Dural tear repair surgery comparative analysis: a stitch in time saves nine

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Abstract
Purpose A dural tear is a common iatrogenic complication of spinal surgery associated with a several post-operative adverse events. Despite their common occurrence, guidelines on how best to repair the defect remain unclear. This study uses five post-operative outcomes to compare repair methods used to treat 106 dural tears to determine which method is clinically favourable.

Methods Data were retrospectively collected from Southampton General Hospital’s online databases. 106 tears were identified and grouped per repair method. MANOVA was used to compare the following five outcomes: Length of stay, numbers of further admissions or revision surgeries, length of additional admissions, post-operative infection rate and dural tear associated neurological symptoms. Sub-analysis was conducted on patient demographics, primary vs non-primary closure and type of patch. Minimal clinically important difference (MCID) was calculated via the Delphi procedure.

Results Age had a significant impact on patient outcomes and BMI displayed positive correlation with three-fifth of the predefined outcome measures. No significant difference was observed between repair groups; however, primary closure ± a patch achieved an MCID percentage improvement with regards to length of original stay, rate of additional admissions/surgeries and post-operative infection rate. Artificial over autologous patches resulted in shorter hospital stays, fewer readmissions, infections and neurological symptoms.

Conclusion This study reports primary closure ± dural patch as the most efficient repair method with regards to the five reported outcomes. This study provides limited evidence in favour of artificial over autologous patches and recommends that dural patches be used in conjunction with primary closure.

Level of evidence I Diagnostic: individual cross-sectional studies with consistently applied reference standard and blinding.

Keywords Dural tear · Incidental durotomy · Primary closure · Dural patch

Introduction
A dural tear, also known as an incidental durotomy, refers to when the outer most layer of the meninges, the dura mater, is torn [1]. Dural tears most commonly occur as a complication of spinal surgery and patients who sustain a dural tear often recover well and do not commonly require further intervention following repair of the defect [2, 3]. However, patients may complain of low-pressure headaches, photophobia and nausea [1, 4, 5]. More serious consequences of poorly managed tears include meningitis, arachnoiditis and the development of pseudomeningoceles [1, 4, 5]. Therefore, further research to better define the management of dural tears may have beneficial clinical outcomes.

Despite the common occurrence of this complication, there are currently no definitive guidelines on how best to manage an intraoperative tear [4]. Consequently, patient outcomes vary on a case by case basis [4]. This may be in part due to the inconsistent and varied methods of repair that surgeons use along with the absence of high quality comparative data [4, 6].

This retrospective study identifies 106 patients who sustained an intraoperative dural tear in Southampton University General Hospital, in either the Orthopaedic or Neurosurgery departments between 01/01/2016 and 04/11/2019. This
study consequentially compares the method of dural repair against five primary outcome measures; length of hospital stay, length of additional admissions, numbers of further admissions or revision surgeries, post-operative infection rate and dural tear associated neurological symptoms. Sub-analysis was conducted regarding patient age and body mass index (BMI) as well as against primary vs non-primary closure and artificial vs autologous patches.

**Methods**

\( H_1 \) With respect to the studies five predetermined outcome measures, primary closure is the most advantageous form of repair for intraoperative dural tears.

\( H_0 \) With respect to the studies five predetermined outcome measures, primary closure is not the most advantageous method of dural tear repair.

Data were collected from Southampton General Hospital’s online ‘surgery complications’ ‘Charts’ and ‘E-documents’ databases. All patients with the terms ‘Dural Tear’, ‘CSF Leak’, ‘durotomy’ or ‘pseudomeningocele’ in their records were identified and later included in the study if it could be confirmed that they sustained an intraoperative dural tear from the Orthopaedics or Neurosurgery department between the 46-month period (Fig. 1). To ensure all relevant patients were included, the term ‘dural tear’ was entered into the main patient database search-bar and patients were cross-searched.

The following patient information was recorded; age at the time of surgery, BMI, title of procedure in which the tear was sustained, length of original stay, character of dural complication, method of repair, post-operative neurological symptoms, infection rate, readmission date(s), readmission procedure(s), duration of readmission(s) (Table 1). Patients were grouped per the method of repair used so that no patient appeared in more than one group (Table 2).

**Statistical analysis**

All statistical analysis was conducted on SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0.). Minimal clinically important difference (MCID) was calculated for the primary repair analysis and for the artificial vs autologous patch analysis. MCID was calculated via the Delphi method amongst resident neurosurgeons to enable a formal consensus to be developed.

