Coll. Antropol. **35** (2011) Suppl. 2: 255–258
Professional paper

Efficancy of Decompressive Craniectomy in Treatment of Severe Brain Injury at the Rijeka University Hospital Centre

Dean Girotto[1], Darko Ledić[1], Goran Bajek[1], Romana Jerković[2] and Slavko Dragičević[1]

[1] Department of Neurosurgery, Rijeka University Hospital Center, University of Rijeka, Croatia
[2] Department of Anatomy, School of Medicine, University of Rijeka, Croatia

A B S T R A C T

Decompressive Craniectomy (DC) is a treatment option for severe brain injury (SBI). This method is applied when the growth of intracranial pressure (ICP) can no longer be controlled with conservative methods. DC belongs to class III »Guidelines« – »option« which has not clear clinical certainty. They do not correspond to »Standards« (class I) in treatment protocol for SBI, which is common in most neurotraumatological centers. We have analyzed retrospectively 95 patients with SBI who were admitted to the Clinical Hospital Centre Rijeka. All patients were managed based on a protocol of current Brain Trauma Foundations (BTF) Guidelines. 39 patients underwent DC while 34 patients underwent standard craniotomy. 22 patients did not undergo any surgical procedures. In each patient we analyzed ICP changes within the first 11 days and in that way we correlated them statistically with the initial Glasgow Coma Scale (GCS) and then with Glasgow Outcome Scale (GOS), after the end of the treatment. We particularly analyzed the outcome with reference to the time of the operation and the size of DC. The standard measurement of ICP shows statistical significance in recovery in the group without DC after 5 days of intensive treatment, when the pressure is stabilized between 20–25 mm Hg. The stabilization of ICP in the DC group is observed already after 3 days of intensive treatment. Furthermore, better functional recovery according to GOS, which is statistically significant, was observed in patients who underwent DC where the area of craniectomy was larger than 25 cm2, within the first 24 hours from the time of injury. The use of DC considerably reduces the need for CT check-ups. Increase in the number of encephalocele was noted, which is to be expected considering that dural decompression is used in DC procedure. The results of our study indicate that the utilization of DC is characterized with lower mortality and better functional recovery if it is applied at an early stage of treatment and if the size of DC is satisfactory.

Key words: *decompressive craniectom, guidelines, mortality, severe brain injury*

Introduction

Decompressive Craniectomy (DC) is a treatment option for severe brain injury (SBI). Namely, a number of studies have indicated the importance of DC in reducing morbidity and mortality in patients with SBI[1–4]. However, this method has not yet been listed as Standard, i.e., Level I of the International protocol but is cautiously recommended as a treatment option for selected patients[5–7]. SBI is a large public health problem with a high mortality rate, especially in younger patients (up to 40 years of age)[8,9]. DC lowers the intracranial pressure (ICP) and enhances neurological recovery in animal models with SBI[10–12]. In certain studies there was improvement and better recovery in patients[1–4,13–15], while in other studies this was not the case[16,17]. Due to development of cerebral edema, which most often leads to fatal outcome, and the fact that conservative methods of treatment do not always produce desired results, DC is classified as recommendation Level III, i.e., a treatment option for SBI[5–7]. Published literature implies that the method is occasionally used. What is known about damaging effects of subsequent brain injury for which there is no ideal treatment still poses difficult questions for scientists and doctors[8,9]. However, because it maintains a moderate degree of clinical certainty, DC is not classified as standard

Received for publication June 17, 2011

in guidelines for treatment of SBI. Therefore, many neuro-traumatological centers do not use it for this pathology. The perception of DC as a high-risk invasive treatment compared to non-surgical treatment arises from the lack of extensive studies and published data on successfulness of the procedure. In the available literature for SBI as one of the indications for DC, so far there has not been a single large randomized study, only the ones for neurological and cardiovascular disorders. Because of the lack of definitive evidence and clear recommendations for use of DC in SBI treatment, additional clinical studies for application of this treatment for SBI are needed. The aim of this study is to analyze prospectively gathered data obtained from SBI patients managed at the Clinical Hospital Centre Rijeka, and perform comparative analysis in relation to the applied method of treatment and contribution to better functional outcome. This surgical method is often followed by complications that range from 6–7% for local and central infections, to 15–20% for encephalocele and hydrocephalus[1–4,14,18–22].

