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ORIGINAL RESEARCH

Role of intraoperative abdominal fat augmented duroplasty in spinal intradural tumors for prevention of CSF related complications

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ABSTRACT

Aim: To evaluate the role of intraoperative abdominal fat augmented duroplasty in spinal intradural tumors for prevention of CSF related complications.

Material and methods: The present prospective interventional study was conducted among 20 patients with an IST were operated, who attended Bangur Institute of Neurosciences, IPGME & R and SSKM Hospital, Kolkata during February 2021 to April 2022.After endotracheal intubation and line placement inthe supine patient, the left paraumbilical area is prepared and draped. Fat was harvested though a 2 cmparaumbilical incision. The harvested fat isplaced in antibiotic saline in a sterile cup until neededfor closure.All patients had neurophysiologic monitoring throughoutthe operation. Once the tumor was resected, the durawas closed with 5-0 Prolen stitches in a running fashion.Any evidence of a CSFleak or pseudomeningocele was evaluated prospectively. The fat-tissue dynamics on postoperative MRIs were also assessed.

Results: The hospital stay lasted anywhere from 2 to 11 days (on average 5 days), with follow-up lasting anywhere from 1 to 12 months. Despite postoperative irradiation and treatment, one patient, a lady in her mid-40s with a grade III conus/cauda astrocytoma, died 1 year later as a result of disease progression and CSF seeding throughout her neuraxis. During follow-up, no evidence of tumour recurrence was seen in any other patient.No sign of a CSF leak or a pseudomeningocele was seen on physical examination or neuroradiologic follow-up.

Conclusion: The use of autologous fat grafting in the future enables a watertight dural closure and eliminates the dead space generated by surgical exposure, muscle dissection, and bone removal.

Keywords: Intradural tumors, CSF, Complications, Harvested Fat

INTRODUCTION

Only around 15% of malignancies in the central nervous system are found intraspinally. The majority of these tumours are benign, with 60% of them appearing extradurally (ED), 30% happening intraduralextramedullarly (ID-EM), and only 10% occurring as true intramedullary spinal cord cancers (IMSCT). While surgery is still the most common treatment for many of these lesions, radiation and chemotherapy are becoming increasingly important in the treatment of recurrent and multilocular disease[1].

Following resection of intraduralextramedullary spinal tumours (IEST) and intradural intramedullary spinal tumours (IIST), the incidence of CSF-related complications (i.e., CSF leak, pseudomeningocele, and meningitis) after intradural spinal tumour surgery (IST)

remains high[2-4]. In 17.6% of instances, postoperative CSF leak after surgery in the cerebellopontine angle has been documented.[5] Cerebrospinal fluid leakage can cause severe morbidity, including meningitis and the development of pseudomeningocele later in life. The placement of a spinal fluid drain and the injection of prophylactic or therapeutic antibiotics are common treatments. Surgical reexploration may be required in cases of persistent CSF leakage[5].

Surgeons have described abdominal free fat grafting as a successful way to repair posterior fossa deficits after retrosigmoid and translabyrinthine craniotomies[6]. Mayfield demonstrated that autologous fat transplants act as an effective water sealant, prevent scar formation, and do not cling to neural elements; the fat persists for a long time and becomes revascularized; the approaches presented by the author are an extension of Mayfield's results. Mayfield advocated placing a fat "plug" into each dural defect in the lumbar region for dural rips.A separate incision in the normal dura close to the dural rupture was made to pass a suture attached to the fat plug, which was then dragged into the dural tear. To bind the fat plug to the surrounding dura, a few sutures may be used. Sutures are used to close the surgical incision adjacent to the dural tear. One of Mayfield's patients who was treated this way acquired a postoperative neurological deficit[7].

Despite Mayfield's[7] recommendations many yearsago to use a fat graft to prevent potentiallylife-threatening CSF complications, the practice did not gain routineuse for those undergoing surgeryfor ISTs. Hence we conducted this study to evaluate the role of intraoperative abdominal fat augmented duroplasty in spinal intradural tumors for prevention of CSF related complications.

MATERIAL AND METHODS

The present prospective interventional study was conducted among 20 patients with an IST were operated, who attended Bangur Institute of Neurosciences, IPGME & R and SSKM Hospital, Kolkata during February 2021 to April 2022. Subjects who didn't give consent, were excluded from the study.

OPERATING TECHNIQUE

After endotracheal intubation and line placement inthe supine patient, the left paraumbilical area is prepared and draped. Fat was harvested though a 2 cmparaumbilical incision. The harvested fat isplaced in antibiotic saline in a sterile cup until neededfor closure.