**Delphi procedure**

Four resident neurosurgeons were provided with a two-round Delphi survey. In the first round, surgeons were provided with information regarding the study and independently suggested MCID values for each outcome. In the second round, surgeons were provided with the group ranges and medians and their own answers so they may adapt their decisions. 100% consensus was achieved.
| Patient Number | Department | Age  | BMI  | Procedure                        | Length of stay | Dural complication                                                                 | Method of repair                                      | Symptoms post repair                                      | Infec-tion post repair | Read-missions procedures | Readmission procedures | Duration of readmis-sions |
|----------------|------------|------|------|----------------------------------|----------------|------------------------------------------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------|-------------------------|-------------------------|----------------------------|--------------------------|
| 1              | Neuro      | 42   | 27.17| L5/S1 microdiscectomy           | 3              | Small dural puncture and Pseudomeningocele                                        | 5.0 Vicryl, duraseal, 6.0 Prolene, tissue dural patch and lumbar drain | Fluid collection, sciatica, back and leg pain, headache and low-pressure symptoms | None                    | 2                        | Dural tear repair         | 9                        |
| 2              | Neuro      | 70   | 28.73| Laminectomy, fusion and fixation for L3-4 instability with radiculopathy        | 5              | CSF Leak whilst drilling the pars/facet complex                                     | 5/0 Vicryl, Tisseel glue and muscle patch               | Back pain                                                 | None                    | 1                        | None                      | 4                        |
| 3              | Neuro      | 48   | 34.26| L4/L5 decompression and microdiscectomy | 2              | CSF leak /lumbar pseudomeningocele and persistent CSF fistula                      | Lumbar drain, 5.0 Prolene, muscle patch, fat graft and duraseal | Back and leg pain, pins and needles, L5 distribution numbness | Yes                     | 2                        | Revision of lumbar wound and washout | 43                       |
| 4              | Neuro      | 38   | 34.26| Microdiscectomy for L5-S1 lateral disc prolapse                                | 2              | Post-operative CSF leak and pseudomeningocele                                      | Lumbar drain, fat graft and Tisseel                    | Occasional pain or tingling in lateral 3 toes of left foot | None                    | 1                        | Repair of pseudomeningocele, re-do microdiscectomy and insertion of lumbar drain | 7                        |
| 5              | Neuro      | 54   | 42.19| L4/L5 decompression              | 3              | Post-operative CSF leak and pseudomeningocele                                      | 5/0 Prolene muscle patch and Tisseel                   | Sudden onset headache and photophobia                   | None                    | 1                        | Repair of dural tear       | 7                        |
| 6              | Neuro      | 45   | 26.03| C5/6 ACDF and bilateral foraminotomy                                          | 5              | Intra-op dural tear with CSF leak                                                  | Micro patty, muscle patch and Tisseel                   | Headaches, right arm pain, burning sensation and hypersensitivity | None                    | 0                        | 0                          | 0                        |
| 7              | Neuro      | 48   | 20.23| L4/L5 luminecetomy and discectomy                                             | 2              | Dural tear due to blunt instruments                                                | Primary repair failed. Patch of fascia, durogen patch and Tisseel glue | Headaches and mild wound swelling                       | None                    | 1                        | Repair of lumbar pseudomeningocele | 3                        |
| Patient Number | Department | Age  | BMI  | Procedure                                           | Length of stay | Dural complication | Method of repair | Symptoms post repair | Infec- | Readmis- | Readmission procedures | Duration of readmis- |
|---------------|------------|------|------|----------------------------------------------------|----------------|--------------------|------------------|----------------------|--|---------|-----------------------|---------------------|
| 8             | Neuro      | 28   | 32.98| Cervical Intramedullary Ependymoma                 | 4              | CSF leak requiring lumbar drain                     | Lumbar drain    | Complete numbness in band around trunk and numb abdomen. Reduced bladder sensation. Keloid scar | None | 1       | Lumbar drain insertion | 10                  |
| 9             | Neuro      | 58   | 24.87| Midline Primary anterior cervical decompression    | 2              | Intra-op dural tear with CSF leak                   | Flowseal, Spong-istan. Tisseel | Residual weakness in left hand | None | 0       | None                  | 0                   |
| 10            | Neuro      | 42   |      | Large inferior central disc taken out in 3 large fragments (L5/S1) | 7              | Two pinhole tears made to the dura with CSF leak   | 5.0 Prolene and tissue patch      | Weakness of left leg calf muscles and reduced toe-off. Numb saddle region. Plantar flexion weakness | None | 0       | None                  | 0                   |
| 11            | Neuro      | 50   | 29.35| L4/5 decompression and L4/5 discectomy for Cauda Equina Compression | 3              | Dural tear and CSF leak noticed post-operatively in relation to a bony spur | 5/0 Vicryl, muscle, Tisseel and lumbar drain | Headaches, lower back pain, wound swelling | None | 1       | Insertion of Lumbar drain, wound exploration and re-do microdiscectomy | 6                   |
| 12            | Neuro      | 74   |      | Laminectomy for L4/5 stenosis                     | 3              | Intraoperative dural tear with CSF leak on and pseudo- meningocele | 5.0 Vicryl sutures and tissue dura patch | Intermittent pain in both legs | None | 1       | None                  | 8                   |
| 13            | Neuro      | 77   | 29.00| L3/L4 decompression and laminectomy for spinal stenosis | 12             | Small dural tear and CSF leak from wound            | Tissue patch Vicryl suture, 6/0 Prolene, Surgical, floseal and Tisseel glue | Trifascicular block and bradycardia | None | 1       | Repair of CSF leak     | 0                   |

