Peer reviewed article

Therapeutic efficacy of selective nerve root blocks in the treatment of lumbar radicular leg pain[1]

Martin Narozny[a], *Marco Zanetti*[b], *Norbert Boos*[a]

[a] Spinal Surgery
[b] Division of Muskuloskeletal Radiology
Orthopaedic University Hospital Balgrist, Zurich, Switzerland

Summary

The objective of this study was to investigate the clinical effectiveness of nerve root blocks (i.e., periradicular injection of bupivacaine and triamcinolone) for lumbar monoradiculopathy in patients with a mild neurological deficit. We have retrospectively analysed 30 patients (29–82 years) with a minor sensory/motor deficit and an unequivocal MRI finding (20 disc herniations, 10 foraminal stenoses) treated with a selective nerve root block. Based on the clinical and imaging findings, surgery (decompression of the nerve root) was justifiable in all cases. Twenty-six patients (87%) had rapid (1–4 days) and substantial regression of pain, five required a repeat injection. 60% of the patients with disc herniation or foraminal stenosis had permanent resolution of pain, so that an operation was avoided over an average of 16 months (6–23 months) follow-up. Nerve root blocks are very effective in the non-operative treatment of minor monoradiculopathy and should be recommended as the initial treatment of choice for this condition.

Keywords: disc herniation; foraminal stenosis; selective nerve root injection; non-operative treatment; outcome

Introduction

Since its first description by Mixter and Barr in 1934 [1], lumbar disc herniation is one of the few abnormalities in the lumbar spine, were a clear relationship between the morphological alteration and pain seems to exist. While pure mechanical compression was considered previously as a source of sciatica, there is increasing evidence that chemical irritation of the nerve root plays an essential and perhaps even more important role [2, 3]. Olmarker et al. [4] have shown in an experimental animal model, that epidural application of autologous nucleus pulposus without compression of the cauda equina leads to a significant drop in the nerve conduction velocity of the cauda equina [4]. Autoimmune responses, microvascular changes and inflammatory reactions are discussed as potential causes of this phenomenon [4–7]. Nucleus pulposus tissue has inflammatory properties, which lead to an intraneural oedema, a very important factor in the pathogenesis of sciatic pain [5]. The negative effect of nucleus pulposus on the nerve root can be significantly reduced by the application of methylprednisolone [8]. The compromising of the nerve conduction velocity by nucleus pulposus tissue seems to be self-limiting. Otani et al. [9] have shown in an animal model, that this effect is most pronounced after seven days and spontaneously normalises within a two month period. These experimental findings may explain, why sciatica has a favourable natural history [10]. Surgery in patients presenting with a radiculopathy with or without minor neurological sensory/motor deficit is only required, if the initial pain cannot be well controlled by non-operative means. Otherwise, surgery is not required because spontaneous recovery can be expected [10, 11].

The aim of our study was to investigate whether a selective nerve root block with local application of bupivacaine and triamcinolone is an effective option for patients with radicular leg pain.

[1] Presented in part at the 59th Annual Meeting of the Swiss Orthopaedic Society, Winterthur, September 9–11, 1999

Patients and methods

From January 1997 to December 1998, 78 patients were treated with selective nerve root blocks at our institution. From this group of patients, we selected those individuals, who had an unequivocal morphological imaging finding explaining the radiculopathy.

The following inclusion criteria were required: (1) monoradicular leg pain with minor sensory/motor deficit (*MRC* grade >M3), (2) unequivocal morphological correlate at MRI, (3) duration of symptoms less then four months.

Exclusion criteria were: (1) relevant motor deficit (MRC ≤M3) or cauda equina syndrome (necessitating immediate surgical decompression), (2) limited knowledge of German (on the part of the patient), preventing clear-cut history-taking and (3) previous spinal surgery. These criteria were defined by the senior author prior to the review of the cases.

The follow-up examination was performed by an independent observer (M.N.), who was not involved in treatment of the patients. The senior author was not involved in the review of the cases.

