Effect of Intravenous Administration of Steroids in the Management of Sudden Sensori-Neural Hearing Loss: Our Experience

S. Raghunandhan · Anoop Kumar Agarwal ·
Kiran Natarajan · Sathiya Murali · R. S. Anand Kumar ·
Mohan Kameswaran

Received: 4 November 2011 / Accepted: 3 February 2012 / Published online: 25 February 2012
© Association of Otolaryngologists of India 2012

Abstract The aim of this study was to investigate the efficacy and outcomes of intravenous high dose steroids in patients diagnosed with sudden sensori-neural hearing loss (SSNHL). The study also looked at the various co-morbidities influencing the outcomes of IV steroid therapy and also evaluated the improvement in associated symptoms like vertigo and tinnitus. This prospective study involved 30 patients treated during the 1 year period from January 2010 to 2011 in the Department of Otolaryngology, Madras ENT Research Foundation, Chennai. Male: female ratio was 1.3:1 and age range was 19–80 years. For all patients, pre treatment pure tone audiometry (PTA) was compared with post treatment PTA at 1 month. Treatment was given in the form of intravenous high dose methyl prednisolone. The patients were divided into two groups. Group 1 (20 pts) included SSNHL with no co-morbidity, group 2 (10 pts) included SSNHL with various co-morbidities. The mean hearing level improved from an average of 79.53 dB (HL) before treatment to 42.33 dB (HL) after treatment. In patients with predominantly low frequency HL (16 pts) PTA improved from 76.01 to 32.6 dB while in high frequency HL PTA improved from 83.55 to 53.43 dB. In our study of 30 patients, complete recovery occurred in 56.66% cases and marked improvement (>30 dB) in 16.66% patients. There was no improvement in 26.66% cases. Patients in group 2 had co-morbid factors like diabetes mellitus, dys-thyroidism

and hypertension. A statistically significant improvement in the associated symptoms of tinnitus/vertigo, were also noted after IV steroid treatment. According to our results, emergency administration of high dose of Intra-venous corticosteroids to patients with SSNHL is highly recommended. Patients with high frequency preservation have better hearing improvement at the end of treatment. The critical time period for commencing IV treatment is less than 6 h from onset of hearing loss in order to restore normal hearing. High dose Intravenous steroids are a safe and effective treatment in sudden sensori-neural hearing loss.

Keywords Intravenous steroids ·
Sudden sensori-neural hearing loss (SSNHL)

Introduction

Sudden sensori-neural hearing loss (SSNHL) is relatively uncommon but may pose a significant problem for patients and a challenge for otolaryngologists. The sudden loss of hearing can be quite devastating to patients and may affect the quality of life. It was first described in 1944 by DeKleyn [1]. SSNHL is defined as a decline in hearing over 3 days or less affecting 3 or more contiguous frequencies by 30 dB or greater with no identifiable etiology [2]. The estimated incidence is 5–20 cases per 100,000, with viral infection being the most common etiological factor [3]. Other etiologies include vascular occlusion and inner ear membrane breaks, acoustic neuroma, autoimmune inner ear disease [4, 5].

The hearing loss (HL) is nearly always unilateral and is commonly associated with tinnitus and aural fullness. It was also noticed that the severe sudden onset of hearing loss associated with other inner ear symptoms like vertigo, has poorer chance of recovery. SSNHL is an otological

S. Raghunandhan (✉) · A. K. Agarwal · K. Natarajan ·
S. Murali · R. S. Anand Kumar · M. Kameswaran
Madras ENT Research Foundation, No. 1, 1st Cross Street,
Off 2nd Main Road, Raja Annamalai Puram, Chennai 600028,
Tamil Nadu, India

M. Kameswaran
e-mail: merfmk30@yahoo.com
URL: www.merfmk.com

emergency and an early therapy is critical to recovery. High dose systemic steroids have been used and proved to be an effective method of treatment and are by far the most agreed upon line of treatment for SSNHL [2]. Although proven to be effective in randomized, double-blind, placebo-controlled trials [2, 6], other studies have questioned the efficacy of systemic steroids in the treatment of SSNHL [3, 7, 8]. Other proposed lines of treatment include vasodilators, antiviral agents, hyperbaric oxygen, and plasmapheresis. It had been noticed in many studies that the earlier the onset of treatment, the better the chance of recovery the patient has.

