C5 palsy following anterior cervical discectomy and fusion

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Abstract The postoperative complication of C5 paralysis is more common than reported in the literature. The incidence associated with anterior cervical discectomy and fusion (ACDF) is yet to be established. The prognosis and etiology is not well understood. Most of the cases go unreported because most of the palsies resolve with time and conservative management. However, some patients are left with devastating impairment of upper extremity function. Two hundred consecutive cases from my practice were analyzed during a period in which I had six cases of C5 palsy following ACDF. While this not an excessive number (and is below the loosely reported incidence of about 8%), each case was worrisome both to the patient and to me, the surgeon. As a result, I was determined to eliminate this complication from my surgical practice.

Method In this study, I analyzed the clinical, imaging studies and surgery performed on 200 patients with C4-5 disc disease operated in a five year period by one surgeon. Six of these patients had C5 palsy immediately following ACDF. All six patients had some degree of deltoid motor weakness prior to ACDF ranging from grade 4/5 to 2/5 on manual muscle testing (MMT). The MRI/CT studies showed marked foraminal stenosis at multiple levels on all six patients. Two patients had disc protrusion to the side of deltoid muscle paralysis. The other three had disc bulging with associated degenerative changes including OPLL. One patient had a disc herniation at C4-5 and C3-4 with associated degenerative changes. The patients who did not have C5 palsy following ACDF had, for the most part, less degenerative disease and minimal deltoid weakness (4/5 on MMT) preoperatively and were mostly one or two level disc surgeries.

Results The initial MRI was carefully reviewed in all cases of C5 palsy and compared with the post- operative MRI. One case was suggestive of preoperative T2 magnetic resonance signal changes in the anterior horn area of the spinal cord. [6] These changes persisted postoperatively. All six cases had in common multiple level disease and ACDF, i.e. two or more disc levels. In addition, the more severe the stenosis, the more likely a C5 palsy would occur subsequent to ACDF. Only one two level ACDF had C5 palsy. Predicting who might develop C5 palsy from the preoperative MRI was suggested but not fully established.

Conclusion The MRI scan findings are suggestive of the etiology of C5 palsy, but this is not conclusively established in this study. There was a suggestion of edema in the C3-4 and C4-5 anterior horn cells (the anterior horn cells for the C5 and C6 nerve roots) postoperatively on the T2-weighted magnetic resonance images(Fig 4).[6] This may suggest that the decompression may have been too extensive for the nerve root in a severely stenosed foramen. All C5 palsy patients were treated aggressively with steroids, galvanic nerve/muscle stimulation and physical therapy including both active and passive shoulder range of motion exercises. All six patients recovered complete function in the affected deltoid muscle. Five patients had full return of function within one to six weeks postoperatively. One patient recovered function in nine months. As a result of these critical analyses, my operative technique was altered to include the use of the diamond tip burr and high speed drill with less use of the Kerrison/curette to decompress the nerve root in the severely stenosed foramina with multilevel disc surgery. The operating microscope was used in all cases.

Key Words C5 Palsy, ACDF, MRI high intensity, Deltoid muscle

Introduction

It is well established that C5 palsy occurs following both posterior and anterior spinal approaches for cervical spine pathology. The posterior approach, i.e. laminoplasty, has been studied for C5 palsy more than the anterior approach. There is still not a clearly established incidence of C5 palsy because most cases go unreported. The reason for the present study was not to establish incidence but to illuminate on the prognosis and treatment of C5 palsy after anterior cervical surgery. Mechanisms of development of C5 palsy following ACDF are also eluded too. This is a report of one surgeon's experience over a five year period from 1995 to 2000 in dealing with six cases of C5 palsy following ACDF. In the following five years, with higher numbers of ACDF, there were no cases of C5 palsy as a result of this study.

Methods

All patients were selected from one surgeon's practice at a well know neurosurgical center. The patient population was between 1995 and 2000. Two hundred patients underwent ACDF by the author. The majority of the patients were operated for cervical spondylotic radiculopathy. However, the next largest category was cervical spondylotic myeloradiculopathy. Ossification of the Posterior Longitudinal Ligament (OPLL) [1, 5] was also well represented in the 200 cases. A fair number of herniated cervical discs, in young adults, were also done in that five year period. See Table 1 for the total number of cases and the results.