Patients and Methods

The study included 95 patients with SBI, who were admitted to and treated at Clinical Hospital Centre Rijeka between 1 January 2002 and 31 December 2008. In all patients the following criteria were applied: SBI, Glasgow Coma Score (GCS)[23] equal to or less than 8, CT-determined SBI with a brain edema, extradural and/ or subdural brain hemorrhage with a midline shift of maximum 1 cm, age between 15 and 65 years, hospitalization within 48 hours from the time of the injury. An intraventricular ICP monitoring system was set up with all patients. GCS was routinely monitored upon admittance. Patients with SBI and bilateral nonreactive pupils larger than 5 mm, and patients with a severe neck marrow injury and intracranial hemorrhage where midline shift was more than 1 cm, were excluded from the study. In all patients ICP changes were analyzed in first 11 and functional recovery was monitored with Glasgow Outcome Score scale at discharge from the hospital with a follow-up due in six months[24]. All patients were treated in the Intensive Care Unit (ICU) according to standard Guidelines for SBI treatment[5–7]. Out of 95 patients with SBI, 39 were treated for malignant cerebral edema with or without extra-axial hemorrhage using DC. The applied DC involved unilateral bone fragment removal and duroplasty was performed with the help of temporal muscle / fascia. In 34 patients standard craniotomy was performed due to borderline results of compression effect of medial shift of 1 cm, but with a large haemorrhage area. 22 patients did not undergo any surgical procedure, except that standard intraventricular ICP monitoring was set up.

Statistics

The numerical data is represented with median and range, and with categorical absolute (N) and relative (share %) of incidence. The comparison between the numerical data was done by non-parametric tests, while the comparison of the distribution between the groups was analyzed with χ^2-test and Fisher's exact test.

Results

Statistical analysis has shown that with conservative treatment monitoring the ICP dynamics, there was significant recovery after five days, when ICP is stabilized

TABLE 1
THE VALUES OF INTRACRANIAL PRESSURE (ICP) ON THE FIRST, THIRD AND FIFTH DAY IN RELATION TO PERFORMED DECOMPRESSIVE CRANIECTOMY, EXPRESSED IN ABSOLUTE AND RELATIVE INCIDENCE(N, %)

ICP		DC not performed		DC within 24 hours		DC after 24 hours		P – x^2 test
		No of cases	%	No of cases	%	No of cases	%	
1. day	< 25 mmHg	45	80.4	12	30.8	0	0	0.001
	> 25 mmHg	11	19.6	18	46.2	9	23.0	
3. day	< 25 mmHg	14	25.0	18	46.2	1	2.5	
	> 25 mmHg	42	75.0	12	30.8	8	20.5	
5. day	< 25 mmHg	30	53.6	25	64.2	2	5.1	
	> 25 mmHg	26	46.4	5	12.8	7	17.9	

TABLE 2
GOS VALUES IN RELATION TO THE AREA OF DECOMPRESSIVE CRANIECTOMY, EXPRESSED IN ABSOLUTE AND RELATIVE INCIDENCE (N, %)

Area of DC	GOS 1		GOS 2–3		GOS 4–5		TOTAL		P – χ^2 test
	No of cases	%	No of cases	%	No of cases	%	No of cases	%	
< 15 cm^2	8	20.5	6	15.4	0	0	14	35.9	0.001
15–25 cm^2	3	7.7	7	17.9	4	10.3	14	35.9	
> 25 cm^2	0	0	1	2.6	10	25.6	11	28.2	

TABLE 3
THE NUMBER OF CT FOLLOW-UP EXAMINATIONS IN RELATION TO PERFORMED DECOMPRESSIVE CRANIECTOMY, EXPRESSED IN ABSOLUTE AND RELATIVE INCIDENCE (N, %)

Decompressive craniectomy		DC not performed		DC within 24 hours		DC after 24 hours		All groups together		P – χ^2 test
		No of cases	%	No of cases	%	No of cases	%	No of cases	%	
Number of control CT scans	2	26	27.4	12	12.6	0	0	38	40.0	0.003
	3	28	29.5	15	15.8	5	5.3	48	50.5	
	4	3	3.2	1	1.1	4	4.2	8	8.4	
	5	1	1.1	0	0	0	0	1	1.1	

TABLE 4
OCCURRENCE OF COMPLICATIONS IN RELATION TO PERFORMED DECOMPRESSIVE CRANIECTOMY, EXPRESSED IN ABSOLUTE AND RELATIVE INCIDENCE (N, %)

Decompressive craniectomy		DC not performed		DC within 24 hours		DC after 24 hours		TOTAL		P-χ^2 test
		No of cases	%	No of cases	%	No of cases	%	No of cases	%	
No complications		46	48.4	13	13.7	2	2.1	61	64.2	0.001
Complications	Bleeding	2	2.1	2	2.1	2	2.1	6	6.3	
	Brain fungus	0	0	13	13.7	2	2.1	15	15.8	
	Infection	3	3.1	1	1.1	1	1.1	5	5.3	
	Death	5	5.2	1	1.1	2	2.1	8	8.4	

between 20–25 mm Hg, whereas in patients where additional DC stabilization of ICP was performed, the recovery can already be observed after 3 days of treatment (Table 1). Furthermore, better functional recovery according to GOS is statistically clearly expressed and visible in patients who underwent DC where the area of craniectomy was larger than 25 cm^2, especially if it was performed within the first 24 hours after admittance (Table 2). Analysis of the number of radiological follow-up examinations (CT) indicates that patients with DC require significantly fewer CT follow-up examinations (Table 3). However, using DC as optional additional treatment of SBI has as a consequence surgical complications. Table 4 shows complications in patients who underwent DC. Increase in the number of encephalocele was noted, which is to be expected considering that dural decompression is used in DC procedure (Table 4).

