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REVIEW

The Diagnosis and Management of Meralgia Paresthetica: A Narrative Review

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ABSTRACT

Meralgia paresthetica (MP) is a sensory mononeuropathy affecting the lateral femoral cutaneous nerve. Diagnosis is typically made clinically, often utilising multiple diagnostic aids such as imaging and electrophysiology. Upon diagnosis, the management of MP follows the standard ladder, with conservative management first line, followed by steroid injection and finally surgery. Surgery may be neurolysis or neurectomy. A literature review of the PubMed database was performed identifying 594 papers regarding MP or the lateral femoral cutaneous nerve. Following a two-stage screening process and reference searching, 34 articles were included in this review, 11 discussing diagnosis and 23 discussing management. Despite the longstanding knowledge of MP, there remains limited comprehensive research discussing its diagnosis and management. Diagnosis of MP is based on clinical examination, imaging and electrophysiology. There is no obviously superior diagnostic strategy for MP. Once that diagnosis is made, the management strategy is typical of any condition, wherein a patient will move up the intervention ladder. It is apparent that conservative management and steroid injection are both adequate in most patients. Where these strategies fail, surgical options such as decompression, radiofrequency ablation or neurectomy are suitable for the majority of remaining patients. While both neurolysis and neurectomy are described as appropriate strategies, there is a scope for discussion regarding whether one is superior. Other management strategies such as botox, acupuncture and kinesio taping may have some value, but limited research exists on these strategies and further research into these is required.

Keywords: Meralgia paresthetica; Femoral cutaneous nerve; Rare mononeuropathies

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Key Summary Points

Effective diagnosis of meralgia paresthetica (MP) requires a combination of clinical examination, imaging and electrophysiological assessments, with no single tool proven superior.

The sensory nerve action potential (SNAP) amplitude is the most reliable electrophysiological parameter for diagnosing MP, but neither SNAP nor somatosensory evoked potentials (SSEP) is definitively superior in detecting pathology.

Conservative management and injection therapy are usually sufficient for most patients with MP, with neurolysis being less invasive than neurectomy if surgical intervention is necessary.

Alternative treatments like acupuncture and botox show promise but need further research and randomised controlled trials to validate their effectiveness.

INTRODUCTION

Meralgia paresthetica (MP) is a sensory mononeuropathy affecting the lateral femoral cutaneous nerve (LFCN). First described in 1885, the condition often manifests itself with a burning sensation on the lateral aspect of the thigh, with paraesthesia or numbness over the affected area [1, 2]. The term MP derives from the Greek terms *meros* meaning thigh and *algos* meaning pain, with the official descriptor founded in 1895 by Roth, thus giving the condition its alternative name Bernhardt–Roth syndrome [3].

MP has been described to occur in any age group, though most classically presents in the 3rd and 4th decades of life. The prevalence of MP is reported to be around 43 per 100,000 individuals and is reported to be higher in individuals with pre-existing health conditions such as diabetes where prevalence is 247 per 100,000 or in military personnel where prevalence is said to be up to 100 per 100,000 [4, 5]. It is also appreciated that, while most cases of MP are unilateral, with no preference for the side of the body affected, up to 20% of patients with MP experience bilateral symptoms [6].

The diagnosis of MP is predominantly made clinically. Despite its relative common occurrence, healthcare professionals often misdiagnose MP due to its clinical similarity with other conditions, i.e. lumbar radiculopathies. MP is often considered an elusive diagnosis due to its mimicry of neurological symptoms (e.g., numbness, paraesthesia) that present with other, more common causes of anterolateral thigh pain, such as lumbar stenosis, disc herniation and nerve root radiculopathy [7].

Despite MP being a well-appreciated condition since 1895, the literature surrounding the condition remains limited. Much of the data remain unchanged since the nineteenth century, and little work has been done to carry out reviews of the work that is available. That is the scope of this project, to create a valuable, updated review of the diagnostic and management strategies available for MP.

METHODS

Literature Search Strategy

An online literature search was conducted using the web portal PubMed on the 13 March 2024. Medical subject headings and free text terms were combined to produce two strings. String A was “meralgia paraesthetica” or “meralgia paresthetica” in Title or Abstract and String B was “lateral femoral cutaneous” in Title or Abstract. The Boolean operator OR was used to combine search results. Three filters were applied, these ensured that the results were available in English, concerned human participants, and access to the full text was provided.

Inclusion and Exclusion Criteria

Articles deemed eligible to be included in this review had the following characteristics:

- The study discussed diagnosis or management of MP.
- The study subjects were human.
- The study language was English.

Articles deemed ineligible to be included in this review had the following characteristics:

- Studies discussed the lateral femoral cutaneous nerve not in the context of MP.
- Studies where the context of MP was not related to diagnosis or management.
- Non-original studies (i.e. review papers, case reports or case series with less than 5 patients).

Two researchers were responsible for screening through the titles of the search results. The abstracts were subsequently examined in a primary screening to give a list of papers viable for secondary screening of full text to be analysed for eligibility of inclusion to review.

Letters, comments, narrative, literature and systematic review articles were excluded from the secondary screening, but were kept separately due to potentially containing useful information, or potentially containing references that may have been missed in the electronic search. Case reports and case series with less than 5 patients were similarly excluded, though retained for reference material.