Table 1 Types of ACDF cases operated from 1995 to 2000

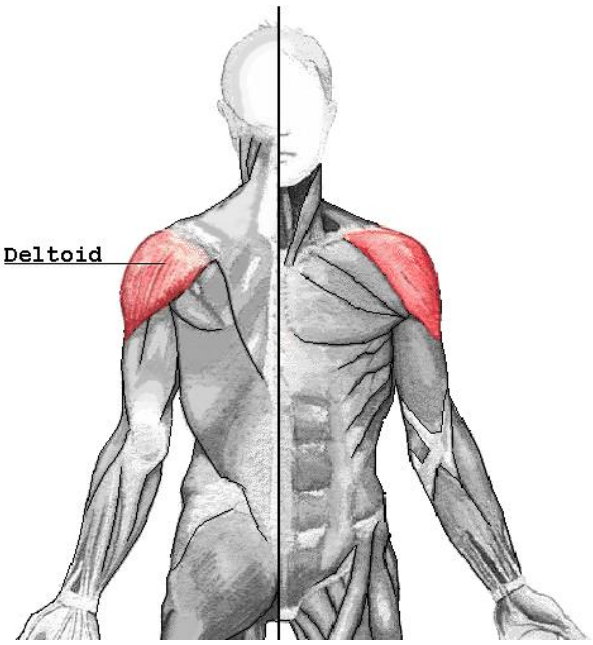
Cervical Disease	Cases	Cases of complete C5 palsy	Levels ACDF
Cervical spondylotic radiculopathy	99	2 with C5 palsy	3 levels
Cervical spondylotic myeloradiculopathy	68 [1, 5]	2 with C5 palsy	3 levels
OPLL [1, 5]	20	1 with C5 palsy	3 levels
Cervical herniated disc (Fig. 2)	13	1 with C5 palsy	2 levels
Total	**200**	**6 Developed C5 palsy Following ACDF**	

Deltoid Muscle Innervation

The deltoid is innervated by the axillary nerve (Fig. 1). The axillary nerve originates from the ventral rami of the C5 and C6 cervical nerves, via the superior trunk, posterior division of the superior trunk, and the posterior cord of the brachial plexus.[4]

For practical clinical purposes, the C6 contribution to the deltoid is nonexistent. This is unlike the biceps and triceps which have strong innervations by two cervical nerve roots and thus, the motor weakness in these muscles is not as profound as in the deltoid muscle with C5 palsy.[7]

The C5 nerve root originates at the C4-5 disc level from the anterior horn cells of the spinal cord. When the anterior horn cells or the ventral rami of C5 are disrupted from degenerative disease, trauma or herniated disc a C5 palsy of varying degrees may occur. The contribution from the C6 ventral rami is essentially negligible in maintaining function in the deltoid muscle.



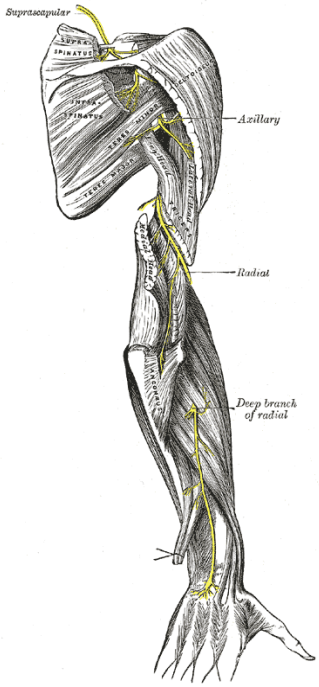


Fig. 1 An important function of the deltoid in humans is stopping: preventing the dislocation of the humeral head when a person carries heavy loads. The function of abduction also means that it would help keep carried objects a safer distance away from the thighs to avoid hitting them, such as during a farmer's walk. It also ensures a precise and rapid movement of the glenohumeral joint needed for hand and arm manipulation [4]

None of the patients who had ACDF at C5-6 had preoperative or postoperative weakness of the deltoid muscle, thus negating the significance of the C6 nerve root contribution to the deltoid muscle. The only cases that developed C5 palsy were those that were operated at the C4-5 disc level. There was no associated C5 sensory deficit in any of the patients preoperatively or postoperatively.[4]