Discussion

The crucial question concerning the use of DC in SBI treatment is whether decompressive craniectomy helps to control the ICP in early posttraumatic period during intensive treatment, and whether its potential benefits are greater than risks of existing complications. Data in the literature indicate that in short-term monitoring there is improvement in ICP control and survival rate. However, a number of results indicate that there are complications in early stages, as well as in long-term monitoring. In our study we have monitored only the short-term outcome of intensive SBI treatment. Important indicators, such as ICP monitoring and survival rate, show the importance and need of the use of DC, which is in accordance with the results of other authors. In the conducted study a small number of complications were registered, such as the occurrence of encephalocele, haemorrhage and infection, but fatal outcome was more frequent in patients who had not undergone DC. Long-term monitoring of SBI patients who underwent DC additionally[1–3,18–20], the results of cranioplasty of a defect retained after DC, and of neurorehabilitation, as well as a possible subsequent internal hydrocephalus have not been the subject of this study and will be shown subsequently.

Conclusion

The results in treatment of SBI using DC in our study indicate the importance and need of the use of DC, because it contributes to statistically significant more successful treatment of SBI. Additional use of DC in relation to non-surgical methods described in Level I of SBI protocol of the »Guidelines« indicates the merit of the procedure. It is a promising procedure for a selected group of SBI patients because ICP values are lowered far sooner than without DC. All that has as a consequence lower mortality and better functional recovery if it is applied at an early stage of treatment and if the size of DC is satisfactory. In order for DC to become classified in standard guidelines for SBI treatment, an analysis of a large number of SBI patients is necessary, in several referential neurotraumatological centres according to strictly estab-

lished criteria and the choice of patients. Such analysis would help to standardize the technique for the size of DC and the method of dural decompression. Considering the variety of data in studies so far, we believe that the conducted research will help many in their choice of this surgical method in SBI treatment protocol.

REFERENCES

1. ALBANESE J, LEONE M, ALLIEZ JR, KAYA JM, ANTONINI F, ALLIEZ B, MARTIN C, Crit Care Clin, 31 (2003) 2535. — 2. AARABI B, HESDORFFER DC, AHN ES, ARESCO C, SCALEA TM, EISENBERG HM, J Neurosurg, 104 (2006) 469. — 3. ZIAI WC, PORT JD, COWAN JA, GARONZIK IM, BHARDWAJ A, RIGAMONTI D, J Neurosurg Anesthesiol, 15 (2003) 25. — 4. JIANG JY, XU W, LI WP, XU WH, ZHANG J, BAO YH, LUO QZ, J Neurotrauma, 22 (2005) 623. — 5. BULLOCK R, CHESTNUT RM, CLIFTON G, GHAJAR J, MARION DW, NARAYAN RK, NEWELL DW, PITTS LH, ROSNER MJ, WILBERGER JW, J Neurotrauma, 13 (1996) 638. — 6. BULLOCK R, CHESNUT R, GHAJAR J, GORDON D, HARTL R, NEWELL DW, SERVADEI F, WALTERS BC,WILBERGER JE, Neurosurgery 58 (2006) 1. — 7. BTF, AANS, CNS, AANS/CNS, JOINT SECTION ON NEUROTRAUMA AND CRITICAL CARE, BRATTON SL, CHESTNUT RM, GHAJAR J, MCCONNELL HAMMOND FF, HARRIS OA, HARTL R, MANLEY GT, NEMECEK A, NEWELL DW, ROSENTHAL G, SCHOUTEN J, SHUTTER L, TIMMONS SD, ULLMAN JS, VIDETTA W, WILBERGER JE, WRIGHT DW, J Neurotrauma, 24 (2007) 1. — 8. GHAJAR NJ, HARIRI RJ, NARAYAN RK, IACONO LA, FIRLIK K, PATTERSON RH, Crit Care Med, 23 (1995) 560. — 9. MURRAY GD, TEASDALE GM, BRAAKMAN R, COHADON F, DEARDEN M, IANNOTI F, KARIMI A, LAPIERRE F, MAAS A, OHMANJ, PERSON L, SERVADEI F, STOCCHETTI N, TROJANOWSKI T, UNTERBERG A, Acta Neurochir, 141 (1999) 223. — 10. HARRINGTON ML, BAGLEY RS, MOORE MP, TYLER JW, Am J Vet Res, 57 (1996) 1659. — 11. ZWECKBERG K, EROS C, ZIMMERMANN R, KIM SW, ENGEL D, PLESNILA N, J Neurotrauma, 23 (2006) 1083. — 12. PLESNILA N, Prog Brain Res, 161 (2007) 393. — 13. KUNZE E, MEIXENSBERGER J, JANKA M, SORENSEN N, ROOSEN K, Acta Neurochir Supll, 71 (1998) 16. — 14. GUERRA WK, GAAB MR, DIETZ H, MUELLER JU, PIEK J, FRITSCH MJ, J Neurosurg, 90 (1999) 187. — 15. MUNCH E, HORN P, SCHURER L, PIEPGRAS A, PAUL T, SCHMIDEK P, Neurosurgery, 47 (2000) 315. — 16. GAAB MR, RITTIERODT M, LORENZ M, HEISSLER HE, Acta Neurochir Suppl, 51 (1990) 326. — 17. UCAR T, AYUZ M, KAZAN S, TUNCER R, J Neurotrauma, 22 (2005) 1311. — 18. YANG XJ, HONG GL, SU SB, YANG SY, Chin J Traumatol, 6 (2003) 99. — 19. QUINN TM, J. J. TAYLOR JJ, MAGARIK JM, VOUGHT J, KINDY MS, ELLEGALA DB, Acta Neur Scand, 123 (2011) 239. — 20. INTISO D, LOMBARDI T, GRIMALDI G, IAROSSI A, TOLFA M, RUSSO M, DI RIENZO F, Brain Inj, 25 (2011) 379. — 21. MALMIVAARA K, KIVISAARI R, HERNESNIEMI J, SIIRONEN J, Eur J Neurol, 18 (2011) 656. — 22. WEINER GM, LACEY MR, MACKENZIE L, SHAH DP, SHAH DP, FRANGOS SG, GRADY MS, KOFKE A, LEVINE J, SCHUSTER J, LE ROUX PD, Neurosurgery 66 (2010) 1111. — 23. TEASDALE G, JENNETT B, Lancet, 13 (1974) 81. — 24. TEASDALE GM, PETTIGREW LEL, WILSON JT, MURRAY G, JENNET B, J Neurotrauma 15 (1998) 587.