Synthesis of Results

As data did not lend itself to meta-analysis, a narrative approach was taken. This study is reported in accordance with the Page et al. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [46].

Quality Assessment of Included Studies

Randomised control trials (RCTs) were assessed for quality using the Jadad scoring system [47].

Compliance with Ethical Guidelines

The article is based on previously conducted studies. Thus, there are no ethical concerns in respect to this study, nor was approval of the research protocol from an ethics committee required.

RESULTS

Search Results

The above-mentioned literature search strategy returned 594 articles. Following a two-stage screening process, 32 articles were deemed eligible for inclusion. Two further articles were found via reference searching leaving a total of 34 articles for review [8, 10–42]. Figure 1 illustrates the study selection process.

Diagnosis of MP

Of the 11 papers that discuss diagnosis, 5 [10, 13–16] focused on imaging and 6 [8, 17–21] focused on electrophysiology.

Bedside Tests

Three bedside tests have been described in the literature: the pelvic compression test, neurodynamic testing and the Tinel test. These tests are often incorporated into research articles and there exists little literature exploring the effectiveness of these tests or comparing them. This is a gap in the literature that should be looked at filling in future works.

The pelvic compression test (Fig. 2) was first described by Nouraei et al. in 2007 [36]. The patient is positioned on their side with their symptomatic side facing upwards. The examiner applies a downwards, compression force to the pelvis and maintains pressure for 45 s. If the patient reports an alleviation of symptoms, the test is considered to be positive. This test is based on the idea that the LFCN is compressed by the inguinal ligament and that a downward force to the innominate will relax the ligament and temporarily alleviate the patient's symptoms.

Neurodynamic testing (Fig. 3) was described by Butler [43] wherein the patient is lying on their side with the symptomatic side facing upwards and the bottom knee bent. The

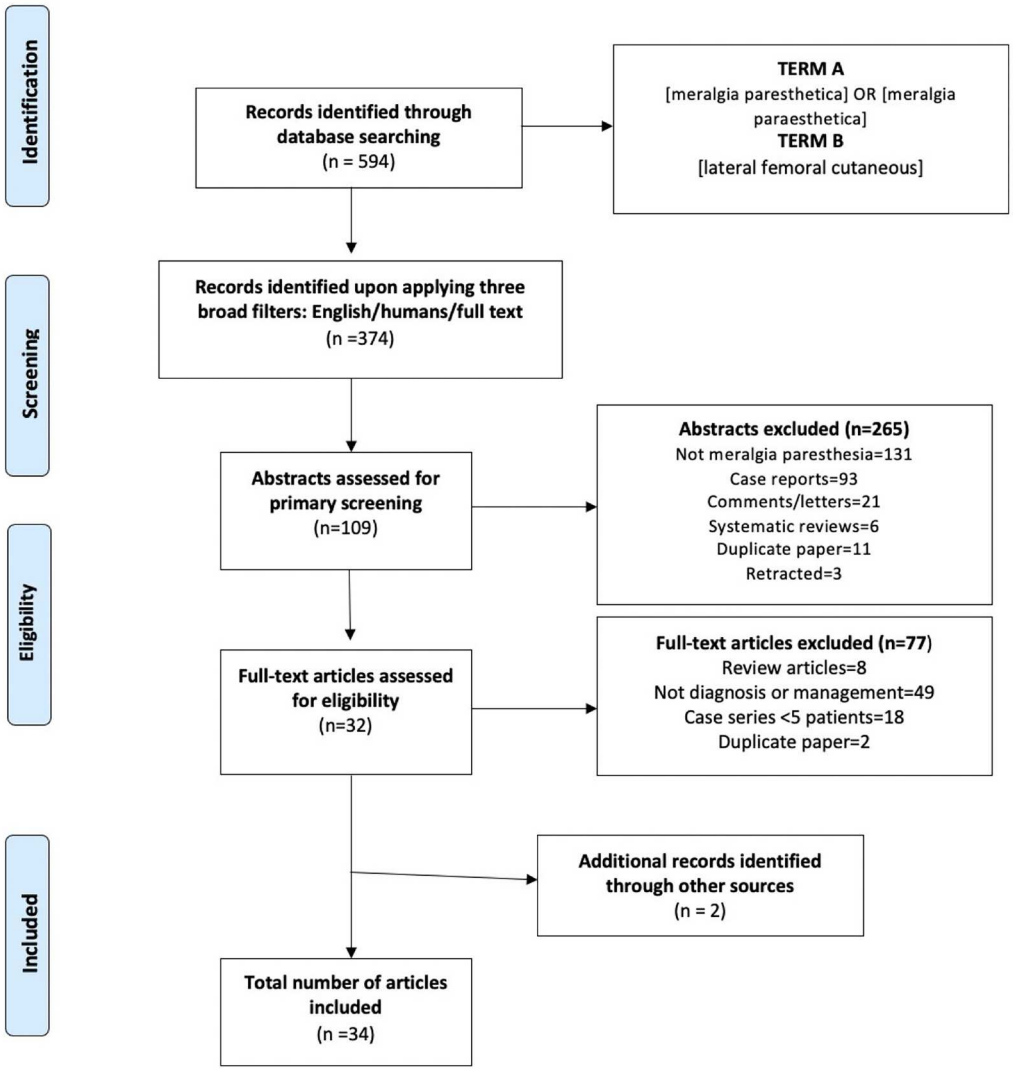

Fig. 1 PRISMA chart displaying screening process

examiner stabilises the pelvis with their top hand and grasps the lower extremity at the knee with their bottom hand. The examiner then bends the knee and adducts the hip in order to elicit tension in the LFCN. A positive test would be the reproduction of the patient's neurologic symptoms versus feeling tension in the soft-tissue structures of the hip which would be considered negative.

