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ORIGINAL ARTICLE

Diagnosis and Management of Lateral Canal Benign Paroxysmal Positional Vertigo

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OBJECTIVE: To present our experience in the treatment of lateral semicircular canal benign paroxysmal positional vertigo by using a 360∞ barbecue rotation followed by placing the patient in a forced prolonged position.

PATIENTS AND METHODS: This study consisted of 34 patients with lateral canal benign paroxysmal positional vertigo. Twenty of those subjects exhibited the geotropic variant, and 14 had apogeotropic nystagmus. The geotropic form was treated with a 360∞ barbecue rotation toward the healthy side followed by the patient's lying in a forced prolonged position on the healthy side. Attempts at canal conversion from the apogeotropic form to the geotropic form were made by subjecting the patient to head shaking, a 180∞ roll or barbecue rotation toward the healthy side, and lying in a forced prolonged position on the diseased side.

RESULTS: Of the 20 patients with the geotropic variant, 17 (85%) were cured and 3 (15%) improved. Of those with the apogeotropic variant, 11 patients (87.6%) were cured, 1 (7.1%) improved, and 2 (14.3%) experienced no benefit from treatment. The overall result was improvement or cure in 32 of 34 patients (94.1%). Many patients underwent more than 1 therapeutic maneuver to achieve those results.

CONCLUSION: Lateral canal vertigo is more difficult to treat than posterior canal positional vertigo. The apogeotropic variant is usually more difficult to treat than the geotropic type, and canal conversion should be tried before treatment is initiated.

Benign paroxysmal positional vertigo (BPPV) is a common cause of vertigo of peripheral origin. It is caused by otoliths that have detached from the maculae and are either floating as free particles in the vestibular endolymphatic space (canalithiasis)[1,2] or (less frequently) have become attached to the cupula itself (cupulolithiasis).[3] Rapid changes of the head or body position trigger the sudden onset of brief episodes of intense vertigo and nystagmus in the plane of the affected canal. BPPV most often affects the posterior semicircular canal, which lies in the most gravity-dependent position.[4,5]

In 1985, McClure[6] first described BPPV of the lateral semicircular canal (LSC), which was caused by canalolithiasis. That variant is induced by rapid turning of the head to either direction while the patient is supine. Three variants (bilateral geotropic nystagmus, bilateral apogeotropic nystagmus, and bilateral apogeotropic intense long-lasting nystagmus) of this condition were later identified.[7] Bilateral geotropic nystagmus, which is the most common of the 3 variants, is caused by heavy free-floating particles in the posterior part of the LSC. When they rotate toward the affected side, those particles move toward the ampulla and create an ampullopetal endolymph flow that causes excitatory nystagmus toward the involved ear. When the patient rolls over to the opposite side, an inhibitory ampullofugal movement causes nystagmus toward the opposite side. The nystagmus is usually characterized by a brief latent period, lasts for less than 1 minute, is purely horizontal, and is not fatigable.[8]

Bilateral apogeotropic nystagmus, which occurs less frequently than does bilateral geotropic nystagmus, is caused by the movement of heavy free-floating particles in the anterior part of the LSC. Another less common variant (bilateral apogeotropic intense, long-lasting nystagmus) is characterized by poor fatigability and is attributed to cupulolithiasis. In both types of apogeotropic nystagmus, rolling to the affected side induces an inhibitory nystagmus, and rolling to the healthy side induces an excitatory nystagmus.

According to Ewald's law,[9] which states that the response to an excitatory stimulus is more intense than that to an inhibitory one, the nystagmus is more intense when the head is turned toward the affected ear in the geotropic type, and it is more intense when the head is rotated toward the healthy side in the apogeotropic type (Figure 1). Different maneuvers have been proposed for the treatment of LSC positional vertigo. The 270° barbecue maneuver toward the healthy side was proposed by Lempert. [10] Other authors have suggested a 360° barbecue maneuver initiated from the healthy side.[11,12] These maneuvers have been used with varying success for the treatment of LSC canalithiasis.