D. Ledić

Department of Neurosurgery, Rijeka University Hospital Center, University of Rijeka, T. Strižića 3, 51000 Rijeka, Croatia
e-mail: darko.ledic@gmail.com

UČINKOVITOST LIJEČENJA TEŠKIH OZLJEDA MOZGA PRIMJENOM DEKOMPRESIVNE KRANIEKTOMIJE U KBC RIJEKA

SAŽETAK

Dekompresivna kraniektomija (DK) je opcija liječenja teške ozljede mozga (TOM). Ovu metodu primjenjujemo kad se više ne može kontrolirati rast intrakranijskog moždanog tlaka (IMT) konzervativnim metodama. DK spada u III razinu smjernica – »opcije« koje nemaju jasnu kliničku sigurnost. One se ne uklapaju u standard I razine protokola za liječenje TOM koja je inače uobičajna u najvećem broju neurotraumatoloških centara. U našoj studiji obradili smo retrospektivno 95 bolesnika sa TOM zbrinutih u KBC Rijeka. Pacijenti su zbrinuti po protokolu »Brain Trauma Foundation« (BTF) za TOM. 39 pacijenata podvrgnuto je primjeni DK dok je u 34 pacijenta učinjena standardna kraniotomija. U 22 pacijenta nije učinjen nikakav kirurški zahvat. Kod svih bolesnika analizirali smo promjene IMT u prvih 11 dana te statistički korelirali sa inicijalnim »Glasgow Coma Scale« (GCS), i potom sa »Glasgow Outcome Scale« (GOS) po završetku liječenju. Posebno smo analizirali ishod u odnosu na vrijeme operacije i površinu DK. Vrijednosti IMT pokazale su da u pacijenta gdje nije učinjena DK stabiliziranje IMT (između 20–25 mmHg) nastupa nakon 5 dana intezivnog liječenja dok u pacijenata s DK spomenuti oporavak nastupa već trećeg dana liječenja. Također bolji funkcionalni oporavak po GOS, koji je statistički jasno izražen, vidljiv je kod bolesnika kod kojih je učinjena DK-a površine veće od 25 cm^2 u prvih 24 sata. Primjenom DK smanjen je broj CT kontrola. Evidentiran je porast broja encefalokela što je i razumljivo s obzirom da se u postupku DK vrši i duralna dekompresija. Rezultati istaživanja ukazuju na važnost DK koju karakteriziraju smanjenje smrtnosti i bolji funkcionalni oporavka ukoliko se provodi u ranoj fazi liječenja i odgovarajućom površinom DK.