While the Tinel test is largely regarded to be diagnostic for carpal tunnel syndrome, Parmer reported the possibility of eliciting the Tinel test on the LFCN in patients with suspected MP [44]. In this test, the patient is lain supine and the examiner taps on the LFCN just medially to the anterior superior iliac spine (Fig. 4). A reproduction of symptoms indicates a positive test.

Imaging

Ultrasound (US) Ultrasound (US) as a diagnostic tool was assessed in three papers [10, 13, 14]. These papers looked at producing diagnostic criteria when analysing potentially pathological LFCNs, focusing on cross-sectional areas and nerve diameters. All three papers reported a significant difference between cross-sectional areas (CSAs) in pathological versus non-patho-

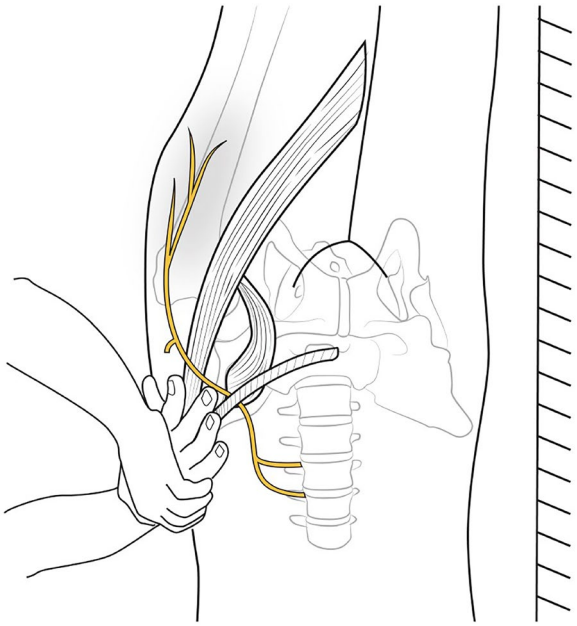

Fig. 2 Pelvic compression test

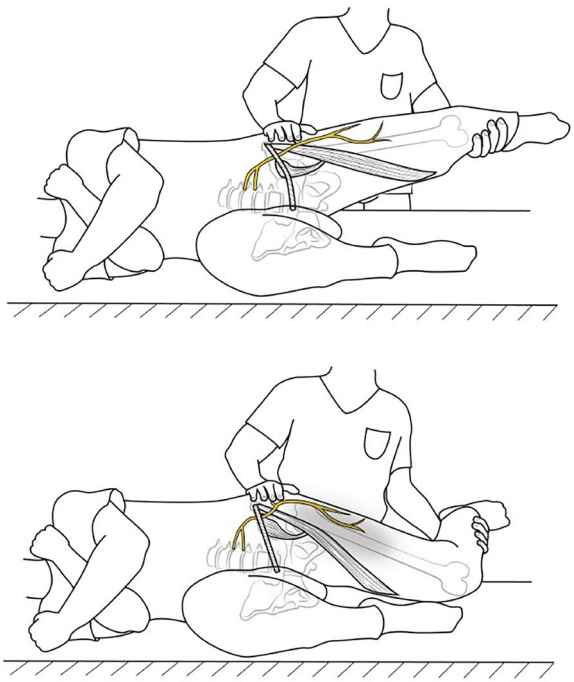

Fig. 3 Neurodynamic testing

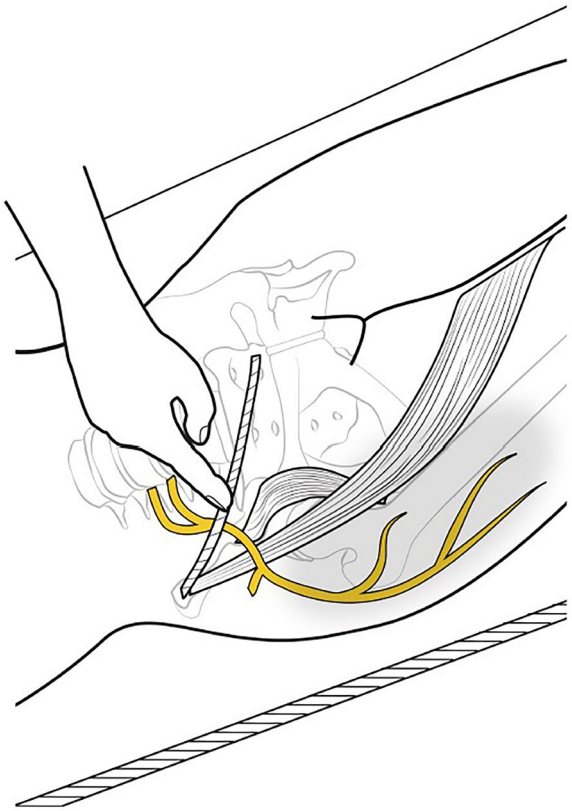

Fig. 4 Tinel test

logical nerves. Suh et al. reported a median CSA of 11 mm^2 (range 5–28 mm^2) in pathological LFCNs and a median CSA of 3 mm^2 (range 2–6 mm^2) in healthy LFCNs, thus suggesting a significant difference in CSA between pathological and non-pathological LFCN's ($p < 0.001$). Powell et al. reported a mean CSA of 9 mm^2 (range 3–25 mm^2) in pathological LFCNs and a mean CSA of 3 mm^2 (range 1–9 mm^2) in healthy LFCNs, thus also suggesting a significant difference between pathological and healthy LFCN's ($p < 0.01$). Both papers suggested a cut-off value of CSA > 5 mm^2 being diagnostic for MP, with Powell et al. reporting a 87% sensitivity and 90% specificity and Suh et al. reporting 95.7% sensitivity and 95.5% specificity at this cut-off.

Aravidakannan and Wilder-Smith looked at CSA but also looked at the nerve diameter using an 8- to 13-MHZ linear-array transducer. They reported a mean CSA of 4 mm^2 (range 2–5 mm^2) in known MP nerves and a mean CSA of 2 mm^2 (range 1–3 mm^2) in healthy nerves, thus reporting a significant difference in CSA's between healthy and pathological nerves

($p < 0.05$). When looking at mean nerve diameter in healthy and MP confirmed nerves, they reported a mean diameter of 0.40 cm (range 0.37–0.42 cm) in pathological nerves and a mean diameter of 0.21 cm (0.16–0.30 cm) in healthy LFCNs. Again, there was a significant difference between healthy and pathological nerves ($p < 0.05$).

Two studies [10, 16] looked at the effectiveness of US imaging in identifying the LFCN as well as pathology in the LFCN. Lee et al. [16] used high-resolution (15–18 MHz) linear US transducers in 136 patients known to have pathology and reported that, in 131 patients, the LFCN was able to be visualised, a 97% success rate. However, of the 136 known pathological nerves, only 83 were identifiable through US, a 49% success rate. Identifiable pathology included perineural scarring, impingement, neuroma and nerve thickening. Powell et al. [10] imaged the LFCN in 50 patients using a 5- to 12-MHz linear transducer. Of the 50 patients with suspected MP, the LFCN was visible in 45 patients, a 90% success rate. Of the 50 known nerves with MP, US found abnormalities suggestive of MP in 35 cases, a 70% success rate.

