CNS 2018 ANNUAL MEETING
HOUSTON, TEXAS
OCTOBER 6-10, 2018

Effect of Dural Substitute and Technique on Cranioplasty Operative Metrics: A Systematic Literature Review

Alankrita Raghavan BS; James Wright MD; Christina Huang Wright MD; Martha Sajatovic MD
University Hospitals Cleveland Medical Center, Cleveland, Ohio

University Hospitals

Introduction

Decompressive craniectomy is performed to relieve elevated intracranial pressure. Dural substitutes are often used in the subsequent cranioplasties but there is little concensus on which substitutes to use or the utility of these substitutes in improving outcomes and reducing complications.

Learning Objectives

By the conclusion of this session participants should be able to: 1) discuss the different options of duraplasty, 2) discuss the morbidity profile of each dural substitute, 3) discuss the literature supporting duraplasty.

Methods

This systematic literature review examined original reports on outcomes with the use of dural substitutes and was intended to compare different techniques. This review used PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). PubMed, Web of Science, Ovid, SCOPUS, and the Cochrane databases were queried for articles using the following search-terms: “duraplasty and craniectomy” or “duraplasty and cranioplasty” or “dural substitute and craniectomy” or “adhesion and craniectomy.” The reference lists of selected articles were screened for additional articles. Articles met inclusion criteria if the abstract was in English, the surgery investigated was supratentorial, and the procedure was performed in

Results

A total of 10 publications met criteria. All were retrospective cohort or case series. A total of 975 patients were included from 2006 to 2018. The majority of adhesion-preventive dural substitutes used were synthetic grafts, although the use of collagen-derived biological grafts was described in four studies. Within each report, the use of adhesion-preventing dural substitutes was associated with statistically significant reduction in operative time and blood loss. The majority of studies did not report a significant difference in complications, although Huang et al. found increased risk of infection in the initial craniectomy with the non-absorbable dural substitute Neuro-Patch.

Table 1: Summary of Studies Reporting Use of Dural Substitutes

First Author (year)	Location Single/Multi Institution Etiology	Type of Intervention*	Type of Study	Experimental			Control			P-value operative time	P-value blood loss
				Sample Size	Operative Time (minutes)	Blood Loss (mL)	Sample Size	Operative Time (minutes)	Blood Loss (mL)		
Sun (2018)	Tianjin, China Single Center Severe TBI	Bovine pericardial membrane	Retrospective cohort study	195	96.6	139.63	192	128.4	205.81	<0.001	<0.001
Kamalabai (2018)	Kerala, India Single Center Not Defined	Double-Layer G-Patch vs. single-layer G-patch	Retrospective Cohort Study	35	124.12	88	35	144.2	106.57	0.0009	0.0001
Pierson (2016)	Missouri, USA Single Center Mixed Etiology	Collagen matrix (DuraGen) w/ ePTFE	Case Series	39	132.5	112					
Khalili (2016)	Shiraz, Iran Single Center Not Defined	OrthoWrap™#	Retrospective Cohort Study	44	113.3	182.1	49	146.9	270.6	<0.001	0.043
Wang (2015)	Shandong, China Single Center Not defined	Dacron Heart Patch and Artificial dura patch	Retrospective Cohort Study	23	90.43		30	130.12		<0.01	
Oladunjoye (2013)	Sacramento, USA Single center Mixed Etiology	Collagen matrix (DuraGen) and gelatin (Gelfilm)	Case Series	62	120.06	213					
Huang (2011)	Kaohsiung, Taiwan Single Center TBI	NeuroPatch	Retrospective Cohort Study	50	232.8	303.8	85	211.2	316.4	0.394	0.740
Horaczek (2008)	Berlin, Germany Two Centers Mixed Etiology	Collagen matrix (Duragen)	Randomized Control Trial	18	112		16	139.3		>0.05	
Lee (2007)	Seoul, Korea Single Center Mixed Etiology	Silastic sheet	Retrospective Cohort Study	24	129.8	280.8	26	172.5	452.3	0.003	0.022
Vakis (2006)	Crete, Greece Single Center Mixed Etiology	ePTFE	Retrospective Cohort Study	23	60.43	58.04	29	79.66	92.41	<0.005	<0.005

*The control group for cohort studies was decompressive craniectomy without the use of dural substitutes unless otherwise specified.
Control group: pericranial duraplasty

Table 2: Types of grafts used as reported by study authors

First Author (year)	Graft Type	Graft Name (material)
Sun (2018)	Xenograft	Bovine pericardium
Kamalabai (2018)	Synthetic	G-Patch (Polypropylene)
Pierson (2016)	Xenograft	DuraGen (Bovine-derived collagen)
	Synthetic	Preclude (ePTFE)
Khalili (2016)	Synthetic	Orthowrap (Polylactic acid)
Wang (2015)	Xenograft	DuraMax (Collagen)
	Synthetic	Dacron patch (Ethylene glycol and terephthalic acid)
Oladunjoye (2013)	Xenograft	DuraGen (Bovine-derived collagen)
	Synthetic	GelFilm (Gelatin film)
Huang (2011)	Synthetic	NeuroPatch (Polyesterurethane)
Horaczek (2008)	Xenograft	DuraGen (Bovine-derived collagen)
Lee (2007)	Synthetic	Silastic (Silicone elastomer sheet)
Vakis (2006)	Synthetic	Preclude (ePTFE)