All patients had neurophysiologic monitoring throughoutthe operation. Once the tumor was resected, the durawas closed with 5-0 Prolen stitches in a running fashion.If the incision was in the midline, the Valsalva maneuverwas done at 30 cm H20 for 5–10 seconds to ensurethat it was watertight. If any area in the suture line leaked CSF, an additional suture was placed there and a piece offat tissue was cut and positioned inside the stitch, which was then tightened. This maneuver reinforced the dural closure. The same Valsalva maneuver was repeated until there were no more leaks. If the dural incision was T-shaped (i.e., for dumbbell, intra/ extradural, foraminal tumors), or Y-shaped (i.e.,for sacral canal/foraminal tumors), the dural incision inthe midline and its T or Y extension over the nerve rootwere closed in running fashion with 5-0 Prolen. Multiplepieces of fat tissue were then incorporated into single additional dural sutures to achieve watertight closure and reinforce the dural suture. When suturing was complete, a layer of fat tissue 6–8mm thick was placed over the entire exposed dura to obliterate the dead space that remained after a laminectomy or face tectomy.

The fat tissue allograftnicely conformed to the allotted space and serves as filler. The fat graft also created small pressure onto the dural sutureline, lessening the chance of CSFseepage and pseudomenigocele. Inother words, the graft prevented apotential low-pressure space into

which CSF may migrate and form a pseudomeningocele, later producinga CSF leak. Fibrin glue was then applied over the graft. Themuscle, fascia, subcutaneous tissue,and skin layers are then closedin the usual fashion.

EVALUATION

Any evidence of a CSFleak or pseudomeningocele was evaluated prospectively. The fat-tissue dynamics on postoperative MRIs were also assessed. The patients' demographics, the tumors' histology,the degree of tumor resection, and neurological outcomeswere evaluated.All patients underwent postoperative MRI scans withand without contrast in the hospital 2 months after surgery and then during each follow-up.The fat-tissue dynamics on postoperative MRIs were also assessed. The patients' demographics, the tumors' histology,the degree of tumor resection, and neurological outcomeswere evaluated.
Data was collected and subjected to statistical analysis.

STATISTICAL ANALYSIS

It was done using SPSS software version 24.

RESULTS

Table 1 present the IST series among the study subjects.Out of 20 subjects, there were 8 males and 12 females. IIST and IEST was revealed in 5 and 15 subjects respectively. IIST comprising 2 Astrocytoma, 1 Anaplastic astrocytoma, 1 Hemangioblastoma and 1 Ependymoma(Grade II) while IEST consisted of 8, 4 and 3 Schwannoma, Meningioma and MyxopapillaryEpendymomas respectively.

Table 1: IST Series

IST Location	Tumor type	N	Gender	Age (Sex)	Level
IIST	Astrocytoma	2	M F	56 62	T1-T2 T3
	Anaplastic astrocytoma	1	F	44	T12-L1
	Hemangioblastoma	1	F	31	C1
	Ependymoma (Grade II)	1	M	45	T12
IEST	Schwannoma	8	M	66	C1-C2
			F	51	C1-C2
			F	62	C2-C3
			M	57	T9-T10
			M	73	S1-S2
			M	54	L4-L5
			F	65	L2
			M	70	T1
	Meningioma	4	F	71	C2-C3
			M	44	C1-C2
			F	77	T5-T6
			F	68	L2
	MyxopapillaryEpendymomas	3	F	39	L3
			F	46	L4
			F	54	L4

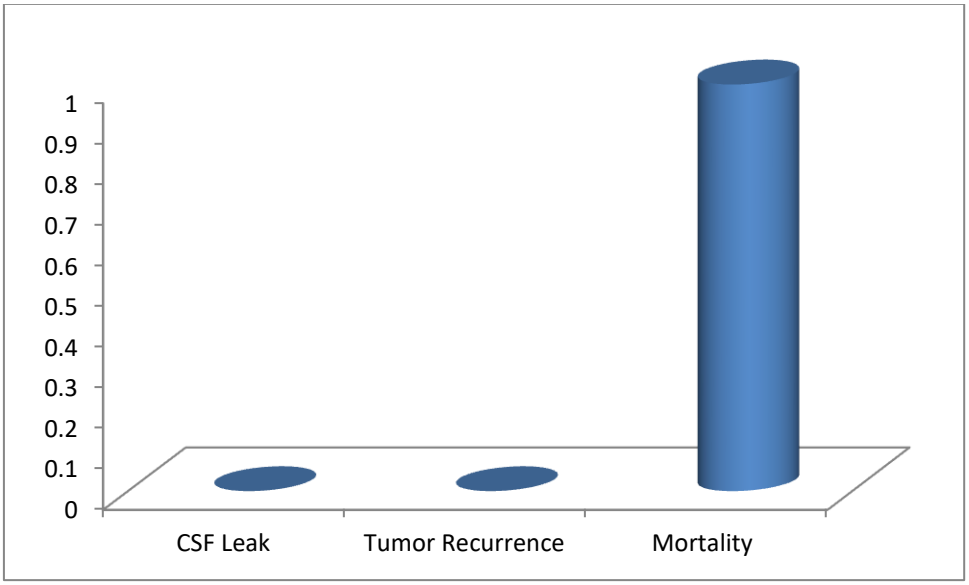
IEST=intraduralextramedullary, spinal tumors; IIST=intradural intramedullary spinal tumors; IST=intradural spinal tumors, M: male, F: female