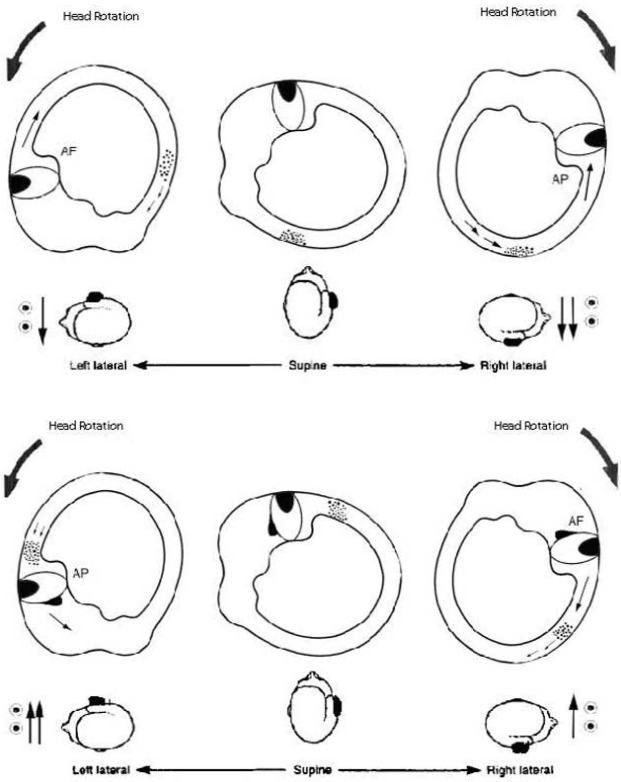

Figure 1: Mechanism of lateral semicircular canal benign paroxysmal positional vertigo of the right ear. a) Geotropic nystagmus caused by otolith particles in the long arm of the canal. On rotation to the side, deflection of the cupula occurs (ampullopetal on rotation to the right and ampullofugal on rotation to the left). The resulting nystagmus is toward the lowermost ear and is stronger on the right side. b) Apogeotropic nystagmus. Free particles are present in the short arm of the canal, or dense particles are attached to the cupula. On rotation to the right side, the cupula moves away from the utricle (ampullofugal), but on rotation to the left side, cupular movement is ampullopetal. The resultant nystagmus is away from the lowermost ear and stronger on the left side.

Vannucchi and colleagues[13,14] proposed the technique of "forced prolonged position" (FPP), which consists of the patient's lying in forced immobility on the healthy side for 12 hours. Guffoni and colleagues[15] used a therapeutic maneuver (a form of a modified Semont maneuver) with a success rate of 90%. That maneuver begins with the patient in the sitting position. A patient with the geotropic variant then quickly moves to lie on the healthy side, and a patient with the apogeotropic variant quickly moves to lie on the affected side. The patient's head is then rotated 45∞ downward, and that position is maintained for 2 to 3 minutes before the patient returns to the sitting position. The Vannucchi-Asprella maneuver[16] is a simple variant of the barbecue rotation. It is performed when the patient rapidly moves from the sitting to the supine position, after which the head is turned rapidly to the unaffected side. The patient then returns to the sitting position, in which his or her head is at midline. That maneuver is repeated 5 to 8 times in rapid succession.

The aim of this paper is to present our results in the treatment of lateral semicircular canal benign paroxysmal positional vertigo (LSC-BPPV) by using a combination of 360∞ barbecue rotation and FPP. In patients with the apogeotropic form, conversion to geotropic LSC-BPPV was tried before the definitive treatment was attempted.

PATIENTS AND METHODS

Of 391 patients with positional vertigo treated in the Hai Al Jamea Hospital in Jeddah, Saudi Arabia, between 2001 and 2005, 34 (8.7%) patients had the lateral canal variant. Those patients underwent a complete neurotologic examination. Diagnosis was made by the observation of either geotropic or apogeotropic bilateral horizontal nystagmus with the patient on the supine position and the head rotated either side with the characteristics already described.[6,8] When the head was rotated to the side that elicited more nystagmus, the affected side was that of the undermost ear in patients with the geotropic variant and that of the uppermost ear in patients with the apogeotropic form. In some patients, nystagmus was noted when the patient moved from the sitting to the supine position. In those cases, the nystagmus was toward the affected side in patients with the apogeotropic type and away from the healthy side in patients with the geotropic form. In all patients, the head was shaken vigorously from side to side and from up to down for 30 seconds before treatment was initiated. Patients with the geotropic form were treated with a 360∞ barbecue maneuver that moved from the diseased side to the healthy side[17] (Figure 2). The patients were then instructed to sleep on the healthy side for 10 to 12 hours (ie, in the FPP). [14] All patients were examined again on the next day. Persistent nystagmus necessitated repetition of the same maneuver. In patients with the apogeotropic form,