Conclusions

Use of a dural substitute in decompressive craniectomy is associated with two important potential advantages: it acts as a structural and protective barrier for the cortex and provides a dissection plane during the subsequent cranioplasty. The results of this literature review reveal that the use of dural substitutes, both biologic and synthetic, in decompressive craniectomy and cranioplasty is associated with decreased operative time and decreased blood loss compared to craniectomy without the use of a dural substitute. One technical difference that arose from the studies was the use of single-layer versus dual-layer dural substitute. Recent studies reported favorable outcomes with the use of a multi-layer approach with both a dural substitute and an adhesion-preventive material. There is limited evidence on the quantitative long-term outcomes associated with use of dural substitutes and few studies report on comparative rehabilitative and functional outcomes. The long-term implications of these methods are unclear.

Table 3: Summary of studies reporting perioperative complications during cranioplasty

First Author (year)	Infection n(%)		Hematoma n(%)		Extra-axial Fluid Collection n(%)		Seizure n(%)		Hydrocephalus n(%)		CSF Leak n(%)	
	Control vs Exp		Control vs Exp		Control vs Exp		Control vs Exp		Control vs Exp		Control vs Exp	
Sun (2018)	24 (12.50) OR 2.43	11 (5.64) p=.021	25 (13.02) OR 3.349	8 (4.10) p=.004			20 (10.42) OR 3.705	6 (3.08) p=.007			25 (13.02) OR 2.689	10 (5.13) p=.012
Kamalabai (2018)		0 (0)		0 (0)		0 (0)				5 (14.2)*		
Pierson (2016)		2 (5.1)^				9 (23.1) 2 (5.1)^		3 (7.7)		0 (0)**		
Khalili (2016)	2 (4.54)	3 (6.12) p=.263										
Wang (2015)	0 (0)	0 (0)	0 (0)	0 (0)								
Oladunjoye (2013)		4 (6.5)^		1 (1.6)		8 (12.9)				5 (8.1)		
Huang (2011)	6 (7.06)	4 (8.00) p=1.000	1 (1.18)	1 (2.00) p=1.000	0 (0)	1 (2.00)					4 (4.71)	6 (12.00) p=.172
Horaczek (2008)					(58)	(13)						
Lee (2007)	1(3.8)	1(4.1)										
Vakis (2006)	0	0										

* Required intraoperative ventricular drain placement for CSF drainage
** Regarding hydrocephalus, 4 (10.3%) required shunt insertion before cranioplasty and 1 (2.6%) at time of cranioplasty. No shunts were placed after cranioplasty.
^ Required reoperation

References

1. Huang YH, Lee TC, Chen WF, Wang YM. Safety of the nonabsorbable dural substitute in decompressive craniectomy for severe traumatic brain injury. J Trauma - Inj Infect Crit Care. 2011;71(3):533-537. doi:10.1097/TA.0b013e318203208a.
2. Pathrose Kamalabai R, Nagar M, Chandran R, et al. Rationale Behind the Use of Double-Layer Polypropylene Patch (G-patch) Dural Substitute During Decompressive Craniectomy as an Adhesion Preventive Material for Subsequent Cranioplasty with Special Reference to Flap Elevation Time. World Neurosurgery. 2018.
3. Wang F, Xue Y, Zhao SS, Yang TJ, Song HQ, Liu H. Suturing-Free Artificial Dura with Dacron Heart Patch in Decompressive Craniectomy and Cranioplasty. Indian J Surg. 2015;77:1008-1011. doi:10.1007/s12262-014-1111-9.
4. Pierson M, Birinyi P V., Bhimireddy S, Coppens JR. Analysis of Decompressive Craniectomies with Subsequent Cranioplasties in the Presence of Collagen Matrix Dural Substitute and Polytetrafluoroethylene as an Adhesion Preventative Material. World Neurosurg. 2016;86:153-160. doi:10.1016/j.wneu.2015.09.078.
5. Oladunjoye AO, Schrot RJ, Zwienenberg-Lee M, Muizelaar JP, Shahlaie K. Decompressive craniectomy using gelatin film and future bone flap replacement. J Neurosurg. 2013;118(4):776-782. doi:10.3171/2013.1.JNS121475.
6. Sun H, Wang H, Diao Y, et al. Large retrospective study of artificial dura substitute in patients with traumatic brain injury undergo decompressive craniectomy. Brain Behav. 2018;0(0):e00907. doi:10.1002/brb3.907.