A total of 30 consecutive patients who fulfilled these inclusion criteria were enrolled in the study. Mean age of the 12 females and 18 males was 59 years (range 29–82 years). Based on MRI analysis by an independent radiologist (M.Z.), 20 patients had a disc herniation (protrusion, extrusion or sequestration [12]) and in 10 patients a foraminal stenosis was diagnosed as a source of the leg pain (Table 1). According to this analysis, all individuals had a compromised nerve root at the target level explaining the patients symptoms. The average duration of symptoms was 8 weeks (range 3–18 weeks). All patients were referred to our center after intial non-operative therapy (analgesics, physiotherapy) had failed to result in a rapid resolution of pain. According to guidelines in the literature [13], surgery may be undertaken in cases with persistent symptoms when more rapid pain relief and resolution of the actual neurological deficits can be expected, compared to non-operative treatment. The patients were informed that the natural history of such minor sensory/motor deficits is benign and that spontaneous recovery occurs in the vast majority of individuals with time. We offered the patients a selective nerve root block to support non-operative treatment. None of the individuals expressed a desire to proceed with immediate surgery. The follow-up period was a minimum of 6 months.

Table 1

Location of disc herniations and foraminal stenosis.

	L2/3	L3/4	L4/5	L5/S1
Disc protrusion	1	2	13	4
Foraminal stenosis	1	2	5	2

Technique

The nerve root block was performed under sterile conditions with an image intensifier. We used the technique described by Bogduk et al. [14]. The target point was a "safe triangle" i.e., above the exiting nerve root and

Figure 1

Schematic description of the technique of a selective nerve root block at the level L1-L5 (A). Correct radiculogram of the L5 nerve root after periradicular injection of contrast medium (B).

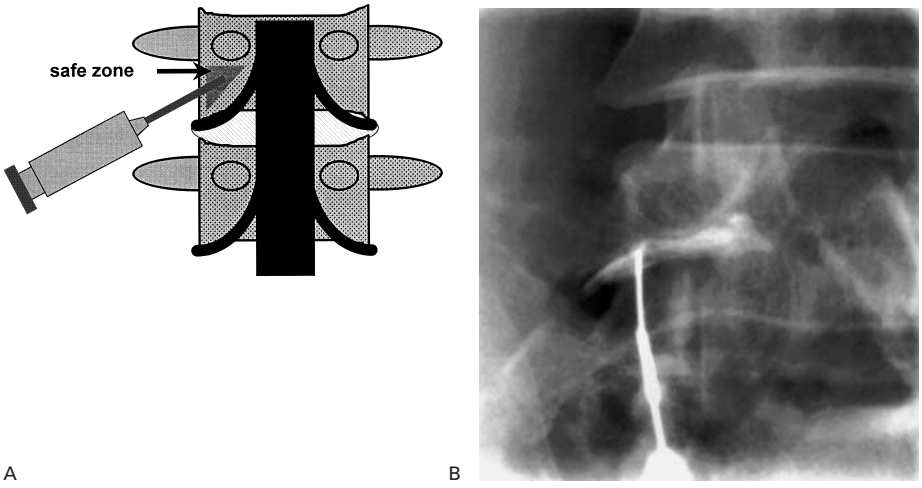


Figure 2

Schematic description of the technique of selective nerve root block at the level S1 (A). Correct radiculogram of the S1 nerve root after periradicular injection of contrast medium (B).

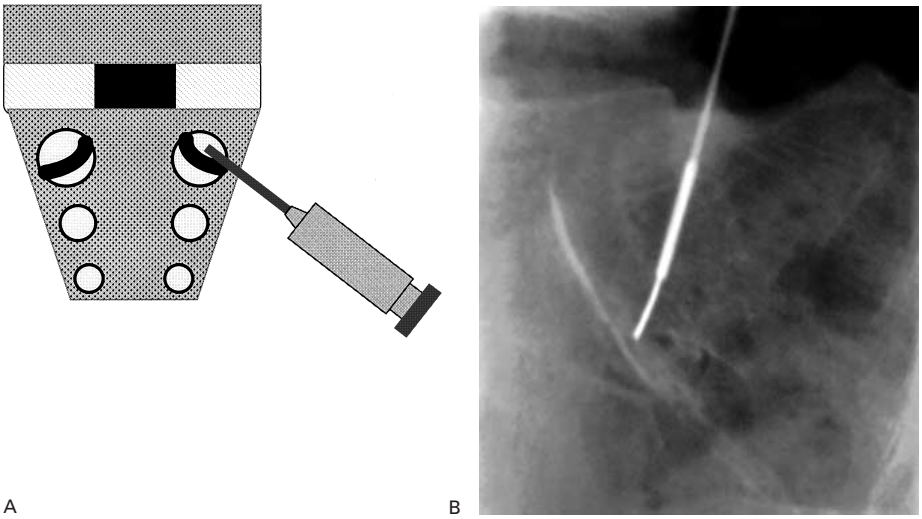


Figure 3

Thirty-five-year-old patient with acute onset of severe radicular leg pain with a mild sensory motor deficit of L5 (MRC grade M4). MRI (A and B) shows a disc herniation at the level of L4/5 with sequestration and compression of the nerve root L5. A selective nerve root block of L5 (C) results in a rapid and permanent resolution of the pain within 3 days. At one-year follow-up, the patient is pain-free and has made a full neurological recovery.