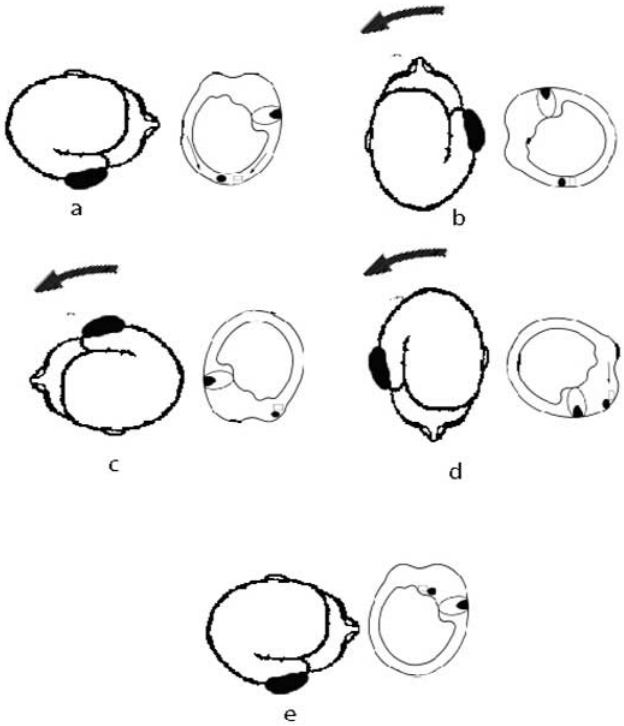

Figure 2: The treatment of right lateral semicircular canal benign paroxysmal positional vertigo by means of a 360∞ barbecue maneuver. The patient is turned 360∞ toward the healthy ear starting from the patient in the supine position and his head turned to the right side. Note that turning the patient to the diseased side leads to the precipitation of otolith particles from the long arm of the canal (black dot) and from the short arm of the canal (empty square) into the most dependent part of the canal (position a). With subsequent rotations, the particles travel into the utricle (position e). The patient is then seated, and the maneuver has been completed.

different methods were used on a case-by-case basis. With the patient in the supine position, a 180° head turn from the healthy side to the affected sided was performed. In our last 5 patients, we performed a barbecue maneuver toward the healthy side instead. In all patients, this initial maneuver was followed by maintaining an FPP on the affected side to shift the canaliths from the anterior to the posterior arm of the canal, thus transforming the apogeotropic form into the geotropic form. The patients were reassessed on the next day. If conversion to geotropic nystagmus had occurred, they were treated as described for that variant. In patients with persistent apogeotropic nystagmus, a 360° barbecue roll toward the healthy side was followed by FPP on the healthy side. That sequence was repeated a maximum of 3 times. In all patients with persistent disease, the affected side was reassessed during each follow-up examination.

All patients were followed up for at least 2 weeks. Cure was defined as the complete resolution of signs and symptoms and the absence of nystagmus in the provoking supine and head lateral position. Patients who still exhibited symptoms after treatment but demonstrated no elicitable nystagmus were considered improved. Persistent nystagmus indicated treatment failure.

RESULTS

This study consisted of 34 patients (19 men and 15 women; age range, 16-80 years; mean age, 42.1 years). The right side was affected in 21 patients, and the left side was involved in 13 patients. In 2 patients, the side on which the lesion occurred could not be determined because the degree of nystagmus was nearly equal on head rolls in either direction (left or right). During reassessment on the day after treatment, the exact side was identified in these patients, and the therapeutic maneuver was performed. The duration from the onset of symptoms until diagnosis ranged from 1 to 14 days (average, 2.4 days). The geotropic variant of nystagmus was present in 20 patients (58.8%), and the remaining 14 patients (41.2%) had the apogeotropic form. Seven patients (6 with the geotropic variant and 1 with the apogeotropic variant) were admitted to our hospital. Four of those patients had severe vomiting and vertigo, and the remaining 3 exhibited paroxysmal atrial fibrillation and concomitant vertigo. One case of the geotropic variant was due to conversion during an Epley maneuver performed to treat posterior canal positional vertigo. Of the 20 patients with the geotropic type, 17 (85%) were cured and 3 (15%) improved. The barbecue maneuver and the FPP were used once in 11 patients, twice in 5 patients, and 3 times in 4 patients. As a consequence of treatment, the disorder converted to posterior canal positional vertigo in 3 patients and was managed successfully with the Epley maneuver. Of the 14 patients with the apogeotropic type, the disorder converted to geotropic nystagmus in 4 patients and was successfully treated as previously described. Four other patients experienced a spontaneous cure after performing repeated 180° lateral rotation maneuvers and lying in the FPP. Six patients experienced persistent apogeotropic nystagmus. Three of those individuals were cured, and the disorder improved in 1 patient treated with a 360° barbecue roll and FPP on the healthy side. The remaining 2 patients continued to exhibit persistent signs and symptoms. In one of those individuals, the 360° roll could not be performed because the patient was very obese. In that case, only the FPP was used. Both symptomatic patients were advised to perform vestibular exercises, and 1 of them was cured after 2 months. The final outcome in this group was cure in 11 patients (78.6%), an improvement in 1 patient (7.1%), and treatment failure in 2 patients (14.3%). The overall results of both groups together were cure in 28 patients (82.3%), an improvement in 4 (11.8%), and treatment failure in 2 (5.9%). Therefore, 32 of 34 patients (94.1%) were cured or improved. Figure 3 summarizes the clinical management of both groups.