Magnetic Resonance Imaging (MRI) MRI imaging was assessed in three papers (Lee et al. [16], Powell et al. [10] and Chhabra et al. [15]). Lee et al. [16] performed MRI in 51 patients and reported a 60% accuracy in identifying the LFCN. Of the 51 known pathological nerves, pathology was identifiable in 15 nerves, a 29% accuracy. Identified pathologies included inflammation, compression and neuromas. Powell et al. [10] performed MRI in 16 patients with suspected MP and identified positive indicators of MP pathology in 4 nerves, a 25% accuracy.

Chhabra et al. [15] assessed MRI in 11 patients and reported a 100% accuracy in identifying the LFCN and a 90% accuracy in identifying pathological LFCNs. They further go on to suggest that MRI has a 71% sensitivity and 94% specificity in identifying LFCN pathology indicative of MP. It should be noted that the paper by Chhabra et al. uses a 3 Tesla MRI, while the other two papers do not report metrics on strength of the MRI machine (Table 1).

Electrophysiology

Both somatosensory evoked potentials (SSEP) and sensory conduction studies (SCS) have been researched for their usefulness in diagnosing MP. SSEP are recorded through surface electrodes placed at the scalp after a continuous electrical stimulation is applied at a peripheral nerve. Among others, they measure the time of conduction from peripheral to central nervous system. During SCS, the sensory nerve action potential (SNAP) is recorded from surface electrodes at the area of innervation when an electrical stimulus is applied at a nerve. Based on the distance between stimulation and recording one can calculate the nerve conduction velocity (NCV).

SCS Spevak and Prevec [19] used SCS to assess MP in 13 patients (total of 14 nerves as 1 was bilateral). They assessed the use of NCV and SNAP amplitude and reported on the scope of using side to side ratio (ssRATIO/ L–R difference) on NCV as a more accurate metric for diagnosing MP, instead of slowed NCV alone. They note that SNAP measurements were possible in 9/14 nerves (8/13 patients). They reported that a normal NCV of 62.3 ± 5.5 m/s versus a pathological NCV of 51.3 m/s. When looking at ssRATIO difference in NCV, they noted 7/8 patients having a significant difference between healthy and MP nerves, giving an 87.5% accuracy. It should be noted that, while Spevak and Prevec suggested an ssRATIO difference in NCV to be a useful tool for diagnosing MP with SCS, the paper does not specify an exact diagnostic cut-off. Overall, they concluded that absolute slowing of the NCV as well as L–R differences in NCV are better diagnostic tools for MP compared to SNAP amplitude.

