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CRANIOPLASTY AS THE RETURN-TO-WORK FACTOR – 112 PATIENTS WITH CRANIAL DEFECTS TREATED IN THE DEPARTMENT OF NEUROSURGERY AT THE MEDICAL UNIVERSITY OF LODZ

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Abstract

Objectives: The number of craniectomies and the consequent reconstructive procedures has grown during the past decades. Cranial defects and methods of their repair could have some influence on work capability of the patients and their employability. **Material and Methods:** The authors analyzed a group of 112 patients with cranial defects treated in the Department of Neurosurgery at the Medical University of Lodz, Poland, in the course of the katamnestic period longer than 6 months after reconstructive operation, and observed them between February 2008 and February 2015. Their work capability and employment were compared, all the patients were interviewed concerning the reasons for not working according to the Social Insurance Institution predication procedure. **Results:** Before the cranioplasty, all the patients were capable of working without limitations according to biological criteria and 89 of them were employed. Twenty-three not working people consisted of 6 pupils, 7 retired and 10 not working for other reasons. During the period between the craniectomy and the cranioplasty, 88 patients were capable of working and only 2 were employed. After the reconstruction, 93 were capable of working without limitations and 16 – with limitations. Forty-seven were employed during the period of the follow-up, the rest of patients consisted of 2 pupils, 13 retired and 50 not working for various reasons. **Conclusions:** Cranioplasty is a very important factor contributing to return to work. This outcome may be seen as having a great social value and be added to the functions of cranial repair as protective, esthetic and normalizing the intracranial pressure previously described in the literature. Int J Occup Med Environ Health 2017;30(5):803–809

Key words:
Cranial defect, Cranioplasty, Employment, Fitness for work, Work capability assessment, Craniectomy

INTRODUCTION

The number of cranial defects has grown during the last hundred years. Centuries ago, the majority of such defects were caused by various reasons connected with military conflicts, and rarely by bone diseases. Currently, the defects originating from transportation accidents and in the access to neurosurgical treatment (iatrogenic defects) are most common [1,2].

The number of patients requiring cranial reconstruction reaches 50–70 annualy in the Łódź region, between 700 to 1000 cases in the whole of Poland and not fewer than several thousand in the European Union.

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Although such data is somewhat uncertain, they do represent estimates of the scale of the problem. They were collected from producers of prostheses and classification data from the Polish National Health Service Fund institution (Narodowy Fundusz Zdrowia – NFZ).

In contemporary clinical practise, there are 2 major cranioplastic approaches. The first one involves transplants – various autogenic prostheses (the patient's own bone taken from various regions of the body). The second one involves implants where allogenic substances are involved such as metals, ceramics or plastics [3]. The patient's own bone is very often resorbed, sometimes causes autoagressive reaction, and always requires additional operative field [4]. Metals have high thermal conduction and as such in various seasons they easily transmit the heat to or out of the body [5]. Another disadvantage of metals is a high cost of preparation. Ceramics are fragile and their production is expensive [6].

So the cranioplastic solution which is predominant in the world of neurosurgery is provided by various plastics. It is difficult to state the exact number of particular types of cranioplastic substances. The majority of cranial reconstructions seems to be performed with poly methyl methacrylate (PMMA) (known also as bone cement), according to estimates by 2 producers interviewed on that matter and based on the review of literature [7,8].

A substance which seems to have some important advantages over other materials used for cranioplastic purposes in the past was created in Łódź in mid 1980s. It is polypropylene polyester knitwear [9]. When compared to the most commonly used PMMA or the newest polyether ether ketone (PEEK) utilized in very trendy 3D printers, it has the same rigidity but is much less breakable. When compared to PMMA, PEEK or porous polyethylene, it has a porous structure and fluid permeability throughout the whole surface. Poly methyl methacrylate or PEEK are not permeable, porous polyethylene (PPE) has micropores only [10,11].

In recent years, neurosurgeons dealing with cranial defects have started to require producers to supply implants which are designed for a particular defect – tailored to a specific gap in the skull. Products which were previously standardized had to be individualized and adjusted to the need of a patient, usually according to his computed tomography (CT) examination. For PMMA, the standard form is liquefied monomer and pulverized polymer. When mixed together, they form a plastic shell, and that process of prosthesis creation is performed during the surgery. Tailored implant form of this material is obtained preoperatively, when hardened plastic is cut to the shape from plastic block by a special numeric mill.