A

B

C

below the corresponding pedicle. The skin was anaesthetised with 2–3 ml mepivacaine 2%. A spinal needle (22G) was inserted paramedian through the skin and muscles in a cranio-medial direction until a bony contact was encountered. This method allows advancing the needle in a safe triangle without contact to the nerve root. After verification of a correct needle positioning under biplanar image intensifier control, 1 ml iopamidol 300 mg was injected until a radiculogram was obtained. Subsequently, 2 ml bupivacaine 0,5% and 1 ml triamcinolone (40 mg) were injected. It should be stressed that this was a periradicular and not an intraneural injection. With this technique the nerve roots L1-L5 could be targeted (Fig. 1).

To perform a selective nerve root block at the level of S1, a different technique is required. First the image intensifier is positioned perpendicular to the foramen S1. A spinal needle is inserted perpendicular to the surface of the sacrum into the foramen. The correct needle positioning is checked by image intensifier in two planes. After obtaining a correct periradiculogram, 2 ml bupivacaine 0,5% and 1 ml triamcinolone (40 mg) is injected (Fig. 2).

The patients had a clinical surveillance on the ward for about 30 minutes to account for any unexpected side effects. Patients were routinely asked to report the pain reduction on a visual analogue scale 30 minutes after injection. The clinical follow-up was at 2–3, 6 and 12 weeks and 6 months after injection. A successful nerve root block was defined as reduction of the leg pain of more than 60% within the first 4 days. This time interval was chosen because the effect of the steroids is not immediate.

Results

The average follow-up was 16 months (range, 6–23 months). At 2 to 3 weeks' follow-up, 26 of 30 patients reported successful pain reduction (Fig. 3). In 18 patients, this pain reduction was obtained immediately and in a further 8 patients within 4 days (2 of these patients had a temporary pain increase). In 4 patients, the nerve root block did not show a sufficient pain reduction despite a correct periradiculogram. In 5 of the patients with initial pain relief (n = 26), the nerve root block had to be repeated, since the first nerve root block did not have the expected success (n = 2) or because the effect was only short-term (less than 1 week, n = 3). Three of the latter 5 patients had a subsequent permanent pain reduction. In total, 18 of the 26 patients with pain relief after the first and/or second injection had a permanent and substantial (>60%) pain reduction and did not require surgery, 12 had disc herniation and the remaining 6 had foraminal stenosis. 8 patients with insufficient pain resolution and 3 patients without postinjectional pain relief underwent surgery (7 discectomies, 3 foraminal decompressions, and 1 decompression and instrumented fusion). The remaining patient without postinjectional pain relief decided to proceed with physiotherapy resulting in a slow (within 6 months) resolution of leg pain. All individuals who had an immediate pain relief after the injection but recurrent symptoms had successful surgery with complete relief of the leg pain. There were no complications, in particular no infections, nerve root injuries or bleeding events.

Discussion

Macnab first described selective nerve root blocks in 1971 [15]. This infiltration performed with contrast agent and lidocaine aimed to differentiate different sources of leg pain in an equivocal clinical situation [15]. Frequently, it is not possible to exactly localise the compromised nerve root either by clinical neurological examination or by imaging studies. This is particularly true for multilevel nerve root compromise as shown by MRI. There is increasing evidence that there is no close correlation between imaging findings and clinical symptoms [16]. The high incidence of asymptomatic disc herniations recently reported in the literature raises questions about the validity of our morphologically based understanding of pain pathogenesis in this condition [17–20]. These findings stress the importance of an unequivocal concordance of the clinical symptoms and imaging findings as a prerequisite for a successful disc surgery. Numerous studies [21–26] have shown that a nerve root block is helpful in cases were this close correlation is lacking. In the event of a positive response (i.e., resolution of leg pain), the nerve root block allows the diagnosis of the affected nerve root with a sensitivity of 100% in cases with disc protrusions and with a positive predictive value of 75 to 95% in cases of a foraminal stenosis [21, 26]. So far, the diagnostic aspect has been the predominant reason for a nerve root block.