Intraoperative Neuromonitoring

Intraoperative neuromonitoring was done on all patients with OPLL and patients with myelopathy undergoing ACDF. Debilitating iatrogenic C5 palsy can be prevented as well as more serious spinal cord injury. [4]

Dedicated Intraoperative Electromyography

Intraoperative EMG monitoring the C5 nerve root may be advisable in certain cases of high risk established prior to surgery, i.e., high signal intensity at C3-4 and C4-5 on the T2 MRI, spinal stenosis at C3-4, C4-5 with or without myelopathy, ossification of the posterior longitudinal ligament (OPLL) with or without myelopathy and preoperative objective evidence of weakness of the deltoid muscle on MMT. [2]

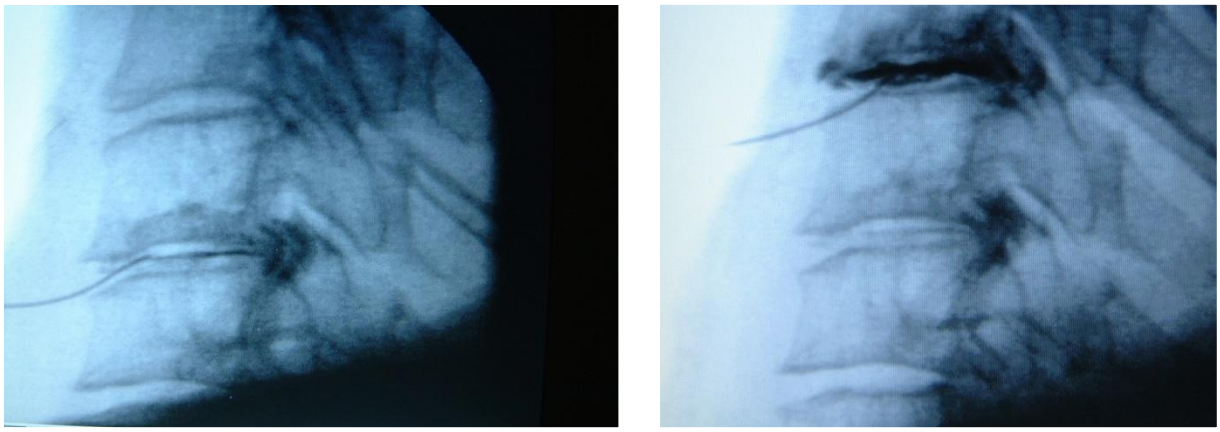


Fig. 2 Discography: Positive at C3-4 and C4-5 with high signal intensity found on the MRI at the ventral horn cells at the corresponding levels. [6] There was deltoid motor weakness 2/5 on MMT and C5 radiculopathy on EMG.

Nerve Root Decompression

The operating microscope is absolutely mandatory in decompressing the nerve roots in ACDF surgery (Fig. 3ab). The use of the high speed drill and diamond tip burr (2.5 mm) is a safe way to decompress a nerve root in a tight foramen (Fig. 5). The diamond tip burr can be used to shell out the foramen leaving a thin layer of cortex to be pushed safely away from the nerve root and removed with a micro curette (Fig. 5). Hypertrophied uncal joints can also be safely removed in this manner. It is also vitally important to operate with an experienced surgical assistant who knows how to keep the field dry while you are decompressing the nerve root (Fig. 3b).