Table 1 (continued)
| Patient Number | Department | Age | BMI | Procedure | Length of stay | Dural complication | Method of repair | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|-----|-----|-----------|----------------|-------------------|------------------|---------------------|----------------------|--------------|------------------------|------------------------|
| 14             | Neuro      | 37  | 37.60 | Re-exploration of L5 nerve root | 8              | Intraoperative dural tear requiring further surgery | Dural glue, stitches, 5/0 Vicryl, muscle patch, Tisseel and lumbar drain | Positional headaches, worsening pain, soft/fluctuant swelling at lumbar site, large pseudomeningocele | Yes 1 | Repair of pseudomeningocele and lumbar drain insertion | 7          |
| 15             | Neuro      | 59  | 31.51 | L3/L4 decompressive laminectomy | 5              | Adherent thickened ligamentum flavum causing dural tear | Primary repair and muscle graft | Continued numbness in right leg, shooting pain bilaterally, L4 nerve root irritation and mechanical lower back pain | None 0 | 0 |                          |            |
| 16             | Neuro      | 68  | 24.94 | Laminectomy at L3/4 and L4/5 | 6              | L3/L4 dural tear | Biogluue | Occasional pain down the back of the leg and back pain in right buttock | Yes 0 | 0 |                          |            |
| 17             | Neuro      | 47  | 29.89 | L5 laminectomy and L5/S1 discectomy | 8              | Small dural tear below L5 | 5–0 Prolene, tissupath and biogluue | Numbness in left side of genital area through to buttock, Pins and needles in left buttock | None 0 | 0 |                          |            |
| 18             | Neuro      | 74  | 26.79 | L3/4, L4/5 decompression and L4 laminectomy | 5              | Ligamentum flavum adherent to dura | 6.0 Vicryl and tissue patch | Constant stinging painful sensation in feet, ankles and shins, hypersensitivity to light touch | None 0 | 0 |                          |            |
| 19             | Neuro      | 67  | 23.24 | L4/L5 intersegmental decompression | 4              | Intraoperative dural tear with a CSF leak | 6/0 Prolene and tissue patch | Severe sciatica from the buttock to the Achilles area | None 0 | 0 |                          |            |
| 20             | Neuro      | 77  | 27.66 | L3-S1 posterior lateral fusion, L3/4, L4/5, L5/S1 TLIF | 11             | Dural tear and 3.1 L blood loss | Dura tissue patch, lumbar drain and 5–0 Prolene | None | None 0 | 0 |                          |            |
| Patient Number | Department | Age | BMI  | Procedure                                      | Length of stay | Dural complication | Method of repair                  | Symptoms post repair | Infec- tion post repair | Readmis- sions | Readmission procedures | Duration of readmis- sions |
|----------------|------------|-----|------|-----------------------------------------------|----------------|---------------------|------------------------------------|----------------------|--------------------------|----------------|------------------------|---------------------------|
| 21             | Neuro      | 52  | 29.55| L4/5 intersegmental decompression             | 5              | Two small dural tears at inferior edge         | 7–0 Prolene sutures and tissue patch | None                 | None                     | 0             | 0                      |                           |
| 22             | Neuro      | 69  | 43.07| L4/L5 posterior lumbar interbody fusion and decompression | 6              | Small dural tear intraoperatively on right side | Tissue patch dura, Duraseal and Flowseal | Back pain and right-sided sciatica | None                     | 0             | 0                      |                           |
| 23             | Neuro      | 22  | 33.56| Revision of paddle SCS and insertion of Surpass Electrode | 4              | Dura stuck to bone. Dural tear was seen in 3 places | Tissue Dura and Adherus | Multiple back pain symptoms and complications | Yes           | 1             | None                     | 5                         |
| 24             | Neuro      | 74  | 31.20| L3/L4 Decompression and Discectomy              | 3              | Dural tear observed on closure                 | Subfascial drain | None                 | None                     | 0             | 0                      |                           |
| 25             | Neuro      | 46  | 27.86| T10/T11 Decompression and posterior instrumented fusion | 10             | Dural tear observed on closure                 | Muscle graft, duraseal and subfascial drain | Patient was unable to move his legs | Yes           | 0             | 0                      |                           |
| 26             | Neuro      | 51  | 22.10| C7/T1 ACDF and plate stabilisation             | 3              | Dural tear sustained                           | Duraseal         | None                 | None                     | 0             | 0                      |                           |
| 27             | Neuro      | 44  | 20.13| Removal of posterior lumbar spine instrumentation | 3              | Small longitudinal dural tear adjacent to midline below S1 | 6–0 Prolene, duragen, durasel, surgical patty and subfascial drain | None                 | None                     | 0             | 0                      |                           |
| 28             | Neuro      | 38  | 27.14| Urgent L5-S1 decompression and microdiscectomy | 4              | Intraoperative dural tear following dissection of the ligamentum flavum | Vicryl 5–0 and Tisseel | Problems with bowel control as well as altered saddle region sensation and sexual dysfunction | None           | 0             | 0                      |                           |
| 29             | Neuro      | 47  | 28.18| L4/L5 discectomy                              | 20             | Two intraoperative dural tears                 | Vicryl 5/0, Flo- seal and Tisseel | Persistent lower back pain and neuropathic pain on the right leg | None           | 0             | 0                      |                           |
| Patient Number | Department | Age  | BMI  | Procedure                                      | Length of stay | Dural complication                                      | Method of repair                      | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|------|------|-----------------------------------------------|----------------|---------------------------------------------------------|---------------------------------------|----------------------|-----------------------|-----------------|------------------------|--------------------------|
| 30             | Neuro      | 56   |      | C4/C5 anterior cervical discectomy            | 4              | Intraoperative dural tear                                | Surgical, Tisseel, Flowseal and subfascial drain | Left hand numbness, pain behind neck, hypersensitivity superior to the wound | None          | 0                      | 0                         |
| 31             | Neuro      | 72   | 30.72| L3-4 decompression and discectomy             | 10             | Intraoperative dural tear caused by removal of the ligamentum flavum | 6/0 Vicryl, surgical and Tisseel | CSF leak, sciatic pain and sensory changes over buttocks | None          | 0                      | 0                         |
| 32             | Neuro      | 82   | 27.06| L3/4 and L4/5 lumbar decompression and body fusion | 10             | Small dural tear with arachnoid intact, no CSF leak | Tissue dura | Ongoing back pain and bilateral lower limb symptoms | None          | 0                      | 0                         |
| 33             | Neuro      | 46   | 36.57| C5/6 and C6/7 ACDF and fusion                 | 2              | C5/6 small dural tear but no CSF leak                  | Surgical and Tisseel                  | Gait abnormalities and light touch sensation abnormalities | None          | 0                      | 0                         |
| 34             | Neuro      | 50   | 34.90| Laminectomy at L3-4                          | 3              | Small dural tear with arachnoid intact, no CSF leak | Not Recorded | Back pain, frontal headaches and widespread sensory deficit to light touch | None          | 0                      | 0                         |
| 35             | Neuro      | 50   | 25.14| Microdiscectomy at L5-S1                     | 3              | Small dural tear with arachnoid intact, no CSF leak | Tisseel                               | Discitis and infection | Yes  | 1                      | None                     | 1                         |
| 36             | Neuro      | 84   | 26.89| L3/4 and L4/5 intersegmental and lateral recess decompression | 3              | Ligamentum adherent to dura, tore the dura when lifted | 6.0 Prolene, Tissue patch dura and Flowseal | Aching in anterior thighs and pelvis | None          | 0                      | 0                         |
| 37             | Neuro      | 54   | 32.42| L2/3 and L4/5 intersegmental decompression   | 6              | Ligamentum was stuck to the dura dorsally under L4    | 6.0 Vicryl and Duraseal             | Pain and weakness in legs, made worse on walking | None          | 0                      | 0                         |
| Patient Number | Department | Age  | BMI  | Procedure                                    | Length of stay | Dural complication                      | Method of repair                      | Symptoms post repair | Infec- | Read- | Readmission procedures | Duration of readmissions |
|----------------|------------|------|------|----------------------------------------------|----------------|------------------------------------------|---------------------------------------|----------------------|--------|-------|------------------------|--------------------------|
| 38             | Neuro      | 45   | 24.22| L4/5 decompression and discectomy            | 4              | L5 dural tear                             | Vicryl 5/0, Prolene 7/0, TissuePatch-Dural and Tisseel | Headaches            | None   | 1     | L4/L5 wound exploration and repair of pseudodermeningocele | 16                       |
| 39             | Neuro      | 39   | 26.04| Right side L4/L5 microdiscectomy             | 4              | Dural tear and pseudodermeningocele noted 2 months post-operatively | 5/0 Prolene, Surgical, Tissue and lumbar drain | Residual saddle anaesthesia and episodes of bladder incontinence | None   | 1     | Repair of CSF leak and pseudodermeningocele | 24                       |
| 40             | Neuro      | 42   |      | L5/S1 decompression                          | 11             | Dural tear in lateral aspect of S1 nerve root | Surgical and Tissue patch Dural | Infection and erythema with slight back pain and reduced light touch and pinprick sensation | Yes    | 0     | 0                         | 0                        |
| 41             | Neuro      | 30   | 31.8 | L5/S1 decompression                          | 4              | Small dural tear with subarachnoid intact | 60 Prolene, fat graft, Tisseel and lumbar drain | None                | None   | 0     | 0                         | 0                        |
| 42             | Neuro      | 20   | 45.7 | L4-5 decompression and microdiscectomy       |                 | Dural tear with bulging arachnoid         | Lumbar drain                      | None                | Yes    | 0     | 0                         | 0                        |