A systematic analysis of the therapeutic effect of nerve root blocks has so far not been extensively studied. In a prospective study, Weiner and Fraser [23] investigated the success of nerve root blocks in 30 patients with foraminal and extraforaminal disc herniation. They found an immediate pain reduction in 27 patients, of whom only 3 required surgery because of recurrent leg pain, whilst 2 individuals were lost to follow-up. In total, 22 of 28 patients (79%) had a substantial and permanent pain reduction during a 1–10 year follow-up.

In our study disc protrusions and foraminal stenosis were included as diagnostic groups. Although we anticipated that the therapeutic effect of nerve root blocks would be more pronounced in cases with a discogenic nerve root compression compared to a foraminal (bony) stenosis, we did not find a difference between the 2 groups. While a chemical irritation of the nerve root by disc material is well documented experimentally [4], mechanical compression appears to be the major source in foraminal stenosis. However, foraminal stenosis in elderly patients often persists for a long time before suddenly becoming symptomatic. It remains unclear whether an acute inflammation is the reason for this sudden pain onset. Our results support the hypothesis of an inflammatory mechanism because 60% of our patients had a rapid and permanent resolution of their leg pain after steroid injections. A more conclusive statement is not possible due to the small numbers and short follow-up but this deserves further exploration.

Since the study by Henrik Weber in 1982 [27], it is well-known, that non-operative (in-hospital bed-rest and subsequent physiotherapy) and operative treatment of disc herniations are equally effective after 4 to 10 years. Weber [27] has also shown, that the functional recovery of the nerve root is not superior in the operative group, in those patients presenting with a minor neurological deficit. The main drawback of the non-operative treatment (medication and physiotherapy) is the slow recovery and patients are disabled for a prolonged time period [27]. The effect of epidural steroid injections is still controversial in the literature [28]. Overall, 6 studies indicated that the epidural steroid injection was more effective than the reference treatment and 6 reported it to be no better or worse than the reference treatment [28]. Cuckler et al. [29] treated 73 patients with radicular leg pain either with methylprednisolone acetate

and procaine or with physiological saline and did not observe an effect of the steroids after an average of 20 months between both groups. In a more recent study, Carette et al. [30] analysed 158 disc herniation patients with a prospective, placebo-controlled trial (methylprednisolone vs. saline) in terms of outcome. After six weeks, the authors observed a significant improvement in terms of leg pain and sensory deficits but this difference did not achieve statistical significance at three months. The authors concluded that epidural injections of methylprednisolone result in a short-term improvement in leg pain and sensory deficits. However, this treatment offers no significant functional benefits at 12 months, nor does it reduce the need for surgery. The drawback of epidural injections is the verification of the correct epidural application of the steroids unless the injection is performed with contrast medium under image intensifier control. On the contrary, a selective nerve root block is always performed under image intensifier control and the correct application to the target nerve root is documented by the injection of contrast medium. Although the steroids applied by the foraminal route can in theory diffuse and involve more than a single nerve root, we did not observe any case reporting a temporary sensory deficit of an adjacent nerve root. This demonstrates the relative selectiveness of the block. With regard to the lack of clinical effectiveness of epidural injections it is important to stress, that the key issue of the local steroid injection is a short-term relief and not a long-term effect because of the benign natural history of this disease [10, 27]. In our study, 26 of 30 patients with a minor neurological deficit and with an unequivocal MRI finding had rapid pain resolution, which was permanent in 18 patients. With regard to an average pain duration of 8 weeks and the presence of a neurological deficit, surgical interventions would have been justifiable in all of these cases. In 60% of the patients a rapid permanent pain resolution occurred, obviating the need for surgery.

Our study is a retrospective analysis of patients with radicular leg pain treated by selective nerve root blocks. We clearly acknowledge the limitations of our study because of its retrospective study design. The assessment of pain relief on a retrospective basis is questionable and no prospective outcome variables could be defined, which substantially limits the conclusions drawn. Despite these limitations, there is circumstantial evidence, that selective nerve root blocks are an effective and less invasive intervention, and serve as an adjunct to non-operative treatment. In the majority of individuals, a surgical intervention could be prevented because of a rapid pain resolution, despite there being a clear indication for surgery. Because a positive treatment effect could be demonstrated by our retrospective analysis, the therapeutic efficacy of a nerve root block deserves further exploration by prospective, randomised double-blind studies.