Follow-up ranged from 2 weeks to 3 years (mean duration of follow-up, 62 days). Recurrence developed in 3 patients. Seven other patients experienced recurrent episodes of posterior canal benign positional vertigo 3 months to 3 years after the initial cure of their disease.

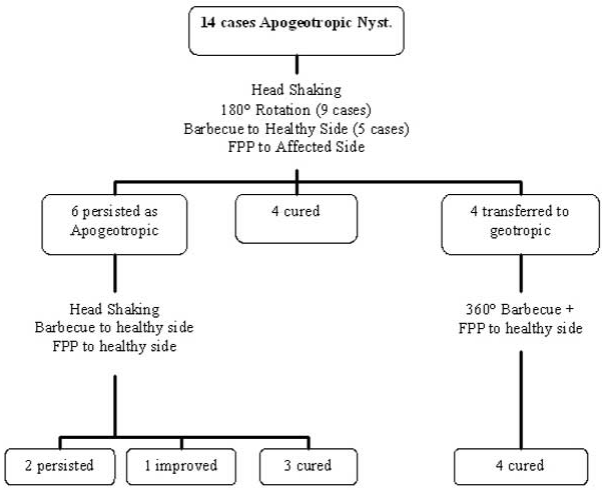

Figure 3: Summary of the treatment of patients with apogeotropic lateral semicircular canal benign paroxysmal positional vertigo.

DISCUSSION

Benign paroxysmal positional vertigo, which is the most common cause of peripheral vertigo, most often involves the posterior semicircular canal. Being the most dependent of the three semicircular canals, the posterior semicircular canal tends to be more affected by the degenerating otolith particles that float in the endolymph of the inner ear.[5] The recently discovered lateral canal variant, which was once thought to be rare, is now diagnosed more frequently.[18] We have found an incidence of lateral canal variant in 8.7% of our patients with paroxysmal positional vertigo, and similar incidences have been noted by other investigators.[7,18,19] We believe that the increasing incidence is due to a greater awareness of this newly recognized condition.

Although the symptoms of lateral canal variant resemble those of BPPV in general, the vertigo associated with the variant is often much more intense than that in patients with posterior canal BPPV.[11] Four of the 7 patients in our series were admitted to our hospital for the treatment of severe vertigo and excessive vomiting. In contrast, hospital admission in patients with paroxysmal positional vertigo (PPV) is extremely uncommon in our practice. An interesting finding was the presence of idiopathic paroxysmal atrial fibrillation in 3 of our patients. The vestibular effects on the autonomic nervous system are well known, although the mechanisms and underlying physiologic basis of those effects are not well understood.[20,21] It might be that the severe vertigo in these patients induced adrenergic stimulation that caused paroxysmal atrial fibrillation. Further studies are needed to validate that hypothesis.

The different techniques proposed for the treatment of LSC-BPPV aim at mobilizing the free-floating otoconial debris in an ampullofugal direction out of the lateral canal and into the utricle. This is achieved by angular acceleration (barbecue maneuvers), linear acceleration (the Gufoni maneuver15), or slow sedimentation potentiated by lying in the FPP.

