Clinical Neurology and Neurosurgery 138 (2015) 169–173

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Fusion after intradural spine tumor resection in adults: A review of evidence and practices

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ARTICLE INFO

Article history:
Received 16 June 2015
Received in revised form 19 August 2015
Accepted 22 August 2015
Available online 28 August 2015

Keywords:
Spinal cord neoplasm
Spinal neoplasm
Internal fixators
Fusion
Adults

ABSTRACT

There is ample evidence supporting concomitant fusion after intradural spinal tumor resection in select pediatric patients. Unfortunately, the data are scarcer in adults. The objective of this work is to review the published literature and analyze practice patterns for stabilization and fusion after intradural tumor resection in adults. We performed a literature review via PubMed for information available regarding fusion in adults with intradural spine tumors. Additionally, we manually searched the references of selected articles to add relevant articles. Finally, we retrieved the criteria for fusion (if any) in the selected studies. A total of 639 articles were found and 35 were finally selected for analysis. Of those, three were literature reviews and 32 were retrospective case series. There were a total of 1288 patients on the series with 104 of them requiring fusion (8.1%). The median follow up of all the series was 24 months (range 1.5–180).The criteria for fusion that were common in most cases series were: previous deformity (i.e. kyphosis in the cervical spine), 3 or more levels of laminectomy, laminectomy encompassing a spinal junction, "young adults" (33 ± 4.2 years), facetectomy $\geq 50\%$ (unilateral or bilateral), persistence of deformity after 1 year of the surgery and, C2 laminectomy. There appears to be some consistent practices for fusion after intradural tumor resection in adults, but this is based on retrospective analyses of case series. Prospective or randomized trials will likely provide more evidence based support for this practice.

Contents

1. Introduction

Primary spinal cord tumors (SCT) are rare entities that represent 2% to 4% of all primary tumors of the central nervous system in adults [1–3]. However, 850 to 1770 intramedullary SCT are diagnosed each year in the U.S. [1,3], making encounters with these tumors not an uncommon experience for the spine surgeon.

Sixty percent of SCT are located in the extradural space, while 30% are intradural, and 10% have both intradural and extradural components [4]. Within the intradural space, SCT can be divided between intradural extramedullary (70%) and intradural intramedullary [4]. The majority of SCT are classified as low grade (I or II) per the World Health Organization (WHO) [1], incurring a good long term prognosis. Intramedullary tumors represent 8% to 10% of all primary SCT; the majority of which (80% to 90%) are classified as gliomas [1,5]. Ependymomas represent up to 70% of gliomas, while astrocytomas represent 30% [1,5]. The current treatment of choice for these tumors is surgery, in order to achieve total resection [1,4–6].

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http://dx.doi.org/10.1016/j.clineuro.2015.08.020
0303-8467/

Spinal deformity occurs in up to 18% of adult patients after laminectomy to remove SCT [7]. The percentage is even higher in children, ranging from 30% up to 100% in some reports [8–12]. Some of these patients may require fixation after removal of the tumors, due to the high risk of deformity or development of deformity after surgery [13].

There are well known data for the use of fixation after removing SCT in children [12,13]. However, guidelines for fixation in adult patients do not currently exist. The goals of this work are to review the current evidence and practices for fixation and fusion after SCT resection in adults, and to provide a working algorithm to for clinicians to facilitate decision making.

2. Methods

We performed a literature review of the U.S. National Library of Medicine database, via PubMed, from January 1980 to March 2015. Four different search strategies containing the terms "spinal cord neoplasm", "spinal neoplasm", "surgery", "fusion", "internal fixators "and "orthopedic procedures" were done. Additionally, manual searches of the references from the selected articles were done and studies were included in order to be as comprehensive as possible for the analysis.

We limited our analysis to adult patients with intradural SCT. We excluded studies of exclusively pediatric populations (<18 years old) and patients with extradural tumors. If the case series had a combination of pediatric and adult patients, we included the study only if the data had a separate analysis by patients' age. Additionally, if any study had a combination of patients with extradural and intradural pathologies, we included only those where patients were analyzed separately.

From the different results of the search strategies, we first selected the articles by title and abstract. After this, full text of these articles was retrieved for a second selection.

To determine the fusion criteria, we retrieve the authors' comment on their particular criteria for fusion. After all the articles were analyzed we paired the criteria together to get the definitive criteria. Additionally we retrieve from each study the number of patients treated, the number of patients that require fusion, the length of the follow up and complications reported.