For the knitwear from Łódź, the standard was a plastic plate which was a section of a sphere, good enough for small or simple defects, especially covered by hair. But at the same time, it was hardly acceptable for patients with very big defects, with defects of complicated shapes, or in visible areas of the head [12].

It took some years to develop a technology allowing such shaping of the knitwear which was not only technologically possible but also economically acceptable for the customer, especially in Polish conditions [13]. The initial stage of the research was completed in 2007, and between February 2008 and May 2015 there were 251 prostheses implanted in various centers in Poland, Lithuania, Latvia, Russia and Brazil.

The purpose of our study has been to evaluate the influence of the cranioplasty on working ability of the group of our patients.

MATERIAL AND METHODS

The authors evaluated 112 patients after the cranioplasty with the katamnestic period longer than 6 months after the reconstructive operation. The patients were asked about their current employment during the control visits at the outpatient clinic when a routine assessment of

neurological condition was performed and their capability to work was assessed.

Three points in time were selected for the assessment purposes:

– before the defect (before the original defect or trauma),
– the date of the CT performed for prosthesis manufacturing (between 1 to 2.5 months before cranioplasty),
– the status of the patient 6 months after cranioplasty.

All 112 cranioplastic patients were evaluated, with 115 prostheses implanted (3 cases of double prostheses). The group consisted of 32 women and 80 men, aged 29–72 years old, of 45 years old on average. The causes of the defects consisted of benign tumors in 20 cases, vascular diseases in 42 cases, and trauma in 50 cases. The prostheses sizes ranged 15–168 cm^2. There were 2 cases of prosthesis removal in the early postoperative period because of an infection.

During the period between the CT scan necessary for the prosthesis and the reconstructive operation, the patients were observed in the outpatient clinic and during the period between the craniectomy and the cranioplasty, they were observed in the outpatient clinic or interviewed only. The time lapse between the defect and the cranioplasty ranged from 0 (for prostheses implanted during one procedure with craniectomy) to 98 months (with a mean of 14.8 months).

All the patients were classified according to capability to work as follows:

– Capable of working without limitations – patients without somatic difficulties as paralysis or paresis, aphasia and similar problems. As a basic concept it was assumed that the presence of the cranial defect was not a work barrier if there were no concomitant neurological deficits connected with the missing bone or with the origin of the defect.
– Capable of working but with limitations – patients with paresis, aphasia, epilepsy, or chronic headaches. Such patients could work in some limited manner, e.g., in a sheltered workshop (or work center).
– Incapable of working – individuals with neurological or other disabilities that precluded employment.

Such grouping of the patients originated in the Social Insurance Institution predication procedure [13] and was based on working ability of a person in direct relation to her/his education and the job as indicated in Polish regulations [14,15].

Each patient was classified to one of the groups above based on his or her health status only, disregarding the age (i.e., whether or not the patient was within the "working age" bracket).

RESULTS

Before the onset of the disease (or the trauma), all 112 patients were capable of working without limitations. Six pupils were not working, 8 adults were registered as unemployed and collecting unemployment benefits, 2 females were not working and not registered as unemployed, and 7 individuals had retired. There were 89 employed individuals.

During the period between the craniectomy and the cranioplasty, 88 patients were assessed as capable of working without limitations, 20 – with limitations, and 4 – as incapable. Two patients were employed (1 male and 1 female) and 9 were retired. Not working people were 101 persons (including 3 pupils during prosthetic CT scan). The female employed patient was classified into the group "without limitations." In her case, the period of time between the craniectomy and the cranioplasty amounted to 22 months, and she returned to work 8 months after the aneurysm surgery. She worked as an accountant. The male patient returned to work 6 months after the trauma. In his case, the period of time between the bone removal and reconstruction also amounted to 8 months, he was classified to the group "with limitations" (occupation – self employed at home). The rest of the patients, were not working during the period between craniectomy and cranioplasty.