Correspondence:
Norbert Boos, MD
Associate Professor
Chief of spinal surgery
Orthopaedic University Hospital Balgrist
Forchstrasse 340
CH-8008 Zürich
E-mail: nboos@balgrist.unizh.ch

References

1 Mixter WJ, Barr JS. Rupture of the intervertebral disc with involvement of the spinal canal. N Engl J Med 1934;211:210–5.
2 Rydevik B, Garfin S. Spinal nerve root compression. In: Szabo RM, ed. Nerve Root Compression Syndromes: Diagnosis and Treatment. New York: Slack Medical; 1989. p. 247–61.
3 Olmarker K, Rydevik B. Pathophysiology of sciatica. Orthop Clin North Am 1991;22:223–34.
4 Olmarker K, Rydevik B, Nordborg C. Autologous nucleus pulposus induces neurophysiologic and histologic changes in porcine cauda equina nerve roots. Spine 1993;18:1425–32.
5 Olmarker K, Blomquist J, Strömberg J, Nannmark U, Thomsen P, Rydevik B. Inflammatogenic properties of nucleus pulposus. Spine 1995;20:665–9.
6 McCarron RF, Wimpee MW, Hudkins PG, Laros GS. The inflammatory effect of nucleus pulposus. A possible element in the pathogenesis of low-back pain. Spine 1987;12:760–94.
7 Marshall LL, Trethewie ER. Chemical irritation of nerve-root in disc prolapse. Lancet 1973/II:320.
8 Olmarker K, Byrod G, Cornefjord M, Nordborg C, Rydevik B. Effects of methylprednisolone on nucleus pulposus-induced nerve root injury. Spine 1994;19:1803–8.
9 Otani K, Arai I, Mao GP, Konno S, Olmarker K, Kikuchi S. Nucleus pulposus-induced nerve root injury: relationship between blood flow and motor nerve conduction velocity. Neurosurgery 1999;45:614–9.
10 Saal JA, Saal JS. Nonoperative treatment of herniated lumbar intervertebral disc with radiculopathy. An outcome study. Spine 1989;14:431–7.
11 Cowan NC, Bush K, Katz DE, Gishen P. The natural history of sciatica: a prospective radiological study. Clin Radiol 1992; 46:7–12.
12 Masaryk TJ, Ross JS, Modic MT, Boumphrey F, Bohlman H, Wilber G. High resolution MR imaging of sequestered lumbar intervertebral disks. AJNR Am J Neuroradio 1988;9:351–8.
13 Eismont F, Currier B. Current concepts review. Surgical management of lumbar intervertebral-disc disease. J Bone Joint Surg 1989;71A:1266–71.
14 Bogduk N, Aprill C, Derby R, Selective nerve root blocks. In: Wilson DJ, ed. Interventional Radiology of the Muskuloskeletal System. London: Edward Arnold; 1995. p. 122–32.
15 Macnab I. Negative disc exploration. An analysis of the causes of nerve-root involvement in sixty-eight patients. J Bone Joint Surg Am 1971;53:891–903.
16 Boos N, Lander PH. Clinical efficacy of imaging modalities in the diagnosis of low-back pain disorders. Eur Spine J 1996;5: 2–22.
17 Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: a prospective investigation. J Bone Joint Surg 1990;72A:403–8.
18 Boos N, Rieder R, Schade V, Spratt K, Semmer N, Aebi M. 1995 Volvo Award in Clinical Sciences. The diagnostic accuracy of magnetic resonance imaging, work perception and psychosocial factors in identifying symptomatic disc herniations. Spine 1995;20:2613–25.

