From the Division of Endocrine Surgery, Department of Surgery, University of Graz, Graz, Austria

Neuromonitoring is not a Standard Procedure in Thyroid Surgery

G. Wolf

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Schlüsselwörter: Chirurgie der Schilddrüse – Endokrinchirurgie – Recurrensparese – Komplikationen – Neuromonitoring – learning curve.

Summary: Background: The main concern with postoperative results is the integrity of the voice. As there is no causal therapy for recurrent nerve paralysis, close attention has to be paid to the preservation of the laryngeal motor nerve. Neuromonitoring (NM) is a new technique for identifying the nerve in its anatomical position, but it has failed to lower the postoperative complication rate.
Methods: The data from the literature were compared. Many studies showed a rapid decrease in palsy rates by general nerve preparation, but the outcome was still influenced by various factors such as underlying disease and surgical radicality. Only one study did not show any difference in outcome with or without nerve identification.
Results: Even though there is an unequal composition of data sources, it is highly suggestive that surgical development that has focussed attention on nerve preservation has led to an improvement in postoperative outcome. In general, palsy rates with nerve preparation are below 1%. The same improvement is reported with the use of neuromonitoring. It seems that these effects are similar to those obtained by nerve preparation alone. Moreover, intra- and postoperative nerve function does not always correlate. No clear-cut advantage in the results achieved with NM can be stated.
Conclusions: Besides the fact that considerable basic research has been done using NM, the data concerning improvement of nerve palsy rates do not necessitate its general use in routine thyroid surgery. Subtle operative technique and visualization of the structure are still mandatory. NM might help shorten the learning curve in identification exercises.

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Neuromonitoring ist keine Standardmethode in der Chirurgie der Schilddrüse

Zusammenfassung: Grundlagen: Die Integrität der Stimme ist ein wesentliches Kriterium zur Beurteilung der postoperativen Ergebnisse in der Chirurgie der Schilddrüse. Da es laryngologischerseits keine kausale, lediglich symptomatische Therapie der Recurrensparese gibt, ist die Vermeidung von Nervenschäden der wichtigste Punkt. Neuromonitoring (NM) ist eine hervorragende Methode zur Identifikation des Nerven in seiner anatomischen Lage, die Rate an postoperativen Komplikationen ist damit aber nicht sicher beeinflußt.
Methodik: Die Daten der Literatur werden verglichen. Zahlreiche Studien zeigen den deutlichen Abfall an Nervenläsionen durch eine generelle Präparationstechnik des Nerven, aber die postoperativen Ergebnisse, bezogen auf Pareseraten, sind durch Multivarianten wie Grundkrankheit und OP-Strategie und -Radikalität beeinflußt. Nur eine Studie zeigt keinen Unterschied, mit oder ohne generelle Nervenidentifikation.
Ergebnisse: Trotz des Vergleichs sehr unterschiedlicher Daten zeigt sich in der Tendenz eine deutliche Verbesserung der Ergebnisse dadurch, daß dem Faktor Nervenpräservation höheres Augenmerk geschenkt wurde. Generell sind Paralyseraten unter Nervenpräparation unter 1%. Der gleiche Verlauf ist unter Neuromonitoring zu verzeichnen. Der Effekt unter Neuromonitoring scheint derselbe wie unter Nervenpräparation alleine zu sein. Außerdem korrelieren intra- und postoperativer Nervenbefund nicht immer. Kein sicherer Vorteil der Verwendung der Methode ist nachgewiesen.
Schlußfolgerungen: Neuromonitoring erlaubt eine intensive wissenschaftliche Auseinandersetzung mit der Elektrophysiologie der Stimme. Die Datenlage, bezogen auf Verbesserung der postoperativen Recurrenspareseraten, ergibt jedoch keinen sicheren Einfluß und erlaubt keine Empfehlung für ihren Einsatz in der Routinechirurgie. Subtile Operationstechnik am Nerven, unter strikter Visualisierung, ist unabdingbar. Allerdings ermöglicht NM eine deutliche Reduktion der Learning-Curve bei Identifikationsproblemen.