Unlike the different repositioning maneuvers used in the treatment of posterior semicircular canal PPV, which had a high rate of success, the treatment of LSC-BPPV vertigo has produced less-than-optimal results in many published series.[7,22] The reason for this might be the presence of dense otoliths that are attached firmly to the cupula (which results in the apogeotropic form of nystagmus) or the failure to identify the affected side in some cases.[23] In 2 of our patients, the affected side could not be identified during the first visit.

Another method used to identify the affected side involves determining the direction of the nystagmus when the patient moves from the sitting to the supine position. The nystagmus beats toward the affected ear in the patients with the apogeotropic type and away from it in those with the geotropic type. In a recent study, this was found to be a reliable method of assessment, particularly in patients with the apogeotropic type, and it proved accurate in 80% of patients with that variant.[24] In sitting patients who have the apogeotropic variant, cupulolithiasis causes nystagmus toward the affected side. In patients with that variant who are supine and who turn their head slowly from one side to the other, the nystagmus stops at the position at which the cupula of the affected lateral semicircular canal is aligned with gravity. This position occurs when the head is slightly rotated to the affected side[25] (Figure 4). We were able to use this technique in only 2 of our patients.

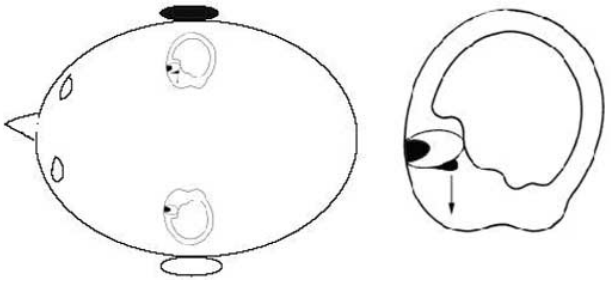

Figure 4: A patient with right-sided lateral semicircular canal cupulolithiasis. Note that when the patient is lying in a forced prolonged position on the healthy side, the gravitational force tends to move the particles into the utricle.

A review of some of the major published series in the literature illustrates the diversity of maneuvers performed for the treatment of LSC-BPPV(Table). Many series obtained high success rates either by repeating the therapeutic maneuvers from 3 to 10 times or by using a multitude of therapeutic maneuvers.[17,23,] Results of such studies have been reported after 3 to 6 days,[17] 1 week,[4] 3 to 5 weeks,[19] or (more often) during the first day of the last therapeutic intervention.[7,22,23,26,] We also assessed all patients on the day after each treatment because we believe that the results of that

Table: Summary of most of the major published series of lateral semicircular canal benign paroxysmal positional vertigo

Author(s)	Type of Nystagmus	Patients (no.)	Management	Maneuvers Performed (no.)	Therapeutic Success (%)
Nuti and colleagues[26]	Geotropic Apogeotropic	95 21	270° Barbecue plus FPP maneuver Conversion	2	71 73 76
Fife[4]	Geotropic Apogeotropic	19 5	Barbecue maneuver Barbecue maneuver	Many?	75 80
Casani and colleagues[7]	Geotropic Apogeotropic	41 25	Barbecue maneuver plus FPP Conversion plus Semont maneuver for persistent disease	3	89 77
Asprella and colleagues[28]	Geotropic Apogeotropic	40 15	Vannucchi-Asprella maneuver with or without Lempert maneuver (270° roll) Vannucchi-Asprella maneuver with or without Lempert or Gufoni maneuver	3-10	100% 100%
Hornibrook[19]	Geotropic Apogeotropic	29 7	360° Barbecue maneuver to the healthy side 360° Barbecue maneuver to either side	> 2	100%† 100%†
Tirelli and Russolo[17]	Geotropic Apogeotropic	62 10	Head shaking and 306° barbecue maneuver to the healthy side	3	100 90
White and colleagues[22]	Geotropic Apogeotropic	10 10	360° roll 360° roll; Brandt-Daroff, Casani, or Vannucchi-Asprella maneuver	1 - 3 Unknown	90 50
Chiou and colleagues[23]	Geotropic Apogeotropic	49 40	FPP on the side of weak nystagmus FPP on the side of weak nystagmus (conversion to geotropic variant in 11 patients and FPP side changed accordingly)	4 4	100 100
This study	Geotropic Apogeotropic	20 14	Head shaking, 360° barbecue maneuver plus FPP FPP on the diseased side plus 360° barbecue maneuver trial conversion; then FPP plus 360° barbecue maneuver to the healthy side	3 3	100 85.7

FPP, Forced prolonged position.
†Follow-up, 3-5 weeks after therapy.

early examination better reflect the true effects of therapy.