| 43             | Neuro      | 73   | 30.93| C5-6 and C6-7 ACDF                          | 2              | Small dural tear with arachnoid intact, no CSF leak | Surgical and Floseal | Right arm radicular pain and slight sensory deficit | None   | 0     | 0                         | 0                        |
| 44             | Neuro      | 65   | 18.34| C6-7 corpectomy and iliac crest bone grafting and plating | 15             | Small dural tear with arachnoid intact, no CSF leak | Surgical, Floseal, blood patch and subfascial drain | Electric shock like symptoms in the right chest, dysphagia and weakness in the right C7 distribution | None   | 0     | 0                         | 0                        |
| 45             | Neuro      | 69   | 31.67| Anterior discectomy, fusion and fixation at C3-4 | 2              | Small dural tear with arachnoid intact, no CSF leak | Tisseel | Headaches, mild myelopathic gait and right L5 distributed sciatica | None   | 2     | Nerve root block and L4/L5 laminectomy | 3                        |
| Patient Number | Department | Age  | BMI      | Procedure                                      | Length of stay | Dural complication                                                                 | Method of repair                                      | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|------|----------|-----------------------------------------------|----------------|-----------------------------------------------------------------------------------|------------------------------------------------------|----------------------|-----------------------|--------------|------------------------|--------------------------|
| 46             | Neuro      | 53   |          | Two level ACDF                                |                | Small dural tear with arachnoid intact, no CSF leak                               | Fat graft, muscle graft, spongostan, Tisseel and Adherus Suture, tissue patch, muscle graft and duraseal | None                 | None                  | 0            | 0                      | 0                        |
| 47             | Neuro      | 1    |          | Bilateral Excision of spinal neurofibroma      | 5              | Small dural tear and CSF leak seen in axilla of C4 nerve root                     | CSF leak                                             | None                 | 1                      | 94           | Aspiration of cervicothoracic pseudomeningocele, repair of dural tear and drain insertion | 0                        |
| 48             | Neuro      | 66   | 34.62    | Bilateral Excision of spinal neurofibroma      | 4              | Small dural tear in right lateral aspect of L4                                    | Prolene, muscle patch, bioglu and flowseal          | Left hip and buttck pain with weakness of left hip flexion | Yes                     | 0                      | 0                        |
| 49             | Neuro      | 72   | 28.71    | Left L5 nerve root decompression and laminectomy | 3              | Small dural tear with arachnoid intact, no CSF leak                               | 6.0 Prolene, muscle graft and duraseal              | Back pain            | None                  | 0            | 0                      | 0                        |
| 50             | Neuro      | 35   | 30.07    | Insertion of right frontal VP shunt            | 4              | Small dural tear causing haemorrhage                                               | Bipolar diathermy                                    | Severe hypotensive headaches and occipital pain with neck stiffness | None                  | 3                      | 11                       |
| 51             | Neuro      | 78   | 31.23    | L4/L5 Discectomy and laminectomy               | 4              | Small tear with adherent dura                                                     | Duragen patch, Duraseal and lumbar drain            | None                 | None                  | 0            | 0                      | 0                        |
| 52             | Ortho      | 89   | 26.10    | L2/L3, L3/L4 and L4/L5 Decompression           | 15             | Dural tear at L4/ L5                                                              | Duragen patch, Duraseal and lumbar drain            | Right middle cerebral artery infarct                   | None                  | 0                      | 0                        |
| 53             | Ortho      | 77   | 31.75    | Midline primary surgery for lumbar disc degeneration | 12             | Small CSF Leak due to calcified ligamentum flavum                                | Vicryl 6.0                                           | Wound leak           | None                  | 0            | 0                      | 0                        |
| 54             | Ortho      | 35   | 22.30    | L5/S1 Decompression and discectomy             | 8              | Small dural tear noted at the end of the procedure                               | Fat graft, nylon suture, duragen patch and duraseal | Left-sided foot drop                                    | None                  | 0                      | 0                        |
| Patient Number | Department | Age  | BMI  | Procedure                                      | Length of stay | Dural complication                      | Method of repair                        | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|------|------|-----------------------------------------------|----------------|-------------------------------------------|-----------------------------------------|----------------------|----------------------|--------------|------------------------|--------------------------|
| 55             | Ortho      | 48   | 41.62| C3—C7 Laminctomy and C5/C6 Foraminotomy      | 5              | Incidental small durotomy at C5/C6         | Prolene 6/0, Dural patch and Duroseal  | Significant neck pain and worsening numbness in right thumb | None                 | 0                      | 0                        |
| 56             | Ortho      | 61   | 20.58| Cervical decompression C2-C4 and instrumented fusion of C2-C5 | 38             | Post-op persisting wound leak and pseudomeningocele | Subfascial drain                      | Left ulnar neuropathy and grade 4 weakness and some muscle wasting | None                 | 0                      | 0                        |
| 57             | Ortho      | 34   | 33.14| L4/L5 primary posterior laminectomy           | 9              | Small dural tear noted during procedure      | 8.0 Nylon, Everseal and lumbar drain  | Saddle analgesia and S1 light touch sensory deficit  | None                 | 0                      | 0                        |
| 58             | Ortho      | 41   | 42.90| L4/L5 Decompression and discectomy           | 3              | Small pin prick CSF leak                    | 6.0 Prolene and everseal              | None                 | None                 | 0                      | 0                        |
| 59             | Ortho      | 69   | 34.57| L2/L3 and L3/L4 Decompression                | 7              | Ligamentum flavum partially adherent to dura | 6/0 Prolene, Duraseal and lumbar drain | Urinary retention              | None                 | 0                      | 0                        |
| 60             | Ortho      | 76   | 27.55| Instrumented fusion and decompression at L3-L5| 5              | Inadvertent durotomy due to thickened calcified ligamentum adherent to dura | Duragen graft, duraseal and lumbar drain | Significant back and right-sided pain in the L5 distribution | None                 | 0                      | 0                        |
| 61             | Ortho      | 66   | 39.92| L3-L5 posterior decompression and fusion and L4/5 PLIF | 9              | Incidental dural tear during the decompression at L4/L5 | Fat graft, Durogen and duroseal       | None                 | None                 | 0                      | 0                        |
| 62             | Ortho      | 84   | 20.40| L4/5 spinal decompression                     |                 | Intraoperative dural tear                   | Duragen, Duraseal, Floseal, Patch and lumbar drain | Patient died              | None                 | 0                      | 0                        |
| 63             | Ortho      | 32   |      | L4/L5 discectomy                              | 3              | Incidental dural tear at L5 dorsal region   | Prolene 5.0, Durogen and duroseal     | Back pain and occasional sharp pain     | None                 | 0                      | 0                        |
| Patient Number | Department | Age  | BMI  | Procedure                                | Length of stay | Dural complication | Method of repair                  | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|------|------|------------------------------------------|----------------|--------------------|-----------------------------------|----------------------|-----------------------|--------------|------------------------|------------------------|
| 64             | Ortho      | 31   | 29.63| Bilateral L4/L5 discectomy               | 12             | Small central posterior durotomy          | Fat graft, nylon suture, durapatch and duraseal | Weakness of the right leg distal to the knee associated with tingling and numbness | None          | 0                      | 0                      |
| 65             | Ortho      | 82   | 32.76| L3/L4 Decompression                      | 11             | Small inadvertent durotomy at L3 root     | Prolene 6/0, Duragen and Evicell               | Pack pain, altered perianal and genital sensation with numbness | None          | 0                      | 0                      |
| 66             | Ortho      | 60   | 36.54| T10-L5 instrumented decompression and fusion | 43             | Dural tear intraoperatively at L3/L4     | Duragen patch and Everseal                       | Patient became paraplegic with major motor and sensory deficits | Yes          | 0                      | 0                      |
| 67             | Ortho      | 59   | 32.18| L2/3 and L3/4 decompression with dynamic stabilisation | 5              | Inadvertent dorsal linear tear of dura    | 6-0 Prolene and Duraseal                        | Weak arms, hand tremor, numbness of left buttock and pelvic region | Yes          | 0                      | 0                      |
| 68             | Ortho      | 55   | 31.88| Posterior L2/3 decompression             | 11             | Large complex dural tear                  | Duragen, duraseal, flowseal and drain          | Severe loss of sensation and power of the right leg | None          | 0                      | 0                      |
| 69             | Ortho      | 30   | 33.24| Anterior and posterior correction and instrumentation of scoliosis | 13             | Small dural puncture in lumbar spine      | Duragen, duraseal, Lumbar drain and local graft | Back pain                                      | None          | 0                      | 0                      |
| 70             | Ortho      | 16   | 23.75| Posterior L5-S1 instrumented fusion      | 8              | Small dural tear                          | Information not available                      | None                | None                  | 1 Revision left lateral ligament reconstruction | 5                      |
| 71             | Ortho      | 36   | 31.88| L4/5 discectomy and decompression        | 12             | Small Dural tear                          | 6-0 Prolene, duragen, duraseal                 | None                | None                  | 0                      | 0                      |