3. Results

A total of 639 articles were found within the primary query; after scanning for title and abstract, 50 articles were retrieved in full text, and 25 articles were selected. Additionally, 10 articles were added from the manual search of the references from those 25 selected articles. The final analysis was performed on 35 articles (Fig. 1).

Of the 35 articles, 3 were literature reviews and 32 were retrospective analyses of patient series. There was no prospective study addressing this topic.

There were a total of 1288 cases; 104 required fusion (8.1%). The median time to follow up between all the series was 24 months (range 1.5–180).

Of all the cases, 38.5% were at the cervical spine, 27.1% at the thoracic spine, 19.6% at the lumbar spine, 7.5% at the thoraco-lumbar spine, and 7.3% at the cervico-thoracic spine.

Though there was inherent variability in the studies and thus, the analysis, the following criteria were common in cases were fusion was advocated: spine deformity present before surgery (i.e. kyphosis in the cervical spine) [14–16], surgery involving three or more vertebral levels [14–18], patients considered "young adults" (mean 33 years S.D. 4.2 years) [14,16], removing 50% or more of the facets joints (unilateral or bilateral) [8,15–17,19–25], persistence of neck/back pain or failure of conservative management 1 year after surgery [7,8,14,26], surgery encompassing a spinal junction (cervico-thoracic or thoracolumbar) [7,14,17,27,28], and laminectomy of the C2 vertebra [17,28–30].

4. Discussion

The preferred treatment for SCT is total surgical excision, as it yields the best long term outcomes [3]. Multlilevel dorsal midline laminectomy has been the most common surgical approach for these tumors; nonetheless, in recent years, a shift to laminoplasty has been seen [7,19,31]. Recently, with the advancement of microsurgical and minimally invasive techniques, hemilaminectomy for certain patients has proved feasible for removing SCT [18,24,32,33].

The incidence of deformity after laminectomy for degenerative disease of the spine is well known [34,35]. Furthermore, deformity after laminectomy for removal of SCT has a high incidence in pediatric patients [8,10,36,37]. Recent studies have shown the incidence of deformity after surgery for SCT in adults ranging from 16% for laminoplasty [7], 18% for laminectomy [7] and from 23% to 52% in the cervical spine [17]. SCT can present with spinal deformity at the first visit [12,36] making these particular cases very likely to need fusion. Although deformity in the cervical spine may be as high as 52% [30], clinical instability will be encountered in 12% of those patients on a long term follow up. Furthermore, specific pathologies will make deformity a more common presentation in SCT such as neurofibromatosis that may lead to kyphoscoliotic deformity [38,39].

To the best of our knowledge, this is the first literature analysis specifically addressing the need and criteria for instrumented fusion after SCT resection in adults. Our results showed that in previous and current practices, approximately 8% of adult patients with SCT required fixation. However this number is an aggregate of the studies found, where fusion procedures where performed in a wide range from 2% [7] to 50% [18] of their cases. The need to fuse the spine after intradural tumor resection in adults is thus low over all, but the difference in fusion rate encountered in the studies may be due to the variety of practices worldwide. We listed the criteria discussed in the articles and that were found in other case series. We included criteria that involved at least 2 different case series, using the same specifications for fusion, for consideration as definite criteria. These criteria are based on analysis of more than 1200 patients treated for SCT.

Despite the available literature on SCT surgery, only two articles directly addressed the need for fusion after surgery. Sciubba et al. [17] only focused on the cervical spine, while Zong et al. [18] compared minimally invasive against non-minimally invasive procedures, with and without pedicle screw fixation to assess spine instability. The remainder of articles found, were descriptions of particular case series or the introduction of new procedures to remove SCT. In our analysis, we try to elucidate the rationale given by the authors when deciding to use fixation; however, most of the reasons were not well discussed, so the rationale to use fixation remains elusive.

Some authors decided to perform a fusion when they considered the tumor large enough to require it [24,28,40]. We did not, however, list this as separate criteria, because it fit within two criteria, already proposed: more than 3 levels of laminectomy and/or surgery encompassing a spinal junction. Others [20] described a new procedure that involved removing the facets; due to their approach, fusion was planned a priori. In the rest of the articles, the authors listed their reason for fusion as one (or a combination of) the seven criteria listed.

Some criteria mentioned above are well known to create instability after spine surgery, such as, facetectomy [41,42] and surgery encompassing a spinal junction [43–45]. The latter may be the