Aims and Objectives

The aim of this study was to investigate the efficacy and outcome of intravenous administration of high dose steroids, in patients diagnosed with SSNHL. The study looked at various co-morbidities influencing the outcomes of IV steroid therapy and also evaluated the improvement in symptoms like vertigo and tinnitus coexistent with SSNHL.

Materials and Methods

30 patients were enrolled in this prospective clinical study over a period of one year at Madras ENT Research Foundation (P) Ltd, Chennai (January 2010–2011).

Inclusion criteria

- Patients with sudden hearing loss presenting to the outpatient clinic within 14 days of onset
- Sensori-neural hearing loss of more than 30 dB (HL) involving 3 or more consecutive frequencies
- Normal MRI scan
- Normal MRI scan
- No history of otitis media and congenital hearing loss
- No history of ear trauma or ear surgery

On admission, otological examination was performed along with audiological test battery including PTA, Impedance, OAE and BERA. Imaging of inner ear and complete blood workup were done. The laboratory examinations included erythrocyte sedimentation rate, fasting glucose, cholesterol, triglycerides, thyroid function evaluation, circulating immune complex, complement, rheumatoid factor, and antinuclear factor. Patients with tinnitus/vertigo were evaluated with questionnaire and VEMP/Video-oculography/Tinnitusgram.

All patients were given a questionnaire in order to evaluate their symptoms. This ‘symptom scale questionnaire’ was formulated in order to grade the patients’ responses to the various symptoms associated with

SSNHL, during the course of treatment with IV steroids. The questionnaire was made on a scale of 0–10 based on the severity of various symptoms. The Symptoms evaluated were HL, tinnitus, vertigo, ear block or fullness, ear pain, symptoms related to co-morbid factors and the overall psychological status. The symptom scale was repeated sequentially every week until the end of therapy.

Patients were classified into two groups. Group 1— included SSNHL with no co-morbidity, group 2 included SSNHL with various co-morbidities. Each group was further divided into those with high frequency preservation (group A) and those with high frequency HL (group B). Mild SSNHL was considered if the average HL was 40 dB (HL) or less, moderate if between 41 and 60 dB (HL), and severe if >60 dB (HL). All patients received a loading dose of 1 g of methyl prednisolone intravenously immediately on admission and then twice a day for 3 days. Patients were discharged on the fourth day with oral steroids at 1 mg/kg body weight which was tapered gradually over a period of 3 weeks. Patients were followed up by pure tone audiometry (PTA) on the 3rd, 5th day, 2 and 4 weeks. Few patients experienced temporary adverse effects during therapy such as increased blood glucose levels, elevated blood pressure (especially those with DM and HTN). Diabetics received the same dose of methyl prednisolone but the blood sugar was closely monitored and managed with sliding scale of insulin as advised by our ‘in-house’ diabetologist.

The criteria for audiological improvement were based on that used by Furuhashi et al. [9], who classified the outcomes as complete recovery, marked improvement, partial improvement, or no recovery. Successful treatment is defined as complete recovery or an improvement of hearing in the six-frequency (250, 500, 1,000, 2,000, 4,000, and 8,000 Hz) pure tone audiometry (PTA) threshold of 30 dB or more—

- Complete recovery
PTA <25 dB
- Marked improvement
PTA improvement >30 dB
- Slight improvement
PTA improvement of 10–30 dB
- No recovery
PTA improvement <10 dB

Observation and Results

In our study, out of 30 patients, 20 had no co-morbidities (Group 1) and of the remaining ten patients (Group II) three were hypothyroid, two were hypertensive, three were diabetics and two had HT & DM. 18 patients presented to us with sudden loss within the first day, six patients within 3 days and six patients after 1 week. Associated symptoms

were tinnitus (11 pts), giddiness (8 pts) and ear block (5 pts). 19 patients had right ear hearing loss and 11 had left ear hearing loss. All the patients in our study had unilateral hearing loss. In this study 17 patients were males and 13 were females (Table 1). Hence male: female ratio was 1.3:1 and age range was 19–80 years. Radio-imaging of the inner ear was normal in all patients included in our study. Our patients were classified according to severity of the onset of HL into mild (10%), moderate (6.5%) and severe to profound SSNHL (83%). 16 patients had low frequency hearing loss with normal hearing in high frequencies. Patients with severe degrees of HL showed less response to treatment than those with mild to moderate degrees of HL (Table 2).