| 72             | Ortho      | 52   | 31.88| C5/6 reduction and instrumented fusion   | 72             | Disc completely disrupted with dural tear at C5/C6 | Duroseal and subfascial drain                   | None                | None                  | 0                      | 0                      |
| Patient Number | Department | Age  | BMI  | Procedure | Length of stay | Dural complication | Method of repair | Symptoms post repair | Infection post repair | Readmissions procedures | Duration of readmissions |
|----------------|------------|------|------|-----------|----------------|-------------------|-----------------|---------------------|----------------------|------------------------|--------------------------|
| 73             | Ortho      | 74   | 29.39| Right anterior cervicotomy C6-C7 spinal cord decompression and fusion | Patient died | Medial dural tear | Spongostan       | Patient died        | None                 | 0                      | 0                       |
| 74             | Ortho      | 68   | 35.49| L3 to S1 lumbar decompression | 7 | 5 mm longitudinal dural tear | 6-0 Prolene, Flowseal, Duraseal and lumbar drain | Back pain | None | 0 | 0 |
| 75             | Ortho      | 77   | 23.96| L3/L4 and L4/L5 spinal decompression | 7 | Small linear dural tear at L5 | 6-0 Prolene, Flowseal and lumbar drain | None | None | 0 | 0 |
| 76             | Ortho      | 57   | 28.20| Microdiscectomy of lumbar intervertebral disc | 6 | Dural tear at S1 root | 6-0 Prolene, Duragen and lumbar drain | Dysaesthesia in the left S1 distribution with marked cramps in left thigh | None | 0 | 0 |
| 77             | Ortho      | 57   | 31.79| Spine decompression and pedicle subtraction osteotomy, T9-L4 | 45 | Dura adherent to the lamina resulting in dural tears at multiple levels | 6-0 Prolene, Duragen and Duraseal | Left foot numbness and loss of function at L5 in right foot | None | 0 | 0 |
| 78             | Ortho      | 76   | 18.49| Posterior instrumented stabilisation T1-L3 and L1 laminectomy | 13 | Small dural tear | 6-0 Prolene Duragen, Duraseal and lumbar drain | Aching in mid thoracic spine | None | 0 | 0 |
| 79             | Ortho      | 65   | 23.66| L1 and L2 laminectomy and L1 and L3 decompression | Patient died | Adherent dura resulting in small tear | 6-0 Prolene Duragen, Duraseal and lumbar drain | Patient died | None | 0 | 0 |
| 80             | Ortho      | 62   | 35.24| Two Level spine decompression at the lumbar spine | 9 | Small dural tear | 6-0 Prolene, Duraseal and lumbar drain | Headache, photossensitivity and wound hypersensitivity | None | 0 | 0 |
| 81             | Ortho      | 73   | 27.21| Two Level spine decompression at the lumbar spine | 5 | Small dural tear | 6-0 Prolene, Duraseal and lumbar drain | Leg aching | None | 0 | 0 |
| Patient Number | Department | Age  | BMI  | Procedure                                 | Length of stay | Dural complication | Method of repair  | Symptoms post repair | Infec- | Readm- | Readmission procedures | Duration of readmissions |
|----------------|------------|------|------|-------------------------------------------|----------------|--------------------|-------------------|---------------------|---------|---------|------------------------|--------------------------|
| 82             | Ortho      | 74   | 38.67| Three Level spine decompression at the lumbar spine | 23             | Small dural tear   | Fat graft, duragen patch and duroseal glue | Fluid collection, faecal and urinary retention and loss of anal tone and squeeze | None    | 0       | 0                      | 0                          |
| 83             | Ortho      | 85   | 23.85| Three Level spine decompression at the lumbar spine | Patient died   | Intraoperative dural tear | Lumbar drain, glue and patch | Patient died | None    | 0       | 0                      | 0                          |
| 84             | Ortho      | 29   |      | Posterior laminectomy decompression         | 3              | Pinprick sized tear with CSF leak | Duraseal and duroseal patch | Pseudomeningocele, faecal and urinary incontinence | None    | 1       | Dural tear repair       | 8                          |
| 85             | Ortho      | 74   | 40.88| L3/4 decompression                          | 4              | Incidental small dural tear at L4 | Durogen, duroseal | None | None    | 0      | 0                      | 0                          |
| 86             | Ortho      | 55   | 37.03| L4-S1 posterior instrumented fusion and L5/ S1 discectomy | 5              | Incidental dural tear at L5 root | Durogen, duroseal and lumbar drain | Right-sided back pain | None    | 0       | 1                      | 1                          |
| 87             | Ortho      | 38   | 24.78| Three Level spine decompression at the lumbar spine | 17             | Traumatic dural tear at L1 level posteriorly and anterior laterally | Durogene dressing, duroseal, 6–0 Prolene and lumbar drain | Incontinence | None    | 0       | 2                      | 2                          |
| 88             | Ortho      | 25   | 38.31| Open reduction of C6/7, ACDF                | 6              | Traumatic dural tear | Duroseal and subfascial drain | None | None    | 1       | Posterior cervical spine fusion | 7                          |
| 89             | Ortho      | 30   |      | L4/L5 discectomy                           | 3              | Small dural tear noted on left L4 nerve root | Dural patch, Duraseal and lumbar Drain | Good post-operative recovery | None    | 0       | 0                      | 0                          |
| 90             | Ortho      | 83   | 27.82| L4/L5 Decompression                        | 16             | Dural tear noted distally | 6–0 Nylon, dural patch, duraseal and lumbar drain | 0/5 weakness of ankle dorsiflexion and toe extension in the right foot and reduced sensation | None    | 0       | 0                      | 0                          |
| Patient Number | Department | Age  | BMI  | Procedure                                      | Length of stay | Dural complication | Method of repair | Symptoms post repair | Infec- | Read- | Readmission procedures | Duration of readmis- |
|----------------|------------|------|------|-----------------------------------------------|----------------|--------------------|------------------|---------------------|--------|------|-------------------------|---------------------|
| 91             | Ortho      | 75   | 24.82| L4/L5 Decompression and TILF                   | 8              | Small dural tear noted                  | 6–0 Nylon sutures, dural patch, Duraseal and lumbar drain | Headaches          | None   | 0                        | 0                   |
| 92             | Ortho      | 67   | 22.46| Posterior correction of scoliosis with instrumen-| 11             | 3 dural tears noticed                  | Primary repair, duragen patch and duraseal      | Reduced L2 sensation | None   | 1                        | Elective posterior correction of post junctional kyphosis | 23                  |
| 93             | Ortho      | 69   | 36.09| Posterior instrumented fusion L3-L5 and decompression laminectomy | 5              | Small dural tear at the axilla of L5 root | Duragen and Duraseal | None                | None   | 0                        | 0                   |
| 94             | Ortho      | 64   | 34.48| T10-Pelvis scoliosis correction, fusion and decompression L4-S1 | 11             | Small dural tear at L5/S1                | 6–0 Prolene, Duraseal and lumbar Drain | Significant mid-lumbar pain | None   | 1                        | Revision degenerative scoliosis correction and TILF | 10                  |
| 95             | Ortho      | 36   | 31.90| L4/L5 decompression discectomy                  | 4              | Small dural tear at L5                   | Duraseal | Urinary leakage and ongoing right-sided back pain | None   | 0                        | 0                   |
| 96             | Ortho      | 58   | 31.37| Left L5 lateral recess decompression            | 2              | Small dural tear at L5                   | Duragen and patch | None                | None   | 0                        | 1                   |
| 97             | Ortho      | 58   | 35.32| Left L4/L5 discectomy/decompression             | 5              | Dural tear at L4                        | 6–0 Prolene, Dural patch and duraseal           | Ongoing back ache and altered sensation over lateral left thigh | None   | 0                        | 2                   |
| 98             | Ortho      | 60   | 28.16| L4/L5 laminectomy, decompression and discectomy | 3              | Dural tear and CSF leak at L5            | Duraseal and Duragen | Left-sided back pain | None   | 0                        | 3                   |
| 99             | Ortho      | 66   | 34.09| Discectomy                                     | 2              | Small dural tear                        | Duraseal | Superficial wound infection                  | Yes                | 0                        | 4                   |
| Patient Number | Department | Age  | BMI    | Procedure                        | Length of stay | Dural complication | Method of repair | Symptoms post repair | Infection post repair | Readmissions | Readmission procedures | Duration of readmissions |
|----------------|------------|------|--------|----------------------------------|----------------|---------------------|-------------------|----------------------|-----------------------|---------------|-------------------------|--------------------------|
| 100            | Ortho      | 30   | 38.41  | Lumbar decompression             | 5              | Small dural tear    | 6/0 nylon, Duragen, Duraseal and lumbar drain | Reoccurring CES symptoms | None                  | 3             | S1 nerve root block, bilateral S1 root decompression and re-do disectomy | 21                       |
| 101            | Ortho      | 69   | 37.96  | Lumbar decompression             | 11             | Dural tear at superior edge of decompression | 6/0 Prolene, Duragen, Duraseal and lumbar drain | Dysaesthesia in the perineal area and posterior aspect of both thighs and urinary urge sensation | None                  | 0             | 0                       | 0                       |
| 102            | Ortho      | 34   | 33.14  | Lumbar decompression             | 8              | Small dural tear    | 8.0 Nylon, Everseal and lumbar drain | Weaker erection than normal. Some sensory deficit | None                  | 0             | 0                       | 0                       |
| 103            | Ortho      | 64   | 31.46  | L3/L4 and L5 Lumbar Decompression | 4              | Pinprick dural tear at L4/L5 | Duragen, Duraseal and lumbar drain | None                  | None                  | 0             | 0                       | 0                       |
| 104            | Ortho      | 49   | 35.11  | L5/S1 disectomy and decompression of the right S1 nerve root | 2              | Pseudo-meningocele noticed post-operatively | Not recorded | Continued pain | None                  | 1             | Dural tear repair        | 7                       |
| 105            | Ortho      | 66   | 25.06  | L3/L4 L4/L5/S1 fusion            | 7              | Small intraoperative dural tear at L3 root | Duragen and Duraseal | Struggle with quadriceps post-operatively | None                  | 0             | 0                       | 0                       |
| 106            | Ortho      | 38   | 38.52  | L3/4 and L5/S1 decompression     | 4              | Adherent dura at L3/4 | 6/0 Prolene and Duraseal | None                  | None                  | 0             | 0                       | 0                       |