The work by Spevak and Prevec was built on by Seror in 1999 [8]. Seror examined 30 patients and looked at an ssRATIO amplitude differences instead of NCV difference as well as NCV and SNAP amplitude. Seror was only able to record SNAP in 17/30 patients. He reported that the ssRATIO for amplitude was abnormal in 100% of patients with suspected MP, and that this metric had a 98.8% sensitivity. SNAP amplitudes between patients with MP and healthy

Table 1 Characteristics of studies using imaging techniques (ultrasound or MRI) to diagnose meralgia paresthetica

Reference	Imaging modality	Population size	Outcome measured	Sensitivity and specificity
Lee et al. (2024)	Ultrasound	136 pathological nerves	Percentage accuracy in identifying the LFCN and pathological LFCNs	N/A
Powell et al. (2020)	Ultrasound	50 pathological nerves 20 controls	Percentage accuracy in identifying the LFCN and pathological LFCNs	90% sensitivity, 70% specificity
Powell et al. (2020)	Ultrasound	50 pathological nerves 20 control	Use of cross-sectional area as diagnostic criteria	87% sensitivity, 90% specificity
Aravidakannan and Wilder-Smith (2012)	Ultrasound	6 pathological nerves	Use of cross-sectional area and nerve diameter as diagnostic criteria	N/A
Suh et al. (2013)	Ultrasound	23 pathological nerves 12 controls	Use of cross-sectional area as diagnostic criteria	95.7% sensitivity, 95.5% specificity
Lee et al. (2024)	MRI	51 pathological nerves	Percentage accuracy in identifying the LFCN and pathological LFCNs	N/A
Powell et al. (2020)	MRI	16 pathological nerves	Percentage accuracy in identifying the LFCN and pathological LFCNs	25% accuracy at identifying pathological LFCNs
Chhabra et al. (2013)	MRI	11 pathological nerves 28 controls	Percentage accuracy in identifying the LFCN and pathological LFCNs	71% sensitivity, 94% specificity

LFCN lateral femoral cutaneous nerve, *MRI* magnetic resonance imaging

were significantly different, with mean pathological nerve SNAP amplitude of 1.5 ± 2.1 µV and mean healthy nerve SNAP amplitudes of 16 ± 7 µV ($p < 0.05$). Seror also reported no significant difference in NCV between healthy and MP suspected nerves, with mean healthy NCV of 60 ± 5.3 m/s and mean pathological NCV of 57 ± 4.4 m/s ($p > 0.05$). Unlike Spevak, Seror did describe a diagnostic value for both SNAP amplitude and ssRATIO, with a SNAP amplitude < 3 µV and a ssRATIO > 2.3 being diagnostic.

Seror and Seror in 2006 then explored the use of SCS in diagnosing MP, with a particular focus on assessing the SNAP amplitude. They assessed 120 patients (131 nerves, 11 bilateral patients) with clinically probable MP. Similarly to Seror's work in 1999, they found no significant difference in the NCV between pathological and healthy nerves, with the MP nerve groups having a mean NCV of 55.6 ± 6 m/s and the control group having mean NCV of 60 ± 5.3 m/s ($p > 0.05$). They did report a significant difference

between the SNAP amplitudes between MP and healthy nerves, with MP nerves having a mean SNAP amplitude of 2.0 ± 2.5 µV and healthy nerves having a mean SNAP amplitude of 16.1 ± 7.2 µV ($p < 0.0001$). They determined that the two cut-off values that were diagnostic for MP were the SNAP amplitude < 3 µV and the ssRATIO > 2.3, and that they had a 73.3% and a 98.3% specificity, respectively.

Tataroglu et al. examined 34 patients (38 nerves, 4 bilateral patients) looking at differences in NCV and SNAP amplitudes in both proximal and distal segments of the nerve. They reported that NCV was significantly different at the proximal segment ($p = 0.0001$), but not significantly different at the distal segment ($p = 0.18$). They also noted that SNAP amplitude was significantly lower in both the proximal segment ($p = 0.002$) and the distal segment ($p = 0.003$). An important consideration in the work by Tataroglu et al. was the appreciation that SNAP could only be recorded in 68.4% of nerves (26/38). The authors noted that this inability to accurately record SNAP limited its diagnostic potential.

SSEP SSEPs for the diagnosis of MP have been used in comparison to SCS and the reports on which test (SSEP, SCS) is superior are somewhat contradictory. Seror evaluated the effectiveness of SCS versus SSEP in diagnosing MP in 1999 and 2003 [8, 20]. In 1999, Seror concluded that, when using SCS SNAPs to diagnose MP, there is a 90% accuracy, while, when using SSEP, there was only a 13% accuracy with a reported SSEP latency of 29.6 ± 1.6 m/s in asymptomatic limbs and 30.9 ± 1.9 m/s in symptomatic limbs ($p > 0.05$). He noted that SSEP were recordable in 90% of nerves (26/30) while SNAP was recordable in 56.7% of nerves (17/30). In 2003, Seror looked at using SSEP in 21 patients, using two methods of stimulation, thigh and anterior superior iliac spine (ASIS). He reported that SSEP with ASIS stimulation showed no significant difference in latency of amplitude ($p > 0.05$) and overall SSEP with ASIS stimulation had a sensitivity of 5% and a specificity of 95%. SSEP with thigh stimulation showed no significant difference in latency but was significantly different in amplitude ($p < 0.05$), while SSEP with thigh stimulation had a 52% sensitivity and 76% specificity. He noted that SSEP with ASIS stimulation was recordable in 95.2% (20/21) of patients and that SSEP with thigh stimulation was recordable in 52.3% (11/21) patients, overall concluding that SSEP had no diagnostic value for its time. Both Spevak and Prevec and Seror concluded that SCS was the superior electrophysiological study for diagnosing MP.

