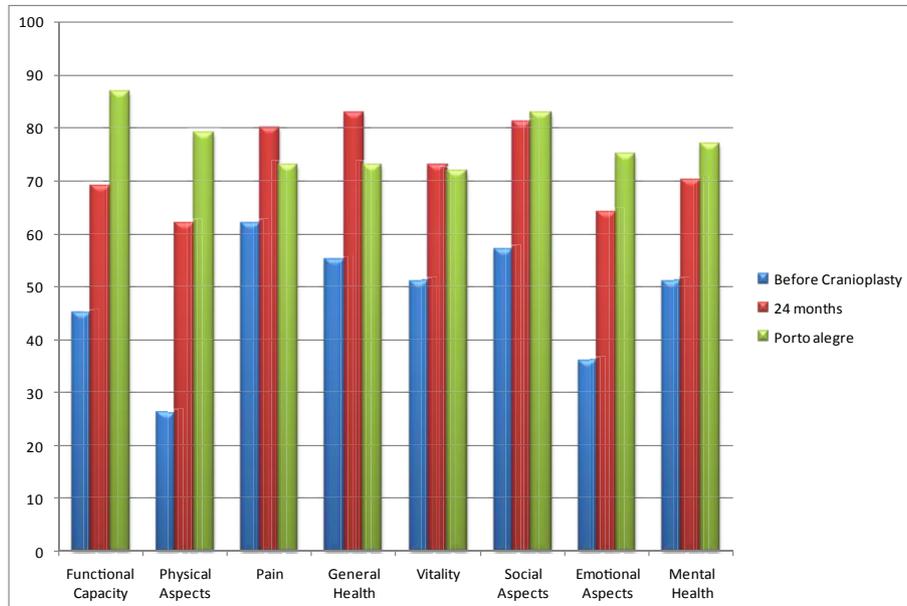


Fig. 1. Comparison of SF-36 results between regular population and patients submitted to cranioplasty.

Table 1 Demographic aspects, CT scan findings and Injury Mechanism of the sample.

Demographic sample aspects	Total (n = 62)	Percentage (%)
Gender		
Female	14	23
Male	48	77
Age ^a	40 ± 14	
Craniotomy		
Bifrontal	2	3
Right	29	47
Left	24	39
Frontal	7	10
Vertex	1	2
Time to cranioplasty ^b	25 ± 15 months	
CT Scan Findings at Hospital Admission		
Cerebral Contusion	45	73
Subdural Hematoma	30	48
Subarachnoid Hemorrhage	31	50
Epidural Hematoma	9	14
Intraparenchymatous Hematoma	12	19
Presence of Blood in the Ventricles	6	10
Hydrocephalus	9	14
Injury Mechanism		
Motorcycle traffic accident	10	16,1
Falls	10	16,1
Gun shot	8	12,9
Aggression	6	9,6
Stroke	6	9,6
Run over victim	6	9,6
Vehicle traffic accident	5	8
Fall of an object on the head	4	6,4
Tumor	2	3,2
Hit by a rock	1	1,6
Other reasons ^b	4	6,4

^a Mean ± Standard Deviation.

^b Bone reabsorption after surgery for arteriovenous malformation, 2- Hit by a tree that fell; 1- Cranial crush.

have different levels of social and economic development (considering employment, income, education and healthcare) and these differences may impact the individual quality of life perception (Vieira et al., 2013). Therefore, it is important to compare the results of the SF-36 questionnaire to the regular population of the

same location (Fig. 1). In other words, it is important to compare the study group to a healthy nontrauma-victim population who lives in the same region.

Cruz et al. performed a study with the objective to determine the normal values of SF-36 in the southern Brazilian regular population (Cruz et al., 2013). Comparing the results of our sample after surgery to the ones described by Cruz, it is clear that functional capacity, physical aspects, emotional aspects and mental health scores were lower in our sample, although general health status and vitality scores were higher in our sample when compared to the same population (Table 3).

It is interesting that patients harboring a disfiguring cranial defect find themselves healthy and with vitality in a higher proportion than does the regular population. In order to try to justify this finding, an important issue to highlight is that in our study all patients suffered severe head injury, most of them life-threatening lesions. Therefore, surviving a life-threatening situation may be relevant for the self-perception of health and vitality when compared to the regular population. Lima et al. (Paoli et al., 2008) concluded that even mild head trauma promoted changes in patients' self-perceptions and opinions about health and interpersonal relations.