Introduction

Postoperative voice disorders are a major concern in surgery of the endocrine organs of the neck. The greater part – but not all of them – will be caused by damage to the recurrent laryngeal nerve. The main improvement of thyroid and parathyroid operative results is due to the fact that technical specialization has focussed on prevention of recurrent nerve injury. Voice disorders, whether caused by intubation injuries, transient or permanent nerve palsy, are no longer considered to be a rare but unavoidable mishap in thyroid surgery. Serious attempts at technical progress and close attention to this problem have led to considerable improvements in this field. Many different methods have been developed to facilitate identification of the structure. It has to be clarified whether neuromonitoring (NM), as described in the recent publications, is a safe and reliable procedure. This method has its merits as a search method for the recurrent nerve intraoperatively and, therefore, perhaps in shortening the operating time. It also gave rise to intense research into recurrent nerve electrophysiology. But

Corresponding address: G. Wolf, M.D., Division of Endocrine Surgery, Department of Surgery, University of Graz, Auenbruggerplatz 29, A-8036 Graz, Austria.
Fax: ++43/316/385-3418
E-mail: gerhard.wolf@uni-graz.at

these results have to be critically reviewed. Some authors do recommend NM for selected indications in complicated head and neck surgery, but no arguments for its general use in thyroid surgery can be made from the database in the literature.

Specific complications in thyroid surgery

Intraoperative control of nerve function has always been of major interest. Up to the 1960s, thyroid surgery was performed under local anaesthesia, mainly because patients were forced to talk during the operation. Any change in vocal function was considered to be a dangerous situation for the nerve, and the operative procedure was directed to avoid close contact with the nerve region. As this was found to be inappropriate, different methods were developed: *Bergmann* (2) recommended direct laryngoscopic control of the vocal cord under anaesthesia. This was done with minor results, as the relaxed patient showed irregular vocal cord movements. Later *Depisch* (3) developed an intubation device with double cuffs to register pressure in the larynx, generated by electrostimulation of the recurrent nerve.

The standard procedure, even in the early 1980s, was a 'no-touch' approach to the retrothyroidal space. The main argument for this strategy was *Prioleau's* finding (18) that 'every nerve seen in thyroid surgery will get injured'. There is some clinical evidence for this opinion as the recurrent nerve does not have blood support from segmental vessels after its separation from the vagal nerve. It is therefore highly dependent on nutrition by diffusion from the surrounding tissue. If this support is interrupted, damage to the axons may occur and functional disorders will result, even when the integrity of the nerve is granted.

Since then, preparation of the nerve in its whole course in the operating field, or at least its exact identification, has become the main prerequisite for adequate surgery. It is well established in the literature that this has led to a considerable decrease in postoperative voice dysfunction (10, 11, 16, 19, 21, 24, 25). The introduction of neuromonitoring (NM) has shown a similar reduction in adverse nerve results (4, 9, 12, 17, 22, 23). It has to questioned whether this development was achieved by focussing the operative excellence on nerve preservation and thus is to be considered a parallel effect, or whether these results were achieved in addition to those by surgical nerve preparation alone.

As *Friedrich* stated (5), there is no causal treatment for recurrent nerve injury. Even if the vocal cord dysfunction may be completely compensated, or despite the fact that logopaedic treatment and phonosurgery may restitute the voice remarkably, all these procedures are only symptomatic. Therefore, it is the main goal in surgery to avoid any trauma to the nerve (5, 6).

Critical view of the use of neuromonitoring

The regular use of NM in everyday thyroid surgery is still to be questioned. The data in the literature have to answer the following critical questions:

* Are the palsy rates lowered by closer attention to the nerve preparation **or** by NM?
* Can a continuous reduction – down to zero – of postoperative nerve palsies be achieved? Can the RN palsy rates even of the specialized centres still be lowered or is there still a minimal rate of inevitable nerve disorders, caused by effects other than nerve injury?
* Is there also, by a more atraumatic approach to the nerve, a constant reduction in general vocal disorders?
* Is therefore the general recommendation for nerve visualization obsolete, as the nerve will be identified by technical methods?
* Can the operating time be reduced by an improved identification method?