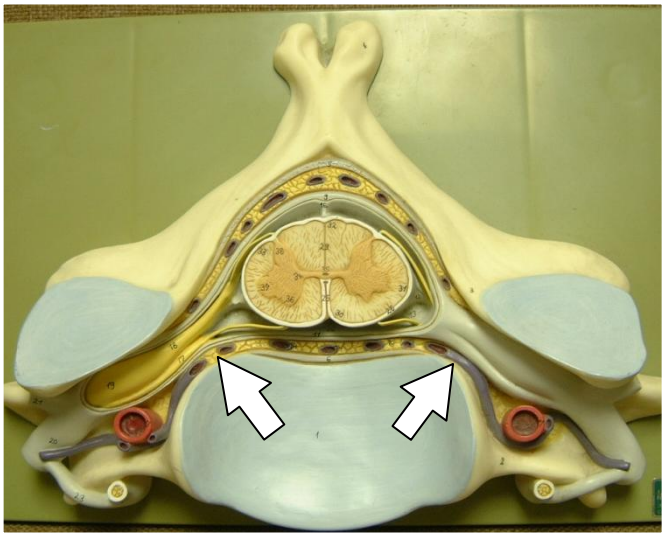


Fig. 3a The Cervical foramina and nerve roots

Fig. 3b The Operating Microscope for nerve root decompression in ACDF

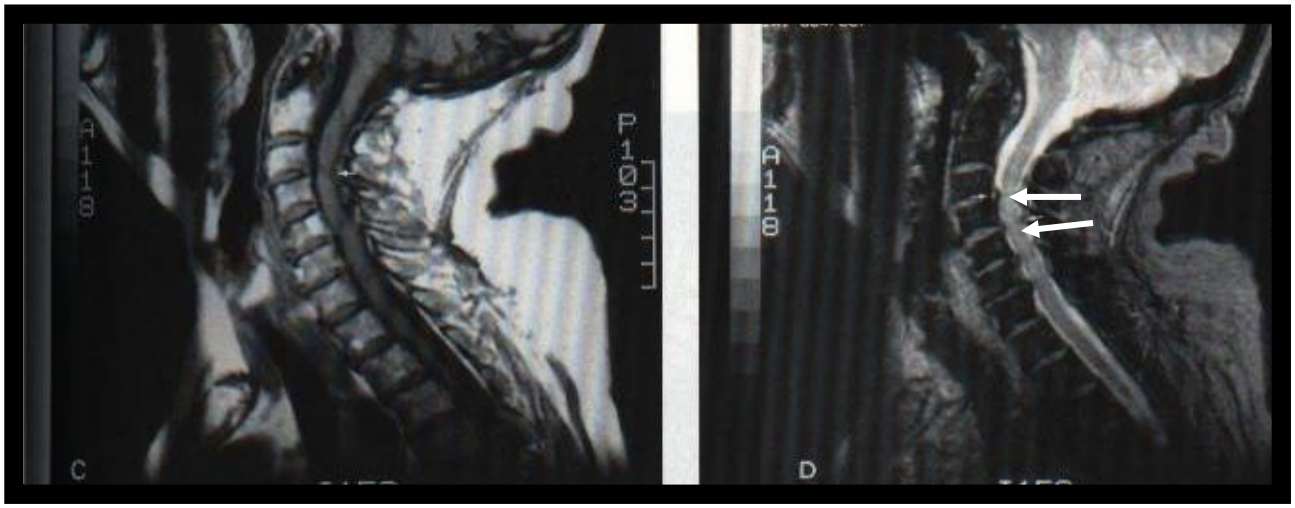
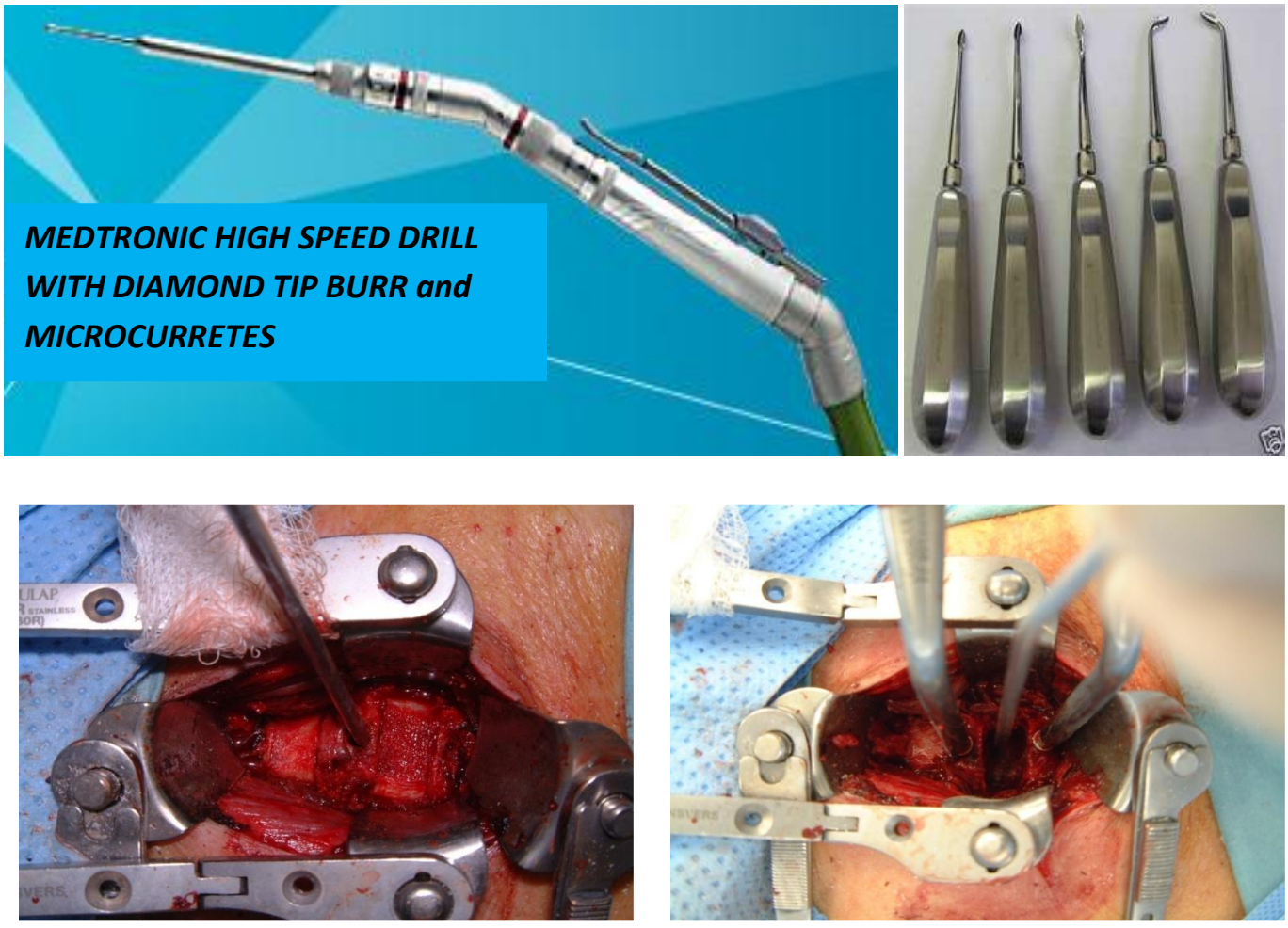