Patient data extracted from Southampton General Hospital databases. **TILF**—Transforaminal lumbar interbody fusion. **ACDF**—Anterior cervical discectomy and fusion. **PLIF**—Posterior lumbar interbody fusion. **Paddle SCS**—Paddle spinal cord stimulation. **VP shunt**—Ventriculoperitoneal shunt.
following round two. Final answers were averaged to give an MCID for each outcome:

1. Length of hospital stay: ≤ 3 days.
2. Rate of readmissions or revision surgeries: < 2 readmissions or revision surgeries.
3. Length of additional admission(s): ≤ 7 days.
4. Infection rate: No infection present.
5. Neurological symptoms: ≤ 3-point score.

Benefit rate (patients surpassing MCID/total patients) was calculated for each MCID outcome and reported as a percentage improvement (benefit rate of intervention—benefit rate of the control) (Table 3).

### Incidence rate

Descriptive statistics were used to identify the surgery and spinal level with the greatest incidence of tears.

### Patient demographics

Two MANOVAs were conducted against BMI and age for the five outcomes. Patients were grouped into the following age categories: 1–10, 11–20, 21–30, 31–40, 41–50, 51–60, 61–70, 71–80 and 81–90. Patients were grouped into the following BMI categories: Underweight (16.00–18.49), healthy weight (18.50–24.99), overweight (25.00–29.99), moderately obese (30.00–34.99), severely obese (35.00–39.99), very seriously obese (40.00–44.99) and morbidly obese (45.00–49.99).