In a study comparing the barbecue maneuver and the FPP for the treatment of the geotropic variant of LSC-PPV, the barbecue maneuver was successful in 71% of cases, and the FPP produced complete relief in 73% of cases.[26] As other studies indicate,[7] a combination of the barbecue maneuver and the FPP appears to produce better results than does either technique alone. The use of that combination resulted in an overall cure or improvement in 94% of our patients. The barbecue maneuver provides immediate relief in most cases. The few residual otolith particles that remain after the barbecue maneuver can then be moved to the vestibule by means of the FPP.

Some studies show that the apogeotropic variant is more difficult to treat than the geotropic form and the therapeutic results are generally less successful.[7,22] This has also been our experience. Many maneuvers have been proposed for the treatment of the apogeotropic variant because none has been universally effective. Most clinicians try to mobilize the particles from the anterior to the posterior arm of the canal so that subsequent therapeutic maneuvers lead to the migration of the particles through the nonampullated end to the vestibule. To achieve this, different methods have been proposed. Nutti and colleagues [26] used repeated 180∞ lateral rotations of the head toward the healthy ear while the afflicted ear was positioned downward. A barbecue maneuver toward the healthy side has also been proposed by various authors[4,17] Maintaining an FPP on the affected side or the side of weak nystagmus has been reported as an effective treatment in many cases.[23] A modified Gufoni maneuver has also been reported to be successful.[27] It is noteworthy that in many series,[27-29] more than 1 technique was used for the transformation of the apogeotropic variant into the geotropic variant. We suggest that transforming free particles from the anterior to the posterior arm of the LSC (the canalith type of apogeotropic nystagmus) is relatively more feasible than detaching adherent particles from the cupula of the canal (the cupulolithiasis type). In the latter type, head shaking (which facilitates the detachment of particles adherent to the canal wall or to the cupula), 180° lateral rotation, or the barbecue maneuver plus the FPP would be necessary for successful treatment. Our patients with the apogeotropic variant in whom treatment or conversion failed were managed by the barbecue maneuver plus the FPP on the healthy side. We assumed that many of those cases were caused by particles that were stuck to the utricular side of the cupula. When the patient sleeps on the healthy side, the contralateral diseased cupula is located uppermost, and the gravitational force tends to dislocate the particles into the vestibule (Figure 5).

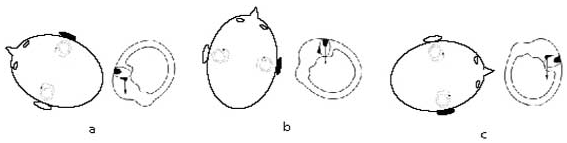

Figure 5: Right-sided lateral semicircular canal cupulolithiasis. When the patient is supine with his head turned to the left, (a) the line of gravity causes ampullopetal cupular displacement. When the head is turned slightly to the right, (b) the line of gravity (arrow) causes no cupular deflection, and the nystagmus resolves. With further rotation to the right, (c) the direction of the nystagmus reverses.

It is noteworthy that the duration of symptoms in our patients was very short (mean duration, 2.4 days). The reason for that is 2-fold. Our center is a secondary care hospital, and therefore most patients present directly to us when they first experience the symptoms of their disease. Most subjects in the literature are accessioned from tertiary care settings that obtain their patients as referrals; hence there is a relative delay in presentation. Another cause is that unlike the manifestation of posterior canal BPPV, that of LSC-BPPV is relatively severe, which prompts the patient to seek medical help as soon as symptoms develop.

As in most series published in the literature, our study did not include a control group. Vannucchi and colleagues[14] who monitored their patients during the first 72 hours after presentation, reported a 26% incidence of spontaneous recovery in 15 patients who received no treatment versus a 90% resolution rate in 35 patients treated with FPP. Nuti and colleagues[26] reported only a 30% spontaneous cure rate during the first few days after occurrence of the disease in 21

patients who received no treatment. We monitored our patients daily for the first 3 days after treatment or until the manifestations of disease subsided and then for 2 weeks. Most of our patients experienced cure during the first 2 to 3 days after treatment. It is therefore unlikely that the cure rate reported in our patients was due to spontaneous resolution.

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