Frequency and Outcome of Neoplastic Brachial Plexopathy: Single Institution Experience

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Abstract
Symptomatic neoplastic brachial plexopathy (NBP) is estimated to occur in about 0.4% of all patients with cancer. The aim of this review was to determine the incidence of NBP occurring in patients referred for magnetic resonance imaging (MRI). A retrospective review over a 5 year period revealed that a total of sixty-six MRIs of brachial plexus were performed. Twenty-nine were performed for assessment of suspected traumatic injuries. Eighteen MRIs were performed in patients with a known cancer diagnosis, one was performed in a patient with a benign thymoma, one with a neurofibroma and the remaining seventeen MRIs were ordered for other conditions. In total, thirteen MRIs were positive for brachial plexopathy (seven traumatic, five due to cancer, one neurofibroma). Of the twenty MRIs performed in patients with neoplasms, six (30%) confirmed a diagnosis of NBP. Twenty seven point eight per cent (5/18) of patients with a diagnosis of cancer had NBP.

Introduction
Neoplastic brachial plexopathy (NBP) may occur with benign or malignant conditions. NBP is a devastating condition; it sometimes is diagnosed late due to failure of physicians to recognise the condition. It can result from direct compression from a cancer mass as seen in Pancoast syndrome (typically a superior sulcus lung cancer invades the lower plexus, principally the inferior trunk and medial cord) However, invasion by cancer cells along nerves or tracking along connective tissue is more common due to metastases from axillary lymphatics. Alternatively, it may occur due to leptomeningeal metastases tracking into nerve sheaths. Brachial plexopathy syndromes are rare. Kori et al (1981) reported a case series of 100 cancer patients with brachial plexopathy and determined that the overall incidence among cancer patients was 0.43%.

In that series, 37% of cases were due to lung cancer, 32% to breast cancer, 8% to lymphoma, 5% to sarcoma and 16% due to other cancers. NBP is estimated to occur in 4% of patients with lung cancer and 2% of patients with breast cancer. An important differential diagnosis is radiation-induced brachial plexopathy. Radiation may injure axons directly or injure the vaso-nervorum causing ischaemic changes to axons with multifocal denervation. Brachial plexopathy associated with radiation therapy occurs in 2% to 4.9% at 5 years.

In patients with cancer there is usually chronic progression of brachial plexopathy. Presenting features include increasing pain (80%) with neuropathic features involving the shoulder and upper arm, progressive paraesthesia or numbness, weakness of particular muscles. Invasion of the lower plexus (inferior cord and medial trunk, 75%) occurs more frequently than invasion of the upper trunk. Sensory loss commonly involves the axillary nerve distribution. The aim of this audit was to determine the frequency of NBP (benign and malignant neoplasms) among patients referred for MRI of the brachial plexus at the Mater Hospital, Dublin, which is a tertiary referral centre for cancer treatment, and to assess outcomes to treatment.

Methods
A retrospective review was performed of the reports of the MRIs of brachial plexus performed over a five year period from 1st January 2004 to 31st December 2008 at the Department of Radiology, Mater Misericordiae University Hospital, Dublin. A list of the MRIs of the brachial plexus was compiled by inserting the search terms “MRI of Brachial Plexus” into the radiology database. Each individual report of MRI of brachial plexus was then reviewed to determine the underlying diagnosis and confirm the presence or absence of brachial plexopathy. The medical records were then assessed for all patients with cancer who were imaged by MRI, focusing specifically on the patients with a confirmed MRI diagnosis of neoplastic brachial plexopathy to categorise the underlying histologic diagnosis and capture baseline demographic data, presenting features, treatment and outcomes.

Results
From 1st January 2004 to 31st December 2008, a total of sixty-six MRIs of the brachial plexus were performed at the Mater Misericordiae University Hospital. Twenty-nine MRIs were performed for assessment of suspected traumatic injuries to the brachial plexus. Eighteen MRIs were performed in patients with a history of cancer. One MRI was performed in a patient with a history of benign thymoma. One MRI was performed in a patient with a neurofibroma. Seventeen MRIs were performed as there was a suspicion of brachial neuritis (Parsonage Turner Syndrome), subclavian steal syndrome or demyelinating disorder. In total, thirteen MRIs were positive for a diagnosis of brachial plexopathy (Figure 1).
In our series in the past 5 years, 9% (6/66) of total number of MRIs of brachial plexus performed were positive for a diagnosis of NBP. Of the twenty MRIs performed in patients with a neoplasm (eighteen in patients with cancer, two with a history of benign neoplasms), six (30%) confirmed a diagnosis of neoplastic brachial plexopathy (Figure 2). Twenty-seven percent (5/18) of patients with a diagnosis of cancer had NBP. The female:male ratio was 5:1. The median age was 67 years (range 35 years to 86 years). There were no cases of radiation-induced brachial plexopathy in this series but of note, radiation oncology services are not performed on site at our cancer centre. Nerve conduction studies were not performed on any of the patients with confirmed diagnosis of NBP. Eighty percent of patients also had an MRI of the cervical spine performed.