The mean hearing level improved from an average of 79.53 dB (HL) before treatment to 42.33 dB (HL) after treatment. In patients with HL at low frequency PTA improved from 76.01 to 32.6 dB while in high frequency HL PTA improved from 83.55 to 53.43 dB (Table 3). Out of 16 patients with normal hearing in high frequencies, 12 (75%) recovered completely, 2 (12.5%) had marked improvement and 2 (12.5%) did not recover at all. Out of 14 patients with high frequency loss, 5 (35.7%) recovered completely, 3 (21%) showed marked improvement and 6 (42.8%) did not recover (Table 4). In this study, eight patients (26.6%) presented with vertigo, all recovered completely with administration of anti-vertigo drugs like beta-histine, prochlorperazine and meclizine which were used to alleviate the acute symptoms when necessary. 11 patients (36.6%) presented with tinnitus out of which 2 (18%) did not recover, 2 pts (18%) showed marked improvement and remaining 7 (63.6%) recovered completely. In our study, patients in group I who did not have co-morbidities had better treatment outcomes than patients in group II who had co-morbidities such as diabetes mellitus, dys-thyroidism and hypertension (Table 5, 6).

Discussion

The interval between SSNHL's onset and medical care appears critical to recovering hearing. Investigators found the proportion of patients experiencing spontaneous recovery declined after 30 days, and with a small proportion regaining hearing spontaneously after 6 months [3]. Systemic steroids, orally or intravenously, have been the mainstay of treatment of SSNHL [2]. The mechanism of

steroid action on the inner ear is still not fully understood, although as a potent anti-inflammatory agent, steroids are suspected to cause vasodilatation with increased micro-vascular blood flow in the cochlea resulting in decreasing the endolymphatic hydrops, decreasing inflammation, or other unknown effects which are still under investigation. To achieve higher concentrations of the therapeutic agent in the inner ear, systemic application has been used, especially intravenously. In Germany, high doses of intravenously administered prednisolone (250 mg/day) are a standard treatment for SSNHL and were demonstrated to result in a high perilymphatic cortisol level. [10].

Steroids as a treatment for SSNHL have emerged due to the work done by Wilson et al. [2] in the early 1980s who demonstrated a recovery rate of 61%. Moskowitz et al. [6] deduced that 24 (89%) of 27 glucocorticoid-treated patients recovered at least 50% of their hearing, whereas 4 (44%) of 9 patients recovered their hearing without any treatment. Veldmann et al. [11] found an effective response to glucocorticoid treatment in 6 (50%) of 12 patients, whereas only 6 (32%) of 19 non-treated patients showed similar results. In our study of 30 patients complete recovery occurred in 56.66% cases and marked improvement (>30 dB) in 16.66% patients. There was no improvement in 26.66% cases.

We observed significant improvement in PTA, with mean improvement of 43.41 dB in the low-frequencies and 30.12 dB in the high frequencies HL. The findings of our study can be compared with those presented in the literature. Mattox and Simmons [7] reported a fundamental difference between hearing losses at low frequencies and those affecting high frequencies, stating that low frequency losses are more easily reversed. This was also observed in our study in which low frequency PTA normalized in 12 cases as compared with five cases of high frequency PTA normalization. If there is no improvement of hearing after a period of 2–3 months, with or without treatment, amplification and supportive audiologic rehabilitation to the patient should be considered. According to Byl [3], vestibular symptoms were identified in 56% of cases, as compared to 45% reported by Psifidis et al. [12].