### Type of repair method

Patients were grouped as per their repair method as shown in Table 2. Repair groups were compared via MANOVA of the five outcome measures. Neurological symptoms are scored as per Table 4.

| Repair method grouping | Group number percentage | Number of patients (n) | Percentage of patients (%) |
|------------------------|-------------------------|------------------------|-----------------------------|
| Primary closure alone  | 1                       | 0.94                   |
| Primary closure and artificial patch | 4 | 3.77 |
| Primary closure and autologous patch | 3 | 2.83 |
| Primary closure and sealant | 7 | 6.60 |
| Primary closure and drain | 1 | 0.94 |
| Primary closure, sealant and drain | 11 | 10.4 |
| Primary closure, sealant and artificial patch | 10 | 9.43 |
| Primary closure, sealant, artificial patch and drain | 10 | 9.43 |
| Primary closure, sealant and autologous patch | 6 | 5.66 |
| Primary closure, sealant and autologous patch and drain | 2 | 1.89 |
| Primary closure, sealant, artificial patch and autologous patch | 2 | 1.89 |
| Primary closure, artificial patch and drain | 2 | 1.89 |
| Autologous patch and sealant | 1 | 0.94 |
| Autologous patch and drain | 1 | 0.94 |
| Sealant alone | 9 | 8.49 |
| Sealant and drain | 3 | 2.83 |
| Sealant and artificial patch | 9 | 8.49 |
| Sealant, artificial patch and drain | 8 | 7.55 |
| Sealant and autologous patch | 1 | 0.94 |
| Sealant, autologous patch and drain | 2 | 1.89 |
| Sealant, artificial patch and autologous patch | 2 | 1.89 |
| Artificial patch alone | 2 | 1.89 |
| Drain alone | 4 | 3.77 |
| Unknown | 5 | 4.72 |
| Total | 106 | 100 |
A MANOVA and series of independent samples t-tests were used against the five outcome measures between patients that received primary closure ± a patch vs non-primary closure ± a patch. MCID percentage improvement was calculated.

### Results

A total of 106 patients sustained an intraoperative tear across the 46 months. Of the included patients, 51 (47.7%) belonged to the neurosurgery department and 55 (51.4%) belonged to Orthopaedics department.

### Incidence rate

1,824 spinal operations were identified in the date range, giving an incidence rate of 5.81%. Of the 106 tears, 43.40% (46) were caused during L4/L5 operations and 72.64% (77) were caused during L3-S1 operations. 44% (47) of tears were elective surgeries, and 56% (59) were emergency surgeries.

### Age

The average age was 55.3 (SD = 18.10, Min: 1, Max: 89). MANOVA analysis indicated that age has a statistically significant impact on the post-operative outcomes (F (40, 360.224) = 5.287, p < 0.000; Wilk’s Λ = 0.134, partial $\eta^2 = 0.331$). Infection was most common in the 41–50 and 61–70 age group.
BMI

The average BMI was 30.54 (SD = 6.00, Min: 18.34, Max: 45.70). 60.71% of patients were overweight or moderately obese, and only 13.10% were of a healthy weight. BMI did not have a significant impact on post-operative outcomes, (F (25, 276.400) = 0.685, \( p \) = 0.870; Wilk’s \( \Lambda \) = 0.800, partial \( \eta^2 \) = 0.44).

Readmissions and rate of revision surgeries were greatest in the moderately obese (\( M = 0.41, \) SD = 0.747) and severely obese (\( M = 0.64, \) SD = 1.082) categories. Infections were only present in the overweight (\( M = 0.12, \) SD = 0.322), moderately obese (\( M = 0.15, \) SD = 0.362) and severely obese (\( M = 0.14, \) SD = 0.363) and neurological symptom severity generally increased with BMI.

Type of repair method

Primary closure, sealant and a lumbar drain was the most common repair technique 10.4% (\( n = 11 \)). Primary closure was used in 55.7% of cases (\( n = 59 \)). However, combinations of sealants, patch’s, lumbar and subfascial drains without any form of primary closure were also commonly opted for (32.1% (\( n = 34 \))). Figure 2 illustrates the frequency of use of each method.

Following MANOVA, no significant difference in the five outcomes was observed between all repair methods (F (105, 342.101) = 0.793, \( p \) = 0.921; Wilk’s \( \Lambda \) = 0.345, partial \( \eta^2 \) = 0.192).

**Primary \pm a patch vs all other repair methods**

When comparing primary closure \pm a patch (\( n = 7 \)) against all other forms of repair (\( n = 99 \), primary closure \pm a patch scored better in 4/5 clinical outcomes:

1. Length of original stay was over 3.5 days shorter (\( M = 4.57, \) SD = 1.40 vs \( M = 8.58, \) SD = 10.16, \( p > 0.05 \)). 4% MCID percentage improvement.
2. The rate of additional admissions/surgeries was almost half (\( M = 0.29, \) SD = 0.49 vs \( M = 0.41, \) SD = 0.805 \( p > 0.05 \)). 27% MCID percentage improvement.
3. Length of additional stays was on average 1.35 days less (\( M = 2.14, \) SD = 3.671 vs \( M = 3.45, \) SD = 11.43 \( p > 0.05 \)). No MCID percentage improvement (−2%).
4. Infection rate post-operatively was 0 for the primary repair ± patch group (\( M = 0.00, \) SD = 0.000) and 0.11 in all other treatment groups (\( M = 0.12, \) SD = 0.328, \( p > 0.05 \)). 12% MCID percentage improvement.
5. Severity of neurological symptoms was slightly greater in the primary repair ± patch group (\(M = 2.29, \ SD = 1.799\) vs \(M = 1.78, \ SD = 1.59\)), this was reflected by an MCID of − 14%.

Following a MANOVA of primary closure ± a patch, no significant difference was observed (\(F (5, \ 89) = 0.559, p = 0.731; \) Wilk’s \(\Lambda = 0.97\), partial \(\eta^2 = 0.197\)).

**Artificial vs autologous patches**

When comparing artificial patches and autologous patches in conjunction with primary closure, no significant difference was seen in the length of original stay (\(M = 3.67, \ SD = 1.155\) vs \(M = 5.25, \ SD = 1.258, \ p > 0.05\)).

No patient in the artificial group required further admission or surgery, however, two patients in the autologous group did (\(M = 0.00, \ SD = 0.000\) vs \(M = 0.67, \ SD = 0.577, \ p > 0.05\)). This equated to a 67% MCID improvement. Due to no patients in the artificial patch group requiring further admission the artificial patch group had a 33% MCID improvement in the length of further admission(s) (\(M = 0.00, \ SD = 0.000\) vs \(M = 5.00, \ SD = 4.359, \ p > 0.05\)).

No difference in infection rate between the two groups was observed as no patients in either groups sustained an infection (\(M0.00, \ SD = 0.00\) and \(M = 0.00, \ SD = 0.00\)). However, the artificial group experienced less severe neurological symptoms post-operatively (\(M2.00, \ SD = 1.826\) vs \(M = 2.67, \ SD = 2.08\)), with an 8% MCID improvement.