Figure 3: Illustrates invasion of the brachial plexus by an axillary metastases from squamous cell carcinoma of the lung.

With regard to the extent of disease at the time of diagnosis of NBP, four patients had widespread metastatic disease: in one patient, NBP was the presenting symptom that led to a cancer diagnosis (squamous cell carcinoma of the lung) and the three other patients had progression elsewhere in addition to developing NBP. In one patient, an 86 year old lady, further investigations to determine the extent of metastatic disease were not performed. One patient had a benign neurofibroma. All patients had preceding symptoms of pain, paraesthesia and reduced power in the upper limb.

Figure 3 illustrates the MRI appearance of one of the cases of NBP. Figure 4 indicates the treatments offered. Radiotherapy was the treatment of choice for five patients with cancer diagnosis, followed by chemotherapy also for one patient. Data was missing on treatment for the patient with neurofibroma. Some improvement in pain control was achieved with radiotherapy but none of the patients had improvement in the neurological deficits as determined by physical examination.

Discussion
In our series spanning five years, 21% (14/66) of MRIs of the brachial plexus performed confirmed brachial plexopathy, whether due to trauma, neoplasm or other causes. Specifically, 9% (6/66) of the total number of MRIs performed confirmed NBP. Thirty percent (6/20) of the MRIs performed in patients with a documented history of a neoplasm (benign or malignant) and in whom NBP was suspected were positive. Twenty-eight percent (5/18) of these cases were in patients...
with cancer. There are a number of limitations to this audit. The audit looked only at NBP diagnosed by MRI imaging and could have potentially missed NBP diagnosed by computed tomography (CT) or positron emission tomography (PET). Neoplastic brachial plexopathy scans were not performed in any of the patients diagnosed with NBP in this series. It is possible that other cases could have been diagnosed solely by electrophysiological studies and thus these patients would not have been captured in this audit as our search used only the radiology database as the source to generate our patient list. Mullins et al reported that the diagnostic yield of MRI was low (33%) in patients with a previous history of cancer in whom nerve conduction studies and electromyography had confirmed a diagnosis of NBP (CT) scanning may be of less value. In a retrospective review of 102 patients with a previous history of breast cancer in whom CT of axilla and brachial plexus was performed for upper limb oedema, palpable mass or symptoms of brachial plexopathy, only 21% of CTs demonstrated tumour recurrence in the axilla.

In a series reported by Cascino et al which included 46 patients with established diagnosis of NBP, the CT scan was normal in 11% of patients. PET with 2-fluorodeoxyglucose (2-FDG) may play a role in identifying NBP. Ahmad et al performed FDG-PET in 19 patients with a history of breast cancer who had symptoms referable to the brachial plexus. Fourteen of the 19 patients had uptake in the region of the brachial plexus identified on PET. CT scans were performed in 9 of these patients but tumour in the brachial plexus was only seen in 3 of the CT scans. The authors concluded that FDG-PET is a useful tool in evaluation of patients with suspected metastatic plexopathy, particularly if other imaging studies are normal.

The incidence of neoplastic brachial plexopathy occurring in all patients with cancer attending the Mater Hospital over five years could not be calculated as the population studied were all patients undergoing MRI of brachial plexus rather than all patients with cancer. Thus the figure of 28% (5/18) is the 5-year incidence of NBP occurring in symptomatic patients with cancer who were brought to the attention of the medical oncology team rather than the total incidence of NBP in the entire population of patients with cancer attending the Mater Hospital. In addition, perhaps cases of radiation-induced brachial plexopathy (RBP) may have been missed, as radiation fibrosis causes more subtle changes that may not be recognised by radiologists who infrequently encounter the diagnosis. Radiation fibrosis is usually low on T1- and T2-weighted MRI images and does not enhance after the administration of gadolinium. Tumour is characteristically low on T1- and high on T2-weighted images and may enhance. However, variations in tumour signal intensity can occur. FDG-PET may be able to distinguish between NBP and radiation-induced brachial plexopathy is the subject of further investigation. Despite therapy NBP is most often irreversible. Physicians should have a high degree of suspicion for NBP in patients presenting with upper limb pain, paraesthesia and weakness.

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