In our study 26.6% patients were having vertigo and they were administered beta-histine, prochlorperazine and meclizine for alleviation of their acute vertigo. Even though these drugs may help to increase the cochlear vascularity, they do not cause any significant improvement in hearing, but only suppress the vertigo. Hence, we believe

Table 1 Demography

	Age <50 years (n = 20)		Age >50 years (n = 10)	
	Males (n = 13)	Females (n = 7)	Males (n = 4)	Females (n = 6)
Right ear (19)	11	5	1	2
Left ear (11)	2	2	3	4

Table 2 Response to treatment according to severity of hearing loss

Patient category	Average hearing loss prior to treatment (dB)	Average hearing loss post treatment (dB)
Mild SSNHL	34.36	19
Moderate SSNHL	46.65	21.65
Severe SSNHL	87.58	47.78

Table 3 Comparison of pre and post treatment mean average PTA thresholds

Hearing loss	Mean pretreatment PTA (dB)	Mean post-treatment PTA (dB) (after 1 month)
Low frequency HL (<i>N</i> = 16)	76.01	32.6
High frequency HL (<i>N</i> = 14)	83.55	53.43
Total (<i>N</i> = 30)	79.53	42.33

that administration of these drugs in conjunction with the IV steroids (drug of choice) will cause any change in the overall audiological outcomes of IV steroid therapy in SSNHL. Concomitant tinnitus was reported by Psifidis et al. [12] in 68% of cases and by Byl [3] in 74%. In our sample, tinnitus was much less prevalent (36.6% of cases). In a study done by Byl [3], tinnitus showed no correlation with hearing recovery after intra-tympanic steroid. In our study 11 patients suffered from tinnitus, of which seven patients recovered completely and two showed marked improvement in tinnitus with intravenous steroid treatment.

The overall observations from our study in Group 2 (candidates with co-morbidities like diabetes mellitus, hypothyroidism, hypertension) showed poorer outcomes than in Group 1 (candidates with no co-morbidities). This highlighted the fact that co-morbid conditions may influence the outcomes in IV steroid therapy for SSNHL. The possible implications for such an influence as noted especially in patients with diabetes mellitus may be, a direct influence of fluctuating blood sugar levels on the micro-vasculature of the cochlea (micro-angiopathy) and a counter-action between the IV steroid dose and the hypoglycemic agent administered, which may probably reduce the potency and efficacy of the IV steroid action within the cochlea [9, 12].

All the five patients with diabetes mellitus in our study were administered the full dose of IV steroids, as was given

to the patients with no co-morbidities (Group 1). We followed a standard protocol in our institute for the management of diabetic patients with SSNHL, whereby an 'In-house' Diabetologist strictly monitored the blood sugar by assessing CBG, FBS, PPBS and HbA1C levels at periodic intervals daily while the patient was on IV steroid therapy, and appropriate glycemic control was successfully achieved with an 'Insulin Sliding Scale'. It was vital to start insulin therapy for both IDDM and NIDDM patients, as soon as the first dose of IV steroid was administered. We observed that in all our diabetic patients, there was reasonable glycemic control during the treatment as was noted by the HbA1c levels which remained below 8%, by the time of completion of therapy. There was no gross derangement of blood sugar levels, while these patients were on the Insulin Sliding Scale and hence there was no necessity for tapering down or stopping the IV steroid course in-between the treatment regimen.

In a similar way, in three patients with hypothyroidism, appropriate administration of oral thyroid hormones was necessary in order to attain Euthyroid status, while IV steroids were administered for SSNHL. Among our hypertensive patients, we did not observe any remarkable influence of raised blood pressure on the SSNHL, even though there is a possibility of hypertension induced endolymphatic hydrops and micro-angiopathy within the inner ear [9, 12]. IV steroid therapy did not affect the blood pressure levels and all these patients with systemic hypertension were comfortably managed with anti-hypertensive agents, which they were using prior to onset of their deafness. Among our two patients having diabetes mellitus along with hypertension, the outcomes were guarded since these patients had long standing diabetes and hypertension and possibly had a pre-existing cochleopathy due to these two co-morbid factors.

From the above results of our study, we infer that, it is mandatory to counsel patients with co-morbidities such as diabetes mellitus, hypothyroidism etc. that their results may be influenced by these conditions and their outcomes with IV steroid therapy may be sub-optimal or guarded. The urgent need for appropriate control of these co-morbid factors needs to be emphasized in order to achieve optimal outcomes in such patients with SSNHL.