El-Tantawi [21] studied SNAP and SSEP in 32 patients with known MP. The results showed significant differences between the MP nerves and healthy nerves in all the same metrics as Seror: distal latency, conduction velocity and SNAP amplitude ($P < 0.001$ for all metrics). When looking at SSEP, El-Tantawi also noted significant differences in conduction and amplitude ($p < 0.001$ for both metrics), and noted that SNAP abnormality had a 62.3% sensitivity to MP while dermatomal SSEP had a 81.3% sensitivity. Thus, El-Tantawi suggested that, when readable, both SSEP and SCS were equally viable diagnostic tools. However, El-Tantawi also noted that SCS was only obtainable in 71.9% (23/32) of patients, while SSEP was recordable in all patients; this difference in respect to recordability was significant ($p < 0.001$). Thus, El-Tantawi lent towards SSEP as a preferable diagnostic tool for MP due to its recordability (Table 2).

Management

Of the 23 eligible management papers, 4 discussed injection therapy alone [12, 22, 23, 25], 10 discussed surgery [25, 27–35], 2 discussed radiofrequency ablation [38, 39], 3 discussed a combination of management options [11, 24, 36] and there was 1 paper for each of botox [39], acupuncture [40], kinesio taping [41] and muscle energy technique [42].

Injection Therapy

Four interventional studies were found that looked at steroid injection therapy alone as a

Table 2 Characteristics of studies using neurophysiology techniques (nerve conduction studies and SSEPs) to diagnose meralgia paresthetica

Reference	Electrophysiological study	Population	Metrics measured	Recordability	Remarks
Spevak and Prevec (1995)	SCS	58 controls 14 MP nerves	SCV SNAP amplitude ssRATIO	SCS recordable in 64.2% (9/14) of nerves	SCV significantly slower in MP nerves SNAP amplitude < 3 is diagnostic ssRATIO difference was 87.5% sensitive
Seror (1999)	SCS SSEP	30 controls 30 MP nerves	SCS SNAP amplitude SSEP latency	SCS recordable in 56.7% (17/30) of nerves SSEP recordable in 86.7 (26/30) of nerves	SNAP = 90% sensitivity, SSEP = 13% sensitivity
Seror (2003)	SSEP	21 controls 21 MP nerves	SSEP latency SSEP amplitude	SSEP with ASIS recordable in 95.2% (20/21) SSEP with thigh recordable in 52.4% (11/21)	SSEP with ASIS stimulation = 5% sensitivity, 95% specificity SSEP with thigh stimulation = 52% sensitivity and 76% specificity
Seror and Seror (2006)	SCS	51 controls 131 MP nerves	SCV SNAP amplitude	Not mentioned	ssRATIO > 2.3 is 98.3% specific SNAP amplitude > 3 was 73.3% specific
El-Tantawi (2009)	SCS SSEP	30 controls 32 MP nerves	SCV SNAP amplitude SSEP latency SSEP amplitude	SCS recordable in 71.9% (23/32) SSEP recordable in 100% (32/32)	SNAP amplitude = 62.3% sensitivity Dermatomal SSEP = 81.3% sensitivity Segmental SSEP = 53.1% sensitivity
Tataroglu et al. (2019)	SCS	38 controls 38 MP nerves	SCV SNAP amplitude	SCS recordable in 68.4 (26/38)	SCV significantly slowed in only 26.3%

ASIS anterior superior iliac spine, *MP* meralgia paresthetica, *SCV* sensory conduction velocity, *SCS* sensory conduction studies, *SNAP* sensory nerve action potential, *SSEP* somatosensory evoked potentials, *ssRATIO* side to side ratio

management strategy for MP: Tagliafico et al. [12], Klauser et al. [22], Kloosterziel et al. [23] and Kilic et al. [25].

Tagliafico et al. [12] treated 20 patients (7 male, 13 female) with perineural injections of 1 mL of methylprednisolone acetate (40 mg/mL) and 8 mL of mepivacaine, 2%, under direct ultrasound guidance. They found that 16/20 patients reported symptom improvement after one injection and 1 week. The remaining 4 patients had a further injection and all 20 patients reported complete resolution of symptoms at 2 months. Mean visual analogue scale (VAS) score symptom reduction was 8.1 ± 2.1 to 2.1 ± 0.5 ($p < 0.001$) and VAS quality of life reduction was 6.9 ± 3.2 to 2.3 ± 2.5 ($p < 0.002$). 5 patients reported sharp thigh pain on needle insertion, all of which were resolved by needle repositioning. No patients reported post-injection side effects.