1) As *Hermann* stated (8), an intact signal in NM does not guarantee an intact postoperative nerve function. On the other hand, no signal during measurement may nevertheless coincide with normal voice function postoperatively. Out of 301 'nerves at risk', only 279 showed a correlation between intraoperative neurostimulation and postoperative voice function (92.7%). Moreover, in five of these cases no signal during operation was achieved, although postoperative vocal cord function was normal. Even nine patients with preoperative nerve palsy had normal electrophysiological stimulation intraoperatively, the mechanism of which is still to be clarified. There has been remarkable basic work on electrophysiology of the recurrent nerve using NM, but to date this method does only provide information about the nerve's position in anatomy. No clear-cut information on functional integrity or on the influence on operative strategies is yet available. The results of prospective NM

Table 1. Influence of routine preparation of the nerve on RLN palsy.

Author	Year	No routine prep.; palsy rate		Routine prep.; palsy rate	
		Early %	Late %	Early %	Late %
Zornig *et al. (25)*	1989	7.7	5.0	3.0	0.9
Jatzko et al. (10)	1994	7.9	5.2	2.7	1.2
Friedrich	1998	4.2	1.4	1.1	0.4
Bergamaschi et al. (1)	1998	–	0.7		0.7
Mattig et al. (16)	1998		6.0		0.9
Thermann et al. (24)	1998		0.9		1.4
Total, median			1.4		0.7
Range			0.7–6.0		0.4–1.4

studies reveal a small rate of recurrent nerve palsies even after an intact signal (8). The same is true after exact surgical preparation and visualization of the nerve. By other effects than surgical trauma, whether nutritional defects, local haematoma or drainage irritation, a small proportion of vocal disorders will appear, sometimes not immediately after operation. So a small number of permanent postoperative voice disorders, although the nerve is visibly intact, may occur, even in specialized centres. It is questionable whether this number can be completely abolished. One possibility of decreasing the risk of injury in the preparation process is leaving the soft surrounding tissue intact and still identifying the nerve correctly. This would be the great advantage of NM. As the authors recommending NM also do surgical preparation of the nerve, no advantage concerning an atraumatic approach or the operating time can be stated (4, 7, 11, 12, 17).

A closer analysis of the studies in the literature yields an interesting result: Up to 1996, the rate of permanent nerve palsies documented in the literature was 999 out of 28 957 cases (3.45%). It was reported in only 114 out of 14 687 patients in publications from 1997 on (21). Despite the fact that there is a considerable bias due to an unequal composition of data sources, these figures are a strong indicator for improvement of surgical technique during the last decade. It also has to be mentioned that high rates of RLN palsies may no longer be felt to be appropriate for publication by various authors. Retrospective and comparative analyses between operations with and those without preparation of the nerve showed a decrease in palsy rates from 5.99% to 0.88% (16) (Table 1). Similar results were obtained by most authors (13, 21). Only one study of 1192 thyroidectomies showed no difference in the results (1).

Establishing a group of 'endocrine surgeons' instead of the occasional thyroid operator gave rise to increased expertise in the surgical procedure. Increased numbers of thyroid operations led to a decrease in RLN damage (9, 14, 20). Surgical excellence and the focus on the nerve reduced the number of nerve damages as reported to be with the help of NM. The progress in postoperative complication results was achieved mainly by this form of specialization in endocrine surgery and improvement of operative technique.

2) A small portion of nerve palsies are caused by traumatic procedures during obligatory nerve visualization. In this case, NM can help as the identification can be achieved while preserving the integrity of the protective soft tissue of the nerve, resulting in little mechanical irritation of the structure. As the nerve is also dependent on the nutritive surroundings, a smaller rate of voice disorders may be expected. All endocrine surgeons, however, still recommend the strict surgical preparation of the nerve. So the main advantage of NM, identifying the nerve and still protecting it, is compromised by this fact. No study in the literature compares these two methods (identification with/without preparation). Even the studies propagating the use of neuromonitoring do not clarify the question whether the method brings a net gain in terms of significantly decreasing the rates of nerve damage. A study of 301 patients who underwent thyroid surgery with neuromonitoring showed a temporary palsy rate of 2.3% and a permanent rate of 0.8% (12). These rates are not better than those achieved without neuromonitoring (9, 10, 12, 20, 24, 25). The main factor in preventing damage is still the excellence of the surgeon as well as the supervision of trainees by experienced endocrine surgeons (14). It cannot be implicated that identification or preparation alone can prevent considerable damage to the function of the nerve. Meticulous operative technique, even in the case of clear visualization, has to be performed to prevent injury to the integrity of the electrophysiological function.