Table 4 Comparison of frequency specific hearing improvement after treatment in groups 1 & 2

Hearing improvement (4 weeks)	Group I (<i>n</i> = 20)		Group II (<i>n</i> = 10)	
	Low frequency loss (group A%)	High frequency loss (group B%)	Low frequency loss (group A%)	High frequency loss (group B%)
Complete	10 (33.33)	4 (13.33)	2 (6.66)	1 (3.33)
Marked	1 (3.33)	1 (3.33)	1 (3.33)	2 (6.66)
No	1 (3.33)	3 (10)	1 (3.33)	3 (10)

Table 5 Analysis of hearing improvement in group 1

Hearing improvement (4 weeks)	Group I (<i>n</i> = 20)	
	Low frequency loss (group A%)	High frequency loss (group B%)
Complete	10 (50)	4 (20)
Marked	1 (5)	1 (5)
No	1 (5)	3 (15)

Table 6 Analysis of hearing improvement in group 2

Hearing improvement (4 weeks)	Group II (<i>n</i> = 10)	
	Low frequency loss (group A%)	High frequency loss (group B%)
Complete	2 (20)	1 (10)
Marked	1 (10)	2 (20)
No	1 (10)	3 (30)

Conclusion

According to our results, administration of high dose intravenous corticosteroids to patients with SSNHL is highly recommended. Hearing outcomes are better in patients who do not have co-morbidities. IV steroids therapy has best results when commenced within 6 h of onset of deafness, which is the critical window period for complete recovery of Cochleopathy. Patients with high frequency hearing preservation have better hearing improvement at the end of treatment. Contraindications for steroids administration are a recent history of stomach ulcer, known left sided heart insufficiency, renal/adrenal disorders or an active systemic sepsis. However, these contraindications and co-morbidities are only relative and in the context of restoring normal hearing in an emergency

situation such as SSNHL, IV steroid therapy should certainly be considered as first line of management for SSNHL at the earliest.

References

1. DeKleyn A (1944) Sudden complete or partial loss of function of the octavus-system in apparently normal persons. *Acta Otolaryngol* 32:407–429
2. Wilson WR, Byl FM, Laird N (1980) The efficacy of steroids in the treatment of idiopathic sudden hearing loss. A double-blind clinical study. *Arch Otolaryngol* 106:772–776
3. Byl FM Jr (1984) Sudden hearing loss: eight years' experience and suggested prognostic table. *Laryngoscope* 94:647–661
4. Stokroos RJ, Albers F, Schirm J (1998) The etiology of idiopathic sudden sensorineural hearing loss: experimental herpes simplex virus infection of the inner ear. *Am J Otol* 19:447–452
5. Fetterman BL, Saunders JE, Luxford WM (1996) Prognosis and treatment of sudden sensorineural hearing loss. *Am J Otol* 17:529–536
6. Moskowitz D, Lee KJ, Smith HW (1984) Steroid use in idiopathic sudden sensorineural hearing loss. *Laryngoscope* 94:664–666
7. Mattox DE, Simmons FB (1977) Natural history of sudden sensorineural hearing loss. *Ann Otol Rhinol Laryngol* 86:463–480
8. Cinamon U, Bendet E, Kronenberg J (2001) Steroids, carbogen or placebo for sudden hearing loss: a prospective double-blind study. *Eur Arch Otorhinolaryngol* 258:477–480
9. Furuhashi A, Matsuda K, Asahi K, Nakashima T (2002) Sudden deafness: long-term follow-up and recurrence. *Clin Otolaryngol* 27:458–463
10. Niedermeyer HP, zahneisen G, Luppap et al (2003) Cortisol levels in the human perilymph after intravenous administration of prednisolone. *Audiol Neurotol* 8:316–321
11. Veldmann JE, Hanada T, Meeuwse F (1993) Diagnostic and therapeutic dilemmas in rapidly progressive sensorineural hearing loss and sudden deafness. *Acta Otolaryngol* 113:303–306
12. Psifidis AD, Psillas GK, Daniilidis J (2006) Sudden sensorineural hearing loss: long-term follow-up results. *Otolaryngol Head Neck Surg* 134(5):809–815