NICE guidance

Phrenic nerve transfer in brachial plexus injury

Interventional procedures guidance
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Your responsibility

This guidance represents the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, healthcare professionals are expected to take this guidance fully into account, and specifically any special arrangements relating to the introduction of new interventional procedures. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer.

All problems (adverse events) related to a medicine or medical device used for treatment or in a procedure should be reported to the Medicines and Healthcare products Regulatory Agency using the Yellow Card Scheme.

Commissioners and/or providers have a responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity, and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with

those duties. Providers should ensure that governance structures are in place to review, authorise and monitor the introduction of new devices and procedures.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

1 Recommendations

1.1 The limited quantity of evidence on the efficacy of phrenic nerve transfer in brachial plexus injury shows useful recovery of arm function in some patients, but there is very little information about long-term functional and quality-of-life outcomes, and evidence on safety shows some impairment of respiratory function. However, patients with brachial plexus injuries are often very disabled and treatment options may be limited. Therefore, this procedure may be used with normal arrangements for clinical governance, consent and audit.

1.2 During the consent process patients should be informed, in particular, that the procedure may not restore useful function in the arm and that it may compromise respiratory function.

1.3 Patient selection and treatment should only be carried out in units that specialise in the management of complex brachial plexus injuries and offer a full range of treatment options.

2 Indications and current treatments

2.1 Brachial plexus injuries are typically caused by traction of the arm at birth and by road traffic accidents. They result in loss of sensation and movement in all or part of the arm and can be associated with severe pain. The exact symptoms depend on the severity and location of the injury.

2.2 Brachial plexus injuries in which the nerves are injured but still intact are usually managed by conservative care, including physiotherapy. If the plexus has been disrupted, then surgical repair is considered. This may be possible by direct

suture, or it may involve the use of nerve grafts if the nerve ends are separated. If neither of these is possible, for example in nerve root avulsion, nerve transfer (neurotisation) can be done, in which a healthy nerve to a different muscle is joined to a damaged nerve, to re-innervate the affected arm muscle. A variety of nerves may be used for this kind of procedure, including intercostal nerves, the spinal accessory nerve, the phrenic nerve and the motor branches of the cervical plexus. Sometimes, free muscle or tendon transfer is done in combination with nerve transfer to re-innervate the forearm muscles.

3 The procedure

3.1 The procedure is performed with the patient under general anaesthesia, by a supraclavicular approach. The brachial plexus is explored and the root avulsion confirmed. The phrenic nerve is identified in the neck on the surface of the scalenus anterior muscle, or in the chest thorascopically to provide a longer segment for grafting. Phrenic nerve function is confirmed by neurophysiology. The nerve is divided, transferred and joined to the distal segment of the selected damaged nerve either directly or via an interposition graft if necessary. The aim of the procedure is to re-innervate the target muscles and improve arm function.

3.2 Postoperatively, a head and shoulder spica may be applied for several weeks to avoid tension on the nerve transfer. Specialist rehabilitation is provided to maximise the recovery of useful arm function.

3.3 Phrenic nerve transfer may be combined with other donor nerve transfers at the same time or in stages.

4 Efficacy

This section describes efficacy outcomes from the published literature that the Committee considered as part of the evidence about this procedure. For more detailed information on the evidence, see the overview.

4.1 A quasi-randomised study comparing phrenic nerve transfer (PNT; n=17) against

intercostal nerve transfer (n=19) to the musculocutaneous nerve in 36 patients reported that motor recovery of biceps occurred significantly later in the PNT group (mean 262 days) than in the intercostal nerve transfer group (mean 195 days; p=0.03). Biceps muscle motor recovery to Medical Research Council (MRC) grade 3 (able to overcome gravity) or greater strength was reported in 29% (5 out of 17) of patients in the PNT group and 53% (10 out of 19) of patients in the intercostal nerve transfer group at 1-year follow-up. In the PNT group 23% (4 out of 17) of patients had no recovery, but all patients in the intercostal nerve transfer group regained some muscle motor function, and after rehabilitation could separate breathing from biceps function.