Surgery satisfaction and self-esteem improvement are important for the patient to return to previous activity, which is one of the main goals for a patient that is living a recovery process (Dijkers, 2003). The return to productive activity has been considered one of the major determinants of the quality of life, since it affects social adjustment, such as socioeconomic status, self-confidence and the sense of social inclusion (Vieira et al., 2013). Many patients in our sample that were unemployed reported being willing to return to labor activities; however, it is difficult to be hired when having a skull defect.

Sober et al. analyzed patients that survived severe general trauma and found a 43% rate of labor return in a two-year period after trauma (Soberg et al., 2007), a similar result described by two other articles (Vieira et al., 2013; Kaske et al., 2014). Authors believe that the lower amount of patients working before cranioplasty in comparison to the studies cited above may be secondary to the feeling that treatment is not finished as long as the skull defect has

Table 2
Quality of life analyses of SF-36 questionnaire comparing pre and postoperative results.

Domain	Before surgery	After surgery (months)				P value
		3	6	12	24	
Functional capacity	45 ± 33	53 ± 36	59 ± 35	67 ± 39 ^a	69 ± 34 ^a	0.001
Physical aspects	26 ± 34	40 ± 39	46 ± 38	66 ± 47 ^{a,b}	62 ± 42 ^{a,b}	<0.001
Pain	62 ± 28	70 ± 28	73 ± 23	78 ± 22 ^a	80 ± 23 ^a	0.001
General health	55 ± 19	68 ± 18 ^a	75 ± 18 ^a	81 ± 16 ^{a,b}	83 ± 14 ^{a,b}	<0.001
Vitality	51 ± 25	60 ± 23	63 ± 24 ^a	71 ± 23 ^a	73 ± 23 ^{a,b}	<0.001
Social aspects	57 ± 29	68 ± 26	72 ± 25 ^a	77 ± 25 ^a	81 ± 24 ^a	<0.001
Emotional aspects	36 ± 41	45 ± 43	48 ± 41	70 ± 50 ^{a,b,c}	64 ± 40 ^a	<0.001
Mental health	51 ± 25	57 ± 23	62 ± 24	67 ± 23 ^a	70 ± 23 ^{a,b}	<0.001

^a Difference before and after the surgery confirmed by Bonferroni post-roc test.

^b Difference before and 3 months after the surgery confirmed by Bonferroni post-roc test.

^c Difference before and 6 months after the surgery confirmed by Bonferroni post-roc test.

Table 3
Comparison of SF-36 results between regular population and patients submitted to cranioplasty.

	Functional capacity	Physical aspects	Pain	General health	Vitality	Social aspects	Emotional aspects	Mental health
Pio et al	82.45 ^a	74.73 ^a	67.53 ^a	71.10 ^a	66.85 ^a	78.30 ^a	70.02 ^a	73.82 ^a
Before cranioplasty ^b	45°	26°	62°	55°	51°	57°	36°	51°
After cranioplasty ^b	69°	62°	80°	83°	73°	81°	64°	70°

^a Mean.

^b Results of the sample analyzed in the study.

not been corrected, because the patient fears a new trauma, and also very few employers hire a person with a skull defect. Probably the patient might wait for cranioplasty before moving on with their personal, social and labor activities. Therefore, cranial reconstruction represents one of the most important situations to be solved in those patients. At the end of 24 months of follow-up, authors identified that 70% of patients returned to labor activities, regaining economic independence.

5. Conclusion

Cranioplasty has a significant impact on the patients' quality of life in all aspects, helping them to recover family, social and labor activities. Therefore, early cranial defect reconstructions must be sought. Even though early cranioplasty has higher surgical complication rates, the impact on the patients' quality of life may overlap this risk.

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Conflict of interest

The authors report no conflict of interest.

Data sharing statement

Authors make available any additional unpublished data, such as unprocessed data and protocols upon request from the corresponding author.

Contributorship statement

Paulo Valdeci Worm PhD MD: The author performed significant contributions in all aspects of the study such as its design; surgical procedure; data collection, analysis and interpretation; article draft; literature review; final version of article review.

Guilherme Finger MD: The author performed significant contributions in all aspects of the study such as its design; surgical

procedure; data collection, analysis and interpretation; article draft; literature review; final version of article review.

Tobias Ludwig do Nascimento MD: The author performed significant contributions in important aspects of the study, including surgical procedure; data collection, analysis and interpretation; final version of article review.

Carla Bittencourt Rynkowski MD: The author performed significant contributions in important aspects of the study, such as data collection, analysis and interpretation; final version of article review.

Marcus Vinicius Martins Collares PhD MD: The author performed significant contributions in important aspects of the study such as its design; data collection, analysis and interpretation; article draft; literature review; final version of article review.

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Appendix A. Supplementary data

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