The hospital stay lasted anywhere from 2 to 11 days (on average 5 days), with follow-up lasting anywhere from 1 to 12 months. Despite postoperative irradiation and treatment, one

patient, a lady in her mid-40s with a grade III conus/cauda astrocytoma, died 1 year later as a result of disease progression and CSF seeding throughout her neuraxis. During follow-up, no evidence of tumour recurrence was seen in any other patient. After this patient, all subsequent patients got a fat autograft at the time of dural closure, and no sign of a CSF leak or a pseudomeningocele was seen on physical examination or neuroradiologic follow-up. There were no difficulties associated with the fat harvest site.The fat tissue usually exhibited signs of considerable resorption on the second postoperative MRI, 2 months after surgery, and the 1-year follow-up MRI scans in all patients showed that the fat was completely reabsorbed(Table 2).

Table 2: Complications among the study subjects

Complications	N	%
CSF Leak	0	0
Tumor Recurrence	0	0
Mortality	1	5



DISCUSSION

Yasargil and coworkers[8] reported successful radical excision of ISTs with positive neurological outcomes utilising microsurgical techniques in their classic paper. Since then, there have been numerous reports of successful IST series. Despite this, the rate of CSF-related problems (such as CSF leak, pseudomeningocele, and meningitis) after IST tumour surgery remained high, ranging from 5% to 18% in reports from major high-volume hospitals.[9-11] Treatment for these problems may include prolonged postoperative bed rest, external lumbar drainage, operational re-exploration, and antibiotic treatment.Deep vein thrombosis, pulmonary embolism, pneumonia, urinary tract infection, skin disintegration, subdural or cerebellar hematomas, and even death might occur as a result of these problems. They also considerably raise medical costs and duration of stay in the hospital, which may negatively impact hospital and individual surgeon outcomes, as well as patient satisfaction surveys. After elective spine surgery, Weber et al[12] found a 50% increase in mean hospital cost per patient due to CSF-related postoperative problems.

In the surgical series of ISTs treated at our institution, our own experience mirrored that of others. As a result, after the third patient in our series developed a large pseudomeningocele, was readmitted to the hospital, and underwent a second surgery with revision of the dural

closure and placement of an autologous fat graft and external lumbar drainage for 5 days, we prospectively adopted the intraoperative use of fat grafting.

We found that reinforcing the dural suture line with autologous fat is useful particularly in cases whenthe Valsalva maneuver revealed CSF seepage. In addition, the fat graft obliterates the dead space created bya laminectomy and muscle dissection, and creates gentle pressure to the dural suture line that may prevent theformation of a pseudomeningocele and a CSF leak. In some cases, it may be impossible to achieve watertightdural closure, and these cases are particularly atrisk for CSF leak and therefore clearly benefit from thisconcept and technique: 1) an IST in a sacral location (oneof our cases); 2) a craniospinal IST requiring a Y-shapeddural incision and patch grafting; 3) when the tumor invades the dura(e.g., meningioma) and necessitates dural excision toachieve radical resection and subsequent dural patching;and 4) if the tumor is a dumbbell IEST extending intothe intervertebral foramen and beyond.

In our series, 20% of patients had dumbbell tumours (3 schwannomas and 1 meningioma), and it was impossible to accomplish a watertight dural closure without inserting a fat graft into the sutures following radical tumour excision. While the patient was supine, fat tissue was collected by a horizontal incision of approximately 2 cm at the start of surgery. It was done on the left side to avoid confusion if an appendectomy or other abdominal surgery was performed on the right side later.Even in people with a low BMI, fat deposits are plentiful in the abdominal area. The tissue harvest, in our experience, did not add significant time or cost to surgery, nor did it result in infection, hematoma, or cosmetic issues for our patients. Furthermore, there is no risk of hypersensitive reaction or infectious illness transfer with fat autograft.

Finally, rather of collecting fat from the subcutaneous tissue in the location of the original incision, we preferred a separate incision for tissue removal. This method avoids the formation of extra tissue pouches in the primary surgical location, which could lead to the formation of a pseudomeningocele or hematoma, jeopardising wound healing.

CONCLUSION

The use of autologous fat grafting in the future enables a watertight dural closure and eliminates the dead space generated by surgical exposure, muscle dissection, and bone removal. This method appears to greatly reduce, if not fully eliminate, postoperative CSF-related problems in IST patients without significantly increasing operational time, cost, or morbidity.

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