4.2 A case series of 40 patients treated by PNT to the anterior division of the upper trunk of the brachial plexus to restore elbow flexion reported that the biceps muscle strength recovered to MRC grade 3 or greater in 83% (33 out of 40) of patients at an average follow-up of 28.2 months. Recovery to MRC grade 3 or greater strength occurred in 91% (29 out of 32) of patients aged under 40 years, and in 50% (4 out of 8) of patients aged 40 years and over. For patients who had the procedure more than 1 year after the injury, the recovery rate was 25% (1 out of 4 patients).

4.3 A retrospective case series of 180 patients treated by PNT to the musculocutaneous nerve followed up 65 patients for more than 2 years. The study reported that 85% (55 out of 65) of patients regained biceps muscle power to MRC grade 3 or greater strength. The average time taken for restoration of muscle strength to MRC grade 3 was 9.5 months. Longer delays in treatment were associated with lower levels of recovery. Patients who had a nerve graft had similar results to patients who had a direct nerve transfer. Poor results were seen in patients with severe crush injuries and associated fractures in the shoulder region.

4.4 The specialist advisers listed key efficacy outcomes as restoration of muscle function or joint movement/elbow flexion, shoulder stability, control of re-innervated muscles and functional scores such as DASH (Disabilities of the Arm, Shoulder and Hand) and QALY (quality-adjusted life year) measures.

5 Safety

This section describes safety outcomes from the published literature that the Committee considered as part of the evidence about this procedure. For more detailed information on the evidence, see the overview.

5.1 A retrospective comparative study of 42 patients comparing phrenic nerve transfer (PNT; n=19) against PNT with multiple intercostal nerve transfer (PNT+MIT; n=23) reported that a certain degree of hemidiaphragm elevation (a mean of 1 to 1.5 intercostal spaces) was observed in 90% (38 out of 42) of patients at a mean follow-up of 10 years. Diaphragmatic excursion was reduced by a mean of 0.5 to 1 intercostal spaces in both the groups after the procedures. Hemidiaphragm elevation and movement reduction did not worsen as the number of intercostal nerves used increased from 2 to 4 in the PNT+MIT group, or if both procedures were done at the same stage or performed at an interval of 1 to 2 months.

5.2 A case series of 19 patients treated by PNT+MIT reported persistent ipsilateral diaphragmatic paralysis in all patients for up to 36 months ($p<0.01$).

5.3 The quasi-randomised study of 36 patients comparing PNT (n=17) against intercostal nerve transfer (n=19) reported that pulmonary function (forced vital capacity, forced expiratory volume in 1 second, vital capacity and tidal volume) was significantly lower in the PNT group than in the intercostal nerve transfer group throughout 1 year of follow-up. Body position had a significant effect on forced vital capacity in the PNT group but no effect in the intercostal nerve transfer group.

5.4 The retrospective case series of 180 patients of whom 65 patients were followed up for more than 2 years reported that pulmonary function tests in 19 patients (including forced vital capacity, total lung capacity, functional residual capacity, vital capacity and maximum ventilation volume) showed decreased pulmonary function during the first year after PNT surgery, improving to normal values by 2 years.

5.5 The case series of 19 patients who had PNT+MIT reported mild dyspnoea on exertion in 42% (8 out of 19) of patients at 6-month follow-up ($p<0.05$), which

resolved by 1-year follow-up.

5.6 The specialist advisers listed theoretical adverse events as chest wall deformity, herniation, basal atelectasis or collapse, poor voluntary control of muscles innervated by the transfer and failure to re-innervate target muscles due to proximal injury to the phrenic nerve.

6 Committee comments

6.1 The Committee was advised that impaired respiratory function is of particular concern in children and that in general this procedure would not be suitable for children.

7 Further information

Sources of evidence

The evidence considered by the Interventional Procedures Advisory Committee is described in the overview.

Information for patients

NICE has produced information for the public on this procedure. It explains the nature of the procedure and the guidance issued by NICE, and has been written with patient consent in mind.

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Endorsing organisation

This guidance has been endorsed by Healthcare Improvement Scotland.