Klauser et al. [22] performed injections in 20 patients (9 male, 11 female) using a 27G needle with a mixture of 1 ml triamcinolone acetonide (10 mg/ml), and 5 ml of 0.5% bupivacaine. They found that 15/20 reported complete symptom relief and the remaining 5 reported partial symptom relief. Mean VAS score, out of 100, reduced from 82 to 0 in the complete relief group ($p < 0.0001$) and from 92 to 42 in the partial relief group ($p < 0.001$). No pain or side effects were reported during injection or post-injection either immediately or at 12-month follow-up. Two patients were noted that required a second session of injections.

Both papers noted the potential necessity of multiple injections to achieve symptom control.

Two RCTs were found, Kloosterziel et al. [23] and Kilic et al. [25]. The JADAD score for Kilic et al. was 2 and for Kloosterziel et al. was 4.

Kilic et al. designed a 3-arm, single blind RCT in which 54 patients were randomly assigned to 3 groups: US-guided injection group, transcutaneous electrical nerve stimulation (TENS) group, and sham TENS group. The injection regime was 1 ml of betamethasone disodium phosphate (5 mg/mL) and 2 mL of prilocaine (2%) using a 22G needle. The results showed a significant decrease in VAS, painDETECT and Semmes–Weinstein monofilament test (SMWt) scoring in the injection arm ($n = 17$) with a mean VAS decrease of 1.88 ± 3.06 to 0.18 ± 0.53 ($p = 0.016$), mean painDETECT decrease from 11.65 ± 7.98 to 4.35 ± 5.56 ($p = 0.001$) and mean SMWt decrease from 1.59 ± 1.12 to 0.82 ± 1.24 ($p = 0.002$).

Kloosterziel et al. designed a 20-patient double-blind randomised, placebo-controlled trial which compared the injection of 2 mL methylprednisolone/lidocaine (80 mg methylprednisolone, 20 mg lidocaine) with 2 mL saline 0.9%. The results showed that the reduction of VAS score within the methylprednisolone group was not significant (VAS at baseline = 7.4; VAS at week 12 = 4.8; test $p = 0.053$). Furthermore, there was no significant difference in the decrease in the mean VAS score between the intervention and control arms.

Surgical Treatments

It should be noted that surgical strategies for MP can be categorised into two broad categories, neurolysis and neurectomy. The term neurolysis has become blurred in modern literature, as historically neurolysis had referred to partial resection of the nerve or partial fibre removal of the nerve. However, modern literature has used the term to refer to any surgical strategy that is not complete resection of the nerve, i.e. not neurectomy. This paper separates neurolysis into its three separate branches, surgical decompression, radiofrequency ablation and partial resection of nerve fibres.

Surgical Decompression Four papers were identified that discussed surgical decompression alone: Morimoto et al. [26], Schwaiger et al. [27], Ataizi et al. [28] and Alberti et al. [29]. In these papers, there are two described models of decompression. In the first type, an incision for the infra-inguinal approach was made 3 cm below and parallel to the inguinal ligament down to the fascia lata. The LFCN was exposed medially to the sartorius muscle and then followed proximally toward the inguinal ligament. In the second type, an incision for the supra-inguinal exposure was made which ran 1 cm above and parallel to the inguinal ligament. The fascia was incised and, subsequently, the peritoneum was encountered by a muscle-splitting

incision and the nerve followed distally to the inguinal ligament.

Morimoto et al. [26] assessed pain relief and mean VAS pain scores in 12 patients undergoing decompression surgery, of whom 9 reported complete relief and 3 reported partial relief at final follow-up. Mean VAS scores significantly decreased from 7.9 ± 1.8 to 1.5 ± 1.3 ($p < 0.05$).

Schwaiger et al. [27] assessed numbness relief, satisfaction post-surgery and NRS pain scores in 13 patients receiving a total of 16 decompression surgeries. A significant mean decrease of 6.6 points on a NRS pain scale was reported ($p < 0.0001$). Four patients reported complete relief in numbness and eight reported partial relief in numbness; however one patient reported new post-surgical numbness. Patients' subjective feelings towards pain were qualitatively measured and 9 of 14 (64%) patients reported a complete resolution of pain, and 5 of 14 (36%) reported a partial resolution of pain. Satisfaction with surgery was also measured, and 12/14 participants reported complete satisfaction with surgery and 2/14 reported partial satisfaction with surgery.

Ataizi et al. [28] assessed pain relief and mean VAS pain scores in 13 patients of whom 8 patients reported complete recovery and 5 reported partial recovery at 3 months, all 13 patients reporting complete recovery at final follow-up. A significant mean VAS score decrease was noted: 8.80 ± 0.93 to 3.30 ± 1.25 ($p = 0.001$).

Alberti et al. [29] assessed improvement in pain and numbness post-surgery as well as satisfaction with surgery in 55 patients, and 87% of patients reported improvement in pain (27 reported complete relief and 21 reported partial relief), 82% of patients reported improvement in numbness (14 reported complete relief, 31 reported partial relief), and 66% of patients were completely satisfied with surgical outcomes at final follow-up while 23% of patients were partially satisfied.