19 Jensen MC, Brant-Zawadzki MN, Obuchowski N, Modic MT, Malkasian D, Ross JS. Magnetic resonance imaging of the lumbar spine in people without back pain. N Engl J Med 1994; 331:69–73.
20 Weishaupt D, Zanetti M, Hodler J, Boos N. MR imaging of the lumbar spine: Prevalence of intervertebral disk extrusion and sequestration, nerve root compression, endplate abnormalities and osteoarthritis of the facet joints in asymptomatic volunteers. Radiology 1998;209:6616.
21 Castro WH, van Akkerveeken PF. Der diagnostische Wert der selektiven lumbalen Nervenwurzelblockade. Z Orthop Ihre Grenzgeb 1991;129:374–9.
22 Stanley D, McLaren MI, Euinton HA, Getty CJ. A prospective study of nerve root infiltration in the diagnosis of sciatica. A comparison with radiculography, computed tomography, and operative findings. Spine 1990;15:540–3.
23 Weiner BK, Fraser RD. Foraminal injection for lateral lumbar disc herniation. J Bone Joint Surg Br 1997;79:804–7.
24 Dooley JF, McBroom RJ, Taguchi T, Macnab I. Nerve root infiltration in the diagnosis of radicular pain. Spine 1988;13: 79–83.
25 Wilppula E, Jussila P. Spinal nerve block. A diagnostic test in sciatica. Acta Orthop Scand 1977;48:458–60.
26 van Akkerveeken PF. The diagnostic value of nerve root sheath infiltration. Acta Orthop Scand Suppl 1993;251:61–3.
27 Weber H. 1982 Volvo Award in Clinical Sciences. Lumbar disc herniation. A controlled, prospective sudy with ten years of observation. Spine 1982;8:131–40.
28 Koes BW, Scholten RJ, Mens JM, Bouter LM. Efficacy of epidural steroid injections for low-back pain and sciatica: a systematic review of randomized clinical trials. Pain 1995;63: 279–88.
29 Cuckler JM, Bernini PA, Wiesel SW, Booth RE Jr, Rothman RH, Pickens GT. The use of epidural steroids in the treatment of lumbar radicular pain. A prospective, randomized, double-blind study. J Bone Joint Surg Am 1985;67:63–6.
30 Carette S, Leclaire R, Marcoux S, Morin F, Blaise GA, St.-Pierre A, et al. Epidural corticosteroid injections for sciatica due to herniated nucleus pulposus [see comments]. N Engl J Med 1997;336:1634–40.

Swiss
Medical Weekly

Official journal of
the Swiss Society of Infectious disease
the Swiss Society of Internal Medicine
the Swiss Respiratory Society

The many reasons why you should choose SMW to publish your research

What Swiss Medical Weekly has to offer:

- SMW's impact factor has been steadily rising, to the current 1.537
- Open access to the publication via the Internet, therefore wide audience and impact
- Rapid listing in Medline
- LinkOut-button from PubMed with link to the full text website http://www.smw.ch (direct link from each SMW record in PubMed)

- No-nonsense submission – you submit a single copy of your manuscript by e-mail attachment
- Peer review based on a broad spectrum of international academic referees
- Assistance of our professional statistician for every article with statistical analyses

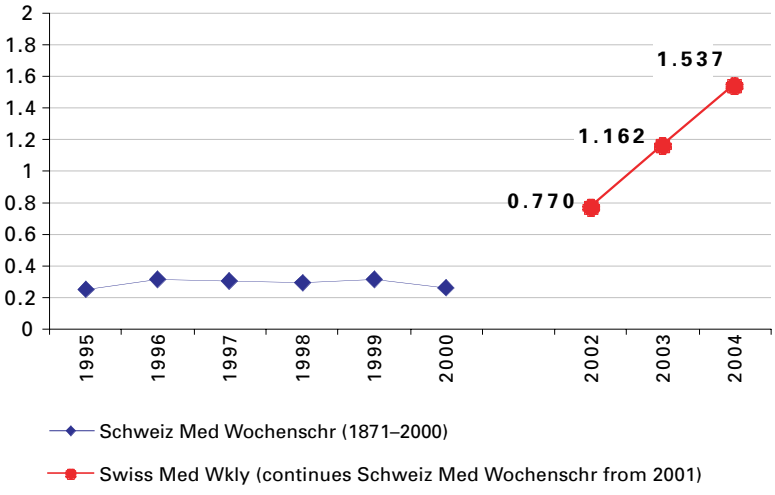
- Fast peer review, by e-mail exchange with the referees
- Prompt decisions based on weekly conferences of the Editorial Board
- Prompt notification on the status of your manuscript by e-mail
- Professional English copy editing
- No page charges and attractive colour offprints at no extra cost

We evaluate manuscripts of broad clinical interest from all specialities, including experimental medicine and clinical investigation.

We look forward to receiving your paper!

Guidelines for authors:
http://www.smw.ch/set_authors.html

Impact factor Swiss Medical Weekly



EMH FMH Schwabe
Editores Medicorum Helveticorum

All manuscripts should be sent in electronic form, to:

EMH Swiss Medical Publishers Ltd.
SMW Editorial Secretariat
Farnsburgerstrasse 8
CH-4132 Muttenz

Manuscripts: submission@smw.ch
Letters to the editor: letters@smw.ch
Editorial Board: red@smw.ch
Internet: http://www.smw.ch