**Discussion**

An incidental durotomy refers to the intraoperative tearing of the outermost layer of the meninges [1]. The incidence rate of dural tears shows considerable inter-study variation dependent on the type of procedure, pathology and re-operative rate [7–11]. Owing to the increasing complexity of spinal procedures the rate of dural tears is increasing and they continue to be a common surgical complication [8].

Our incidence rate of 5.81% falls within the reported range of 1–17% [12, 13] and supports the literature theme that such tears most commonly occur at the lumbar spine with 72.64% of the 106 tears occurring between L3-S1 [8].

Further to their common occurrence, dural tears are associated with a range of side effects including fistula formation, meningitis and more commonly orthostatic low-pressure headaches [10, 13, 14]. The most common side effects reported in this study were low-pressure headaches, stiffness across the back and CSF leak.

Despite these side effects, the long-term implications of incidental durotomies is disputed [15, 16] as is the most suitable method for repair. Whilst, primary repair is generally considered a suitable management strategy [10], some studies have concluded that it may not be essential for successful management [13, 17] whilst others report the contrary [10]. Equally, there is little comparative data regarding patient outcomes associated with combinations of repair methods and the repair combinations commonly opted for.

In this study, patients were grouped per their specific repair method and compared against the five clinical outcomes. Further analysis using the same outcomes were conducted on patient age, BMI and on the use of primary closure and type of dural patches used. Minimal clinically important difference was reported according to the Delphi method [18, 19].

Our study demonstrated that when considering these five outcomes, the age of a patient has a significant impact post-operatively. Based on previously published research and the patients included within this study, this finding was suspected to be a result of generalised increased morbidity due to prolonged hospital stay and poorer wound healing as well as more complex initial operative indications within the more elderly patients [20, 21]. Despite BMI not having a significant impact, the rate of readmissions, revision surgeries and infection rate increased with BMI. Complications associated with bariatric spinal patients are well documented [22–24]; therefore, highlighting the significance that 60.71% of the patients were either overweight or moderately obese.

Primary closure, sealant and a lumbar drain was the most common repair method. However, despite primary closure being considered the gold standard [6, 10], it was only used in 55.7% of cases (\(n = 59\)). The sample size and grouping of patients resulted in each group containing a small number of patients which likely contributed to non-significant MANOVA results. However, the use of primary closure with or without a patch was shown to be superior in four out of the five of the outcomes. These data show that primary closure ± patch generates on average a shorter initial stay in hospital (4% MCID improvement), a reduced rate of readmission or need for additional surgeries (27% MCID improvement), a shorter readmission period (No MCID improvement) and a lower infection rate (12% MCID percentage improvement). ‘Future research may benefit by comparing the outcomes in a homogenous patient sample between those who received no drain, a subfascial drain or a lumbar drain as part of their tear management. Each type drain cannot be considered as equal and therefore an inter-drain outcome comparisons should be made’.

In recent years, synthetic patches such as a collagen matrix or gelatin sponge have received US Food and Drug Administration approval for use in the repair of a dural tears. This approval provided a growing alternative to the more traditionally used autologous fat, muscle and fascia based patches [25]. Previously opted for autologous patches have reported success rates as low as 70% when...
performed within 24 h of a dural tear [26] and speculative evidence suggests that artificial patches may be better suited to adapt to all defects as they are more readily available, can be cut to shape and may achieve watertight closure in a possibly shorter operative time [25, 27]. Additionally, artificial grafts may display further benefits through their chemotactic interaction with dural fibroblasts [28]. However, there is little direct research between artificial and autologous patches and consequently no consensus on which material is best.

Within this study, when comparing artificial and autologous patches in conjunction with primary closure, artificial patches resulted in shorter hospital admission (33% MCID percentage improvement), lower rates of readmission/need for revision surgeries (67% MCID percentage improvement) and shorter length of additional stays (33% MCID percentage improvement) as well as less severe neurological symptoms post-operatively (8% MCID percentage improvement). This is contrary to the results of Sabatino G, et al. [29] and Abla AA, et al. [30] who both reported no difference when comparing autologous and non-autologous grafts.

Conclusions

This study reports an incidental durotomy rate of 5.81% in a total of 106 patients from Southampton General Hospital’s Neurosurgical and Orthopaedics departments. In accordance with the current literature, 72.64% were sustained at the L3-S1 spinal level.

In this study, age was shown to have a significant impact on post-operative outcomes and BMI displayed positive correlation with the rate of readmissions, revision surgeries and post-operative infection. No significant difference was observed between repair groups; however, primary closure ± a patch scored better in 4/5 clinical outcomes when compared to other forms of repair.

The use of primary closure, a sealant and a lumbar drain was the most commonly opted for repair method and primary was used in only 55.7% of cases. Further analysis showed that artificial patches in conjunction with primary closure achieved lower rates of readmission/need for revision surgery and shorter length of additional hospital stays as well as less severe neurological symptoms post-operatively than autologous patches.

This study highlights the importance of age and BMI on post-operative dural tear outcomes and supports the use of primary closure ± a patch. This study also provides limited evidence in favour of artificial over autologous patches and recommends that dural patches always be used in conjunction with primary closure.

Limitations

The limited data that could be obtained retrospectively restricted analysis to only five outcomes and the small sample size and patient grouping resulted in several groups containing a limited numbers of patients. The study analysis was also dependent on the accuracy of operative notes. Primary limitations of this study therefore include its retrospective method of data acquisition, small sample size, considerable patient and operative heterogeneity and reliance on the accuracy of operative procedural notes. It is important to note that clinical heterogeneity arose from differing pre-operative diagnoses, type of procedure, duration of follow up and method of wound closure which due to insufficient data are unreported in this study. However, despite these causes of heterogeneity, the authors believe that the present study adequately addresses its primary aim of comparing all current methods of iatrogenic dural tear repair surgery across a variety of clinical scenarios and operative indications. This study should therefore serve as a generalizable and more widely applicable attempt to evaluate the most effective dural tear repair method in a boarder operative context. Future research should further define individual patient populations to subsequently eliminate causes of clinical heterogeneity. However, such studies must follow prior non-exclusive research.

Finally, it cannot be certain as to whether the reported neurological deficits in the study were the consequence of the dural tear or the primary surgical procedure. Despite these limitations, the authors believe that this study provides an important overall and generalised evaluation of dural tear repair methods and raises several questions on a clinically and scientifically important topic of spinal surgery.

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Data availability All data generated or analysed during this study are included in this published article.

Declarations

Conflict of interests The authors declare that they have no conflict of interests.

Ethical approval Ethical approval was waived by the local Ethics Committee of The University of Southampton in view of the retrospective nature of the study and all the procedures being performed were routine care.
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