3) The integrity of the human voice after surgery is a major concern. The main interest in this respect has been focussed on injuries of the recurrent nerve. From the phoniatric point of view, there are many other causes of vocal disorders besides that situation, so a more differentiated description should be applied (Table 2). For the judgement of postoperative outcome, the term 'postoperative voice disorders' rather than 'recurrent nerve palsy' alone seems to be more accurate (6).

Table 2. Postoperative voice disorders (according to Friedrich [5]).

* Transient vocal cord irritation
* Motility disorders of the larynx
– myogenous
– arthrogenous
– neurogenous
* Intubation injuries
* Functional immobilization (psychogenic dysphonia)

It seems to be justified to measure successful operative outcome by the general vocal status of the patient, including superior nerve function and myogenic disorders, and not only focus on recurrent nerve palsy. This would, on the other hand, include a thorough phoniatric investigation, whereas recurrent nerve palsy can be diagnosed by simple direct laryngological view. Even when NM can also be applied to the superior laryngeal nerve, the remainder of these different disorders cannot be influenced by NM.

Discussion

There is considerable variation in the literature concerning the rate of transient and permanent nerve palsies. A partial explanation for this diversity is the fact that there is a very heterogeneous patient mix in different reports. Small thyroids in iodine-replete areas, where the recurrent nerve can easily be identified during operation, are rarely prone to this complication. In contrast, large, multinodular bulky goitres requiring technical excellence in nerve preparation show a higher rate of complications *per se.* On the other hand, there is a great diversity in the methods of describing nerve dysfunction in the literature: In general, there is a 0.4% to 12.5% rate of transient or permanent palsies with nerve preparation versus a 3.5% to 14% rate without (9, 10, 13, 16, 21, 25). However, the reports do not state the exact procedure: Has the nerve only been identified or 'visualized' in its surrounding tissue? Has it been separated in its whole course in the operating field or only on the junction with the thyroid artery/its entrance point in the larynx? The time of the laryngological examination varies considerably and, moreover, no report states the influence of logopaedic or phonosurgical therapy. Many publications fail to state the amount of damage, whether a deficit in motility of the vocal cord or a total palsy. Moreover, the fact that vocal disorders may have an onset days after surgery is not considered in the literature.

Neuromonitoring – who benefits?

Even when there are no clear arguments for the general use of NM in routine thyroid surgery, it may have some advantages in clinical practice. In less than one per cent, mostly on the right side, the RLN leaves the vagal nerve during its descent into the collar region and reaches the thyroid laterally. This is called the nonrecurrent nerve. In this case, NM would ease the identification of an irregular structure in the operating field. But again, visual proof of every structure during operation is mandatory. In reoperative cases, intramediastinal goitres or advanced cancer cases, even an experienced surgeon might find the help of NM useful, even if adverse postoperative results concerning nerve function cannot be avoided generally due to the intraoperative situation. The main advantage will be stated by those surgeons and centres who are changing their technique from a 'no-touch' approach to general identification. In this case, NM will certainly improve their learning curve. Moreover, NM has given rise to some very innovative research on nerve electrophysiology.

To date, there is no information that NM would lead to increased safety for the motor nerve compared with conventional visual proof. There is some hazard in the finding that, occasionally, centres with minor experience in endocrine surgery, advocating the general use of NM in everyday procedures, take the opportunity to generate apparently higher safety for the patient. Even when the data do not show this correlation, this presumably leads to forensic impacts in cases of nerve palsy for those centres not applying NM, even if they are specialized endocrine centres with results superior to standard clinics.

In conclusion, further progress with data acquisition on neurophysiology should be made, consensus concerning the necessity of nerve preparation after NM identification should be found, but no general recommendation for NM instead of meticulous surgical technique should be given.

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