Six months after the cranioplasty, 93 patients were assessed as capable of working without limitations, 16 – with limitations, and 3 as incapable of working. Forty-seven

patients were employed, 13 were retired, 2 were still students. Fifty persons did not work but were on long-term medical leaves or had applied for a disability pension.

Work capability after the cranioplasty did not change much and in all groups of patients some improvement was noted. There was no case of deterioration. In one case, the status assessed as "incapable" after the craniectomy was improved to "capable without limitations" after the cranioplasty and the patient returned to work as a priest. In 4 cases, the patients assessed as "capable with limitations" were assessed as "capable without limitations" after the reconstruction.

All the patients were asked for the self-assessment of the causes of not working. In a very simple questionnaire, 4 possible answers were given: fear of secondary injury in the defect site, unsatisfactory appearance, general symptoms (headache, epilepsy, paresis, etc.), other reasons such as fear of taking up a job, fear of an attempt to look for work, feelings of rejection).

The patients were also asked to identify the reason which was the most important. Among 101 non-retired patients who did not work during the period between the craniectomy and the cranioplasty, 96 (95%) indicated the fear of secondary injury as the most important reason for not working. After the cranioplasty, 49 out of 50 (98%) not working (and not retired) individuals also indicated the same cause as the major one.

Data was collected in the Tables 1, 2 and 3.

Table 1. Work capability and sex of analyzed patients with cranial defects and katamnestic period longer than 6 months after reconstructive operation

Time range analyzed	Respondents (N = 112)							
	capable of working without limitations		capable of working with limitations		incapable of working		working	
	F+M [n]	total [n (%)]	F+M [n]	total [n (%)]	F+M [n]	total [n (%)]	F+M [n]	total [n (%)]
Before the defect	32+80	112 (100.0)	0	0 (0.0)	0	0 (0.0)	26+63	89 (79.5)
1–2.5 months before cranioplasty	25+63	88 (78.6)	5+15	20 (17.9)	2+2	4 (3.6)	1+1	2 (1.8)
6 months after cranioplasty	26+67	93 (83.0)	4+12	16 (14.3)	2+1	3 (2.7)	14+33	47 (42.0)

F – females; M – males.

Table 2. Employment and type of work of analyzed patients with cranial defects and katamnestic period longer than 6 months after reconstructive operation

Time range analyzed	Respondents [n (%)]						
	pupils	retired	not working		working		total
			manual	office	manual	office	
Before the defect	6 (5.3)	7 (6.3)	7 (6.3)	3 (2.7)	55 (49.1)	34 (30.4)	112 (100.0)
1–2.5 months before cranioplasty	3 (2.7)	9 (8.0)	62 (55.4)	36 (32.1)	1 (0.9)	1 (0.9)	112 (100.0)
6 months after cranioplasty	2 (1.7)	13 (11.6)	34 (30.6)	16 (14.3)	24 (21.4)	23 (20.5)	112 (100.0)

Manual – "blue collars," office – "white collars."

Table 3. Reasons for avoiding employment and professional activity – answers of patients (in self-assessment) with cranial defects and katamnestic period longer than 6 months after reconstructive operation

Respondent not working	Work avoiding reason*				
	fear of secondary injury	unsatisfactory appearance	general symptoms	other	total
Before cranioplasty [n]	96	4	1	0	101
After cranioplasty [n]	49	0	1	0	50

* Included pupils and excluded retired.

DISCUSSION

It is very difficult to analyze the relationship between the cranial defect, reconstructive surgery and the return to work of the patient who was employed before the primary operation or trauma. One reason for this is the difficulty in the creation of a prospective protocol for such patients. Another reason is that it is difficult to compare various cranioplastic methods employed in various neurosurgical departments. In standard clinical practise, the number of such methods is usually reduced to a minimum to decrease the costs of treatment, and the selection of a method reflects the habits and preferences of practicing surgeons.

In the described group, only 2 patients out of 112 were in employment while they had the defect. Out of those who had cranioplasty performed, a half of them returned to work.

Some limitation in this paper seems to be the lack of detail data concerning the workplaces of the patients. Therefore it is difficult to analyze the problem from the fitness to work point of view. Such information has not been collected by the authors in database constructed when a new method of cranioplasty was introduced and when collection of adequate cases was started.