Fig. 4 Signal changes on MRI (arros) Hyperintensity on *T2 W* at C3-4 and C4-5. Some have suggested that patients with spinal cord lesions at C3-4 and C4-5 levels may be prone to the development of C5 palsy [6]. One such case was encountered in this series.

Fig. 5 Instrumentation to avoid trauma to the nerve root.



Conclusion In one of my cases, the MRI detected spinal cord signal changes suggestive of edema in the anterior horn cells.[6] Although the scan findings are suggestive as the etiology of C5 palsy, this is not conclusively established in this study. There was a suggestion of edema in the C3-4 and C4-5 anterior horn cells (the anterior horn cells for the C5 and C6 nerve roots) postoperatively on the T2-weighted magnetic resonance images.[6] To me this indicated that my decompression may have been too extensive for the nerve root in a severely stenosed foramen. All C5 palsy patients were treated aggressively with steroids, galvanic nerve/muscle stimulation and physical therapy including both active and passive shoulder range of motion exercises. All six patients recovered complete function in the affected deltoid muscle. Five patients had full return of function within one to six weeks postoperatively. One patient recovered function in nine months. The return of function was with unexplained spontaneity ("overnight") in all six patients. As a result of these critical analyses, my operative technique was altered to include the use of the diamond tip burr and high speed drill with less use of the Kerrison/curette to decompress the nerve root in the severely stenosed foramina with multilevel disc surgery. Of course, the operating microscope was used in all cases. All patients were forewarned that C5 palsy could happen post operatively and they were reassured that function would more than likely return to normal in a few days.

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