The choice of time points for the assessment of neurological status and the ability to work may always be criticized. Only the assessment before the craniectomy does not seem to provoke a discussion.

The authors chose the date of "cranioplastic" CT scan as the point in time before reconstruction for technical reasons. Such a CT scan was performed 1–2.5 months before cranioplasty. Prosthesis production takes usually 2–3 weeks after CT. Cranioplasties belong to a category of planned (not urgent) surgeries and their dates depend on various administrative factors in addition to the availability of the prosthesis. The third time point was chosen as 6 months after cranioplasty because that is the most common time point of the early assessment of many therapy results.

There are 3 main reasons for bone reconstruction. Cranial prosthesis is necessary to avoid a secondary trauma for the brain not covered by the bone. Another important factor is the esthetic aspect. A patient with the head deformed by the defect may be unable to fulfill his or her social role. But from the clinical point of view, the covering or esthetic functions of the prosthesis are of secondary importance when compared with the third factor, which is a chance to restore the correct value of intracranial pressure in particular and volume-pressure relation inside the skull in general. This restores the correct cerebral hemodynamics and has a major influence on the patient's recovery [16,17].

In the analyzed group, the cranioplasty improved neurological conditions and (in consequence) work capability only in a few patients. The esthetic function is very difficult to estimate. Post-craniectomy patients may correct it with hair or headwear to some degree. During the outpatient clinic visits, patients, especially females, tried to mask the presence of the defect in some way. However, the third rationale of the defect – missing bone cover seemed to have the major influence on giving up work despite the lack of objective contraindications. This factor

was also indicated as the prime reason by 95% of the patients before cranioplasty. It is shown in the Table 3.

The next issue which seems to be important is the classification of the patients according to their work capability. Such feature is not the same as capability to work as defined by various authors [18] because in such terms patients should be analyzed in connection with some given profession and/or workplace. Authors had not collected such data and patients had not been interviewed in this matter so only simple assessment was performed concerning general health condition and possible biological consequences of the disease leading to cranial defect and cranioplastic surgery. At that moment patients were divided into capable, incapable, capable with limitations similarly to fit, unfit and fit – subject to work modifications as presented in "Guidelines for fitness-to-work examinations" [19].

In Poland such all-inclusive system of return-to-work evaluation as described in literature [20] seems to be still missing so patient assessment may be performed correctly only as neurological problem.

Fitness to work is usually treated as a wide analysis of the relation between patient's abilities and workplace hazards, and authors of this paper performed a much more simple assessment of major disabilities and general working potential of own cases of the patients with cranial defects.

It is possible that the proportions of the patient numbers fit/unfit/may-be-fit as indicated by the current British authorities [20] and dividing them into capable/incapable/capable with limitations would give some different result.

CONCLUSIONS

The method of the cranial reconstruction which is beneficial to the patient and friendly for the neurosurgeon, with low complication ratio gives favorable prerequisites for restoring employment activity. In the analyzed group, before the defect, all the patients were capable of working without limitations and majority of them were employed. With the defect but before the reconstruction most patients were capable of working without limitations (according to strictly biological criteria and excluding psychological factors, workplace hazards and other factors) but hardly any of them worked. After the cranioplasty, the majority of patients were still capable of working, and a half of them worked. Not working people mentioned the fear of secondary injury as the major factor in any period analyzed.

Majority of patients with cranial defects are persons belonging to the group of the general population which is most active in the labor market (or has the highest labor force participation). Cranioplasty allows the rehabilitation of the affected individuals to resume their preoperational or pretraumatic employment activity, which is an outcome with a valuable socio-economic dimension.

Therefore, the cranioplasty in addition to the factors described earlier such as protective, esthetic and linked to the restoration of normal intracranial pressure, has also a multi-dimensional psychological aspect. That seems to be a significant reason for returning to work in the population of patients with cranial defects. But when individual factors of socio-economic nature are analyzed, a much bigger population has to be observed. Assessment of the relationship between returning to work and cranioplastic solution requires a multicenter study and a much longer observation period than 6 months.

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