Use of Radiofrequencies Elsayed et al. [37] looked at radiofrequency ablation (RFA) in 6 patients with MP. The method utilised the insertion of 100-mm/18-g/10-mm active-tip RFA needles towards the LFCN under US guidance. An initial 2% lidocaine injection was delivered followed by radiofrequency ablation at 80º for 180 s in lesion mode. An 11-point pain scale was used which recorded mean pain scores at baseline, 1-, 2-, 3-, 6- and 12-months post-procedure. Pain scores were 6.29 ± 2.14 at baseline, 1.86 ± 1.46 at 1 month, 2.83 ± 2.99 at 2 months, 3.17 ± 2.86 at 3 months and 3.80 ± 2.95 at 6 months. There was a 75.5% reduction in pain scores immediately post-procedure and a 37.5% pain reduction at 12 months, both being statistically significant ($p < 0.05$).

Lee et al. [38] looked at neuromodulation in 11 patients with MP. The method involved the use of a NeuroTherm radiofrequency generator delivered under fluoroscopy. The nerve was initially stimulated for identification and, upon successful identification, pulsed radiofrequency neuromodulation was performed for 2 min (45 V, 240 pulses and pre-set maximum temperature of 42°C). A 10-point VAS pain score was measured at baseline, 1-, 3-, 6- and 12-months post-procedure. Mean VAS scores were 6.40 ± 0.97 at baseline, 0.91 ± 0.70 at 1 month, 0.82 ± 0.75 at 3 months, 0.63 ± 0.90 at 6 months and 1.00 ± 1.41 at 12 months. All mean VAS pain score decreases were significant: $p < 0.001$ at all stages. Seven patients reported complete symptom relief at the end of follow-up and three reported partial symptom relief (> 50% reduction in pain) at final follow-up.

Nerve Resection Six papers were identified that discussed nerve resection, either partial or complete: Berini et al. [30], van Eerten et al. [31], de Ruiter and Kloet [32], de Ruiter et al. [33], Emamhadi [35] and Benezis et al. [35].

Berini et al. [30] recruited 7 patients who underwent complete resection surgery after all patients had failed adequate pain relief following steroid injection, and 6/7 patients reported complete relief of symptoms following surgery at the end of follow-up and 1 reported partial relief.

van Eerten et al. [31] recruited 21 patients, 10 of whom underwent surgical decompression and 11 who underwent complete nerve transection. Relief was reported in 6/10 patients (3 complete, 3 partial) in the decompression group and all patients (9 complete, 2 partial) in the neurectomy group ($p = 0.002$).

de Ruiter et al. compared surgical decompression versus neurectomy twice [32, 33]. In 2013 [33], a total of 18 patients were identified, 10 of whom underwent surgical decompression and 8 underwent resection, with 60% of patients reporting positive outcomes with decompression while 87.5% reported positive outcomes with neurectomy. The 4 patients who failed decompression underwent resection of the LFCN, with 3/4 achieving positive outcomes post-secondary surgery. In 2015 [32], a total of 22 patients were recruited, 8 of whom had decompression and 14 of whom had neurectomy. Only 37.5% patients reported positive outcomes with decompression while neurectomy had a 93.3% positive outcome rate.

Emamhadi [34] recruited 14 patients, 5 of whom had decompression (transposition of the LFCN by incision of the inguinal ligament) and 9 of whom had neurectomy (either complete or partial resection). All 5 patients with neurolysis reported recurrence of symptoms at the end of follow-up and all 9 patients who underwent complete resection reported complete symptom resolution at the end of follow-up.

Benzis et al. [35] recruited 160 patients undergoing a total of 167 procedures (7 underwent bilateral surgeries), and 153 decompression operations were carried out, with 97 patients reporting complete symptom resolution and 24 reporting partial symptom resolution. Eleven patients underwent primary neurectomy and three additional patients underwent neurectomy following on from unsuccessful decompression. Of these, five patients reported complete symptom resolution and four reported partial symptom resolution.

Which Intervention is Superior One paper, Nouraei et al. [36], was found that discussed conservative versus surgery, one that compared injection versus surgery, Tagliafico et al. [24], and one paper, Williams and Trzil [11], that compared conservative versus injection versus surgery.

Nouraei et al. recruited 45 patients, in which conservative measures (avoidance of tightly fitting garments, analgesia, and physical therapy) produced positive outcomes in 25 patients. The remaining 20 patients underwent decompressive surgery, producing positive outcomes in 17 of them. The remaining 3 underwent complete resection, yielding 100% complete symptom resolution.

Williams and Trzil [11] recruited 277 patients, of whom all underwent conservative therapy (removal of restricting clothing, applying ice to area of constriction for 30 min 3 times a day, NSAIDs for 7–10 days and avoidance of exacerbating physical activities). Of these, 137 patients reported resolution of symptoms using conservative measures alone, while the remaining 140 patients were injected with 5–10 ml of local anaesthetic and corticosteroid (not named) and the reported symptom resolution was 83%. They reported that 50% (70) of patients required a further injection, with an unspecified number requiring up to four sessions. The 24 non-responders underwent complete nerve resection in which complete relief was reported in 23/24 cases while the remaining patient reported partial relief.

Tagliafico et al. [24] conducted a meta-analysis of 7 papers. In total, 59 patients underwent steroid therapy and 92 patients underwent surgery. This meta-analysis reports three regimes of anaesthetic + corticosteroid injection: betamethasone 5 mg/mL + pilocarpine 2% [25], triamcinolone acetonide 10 mL/mg + 5 mg bupivacaine 0,5% [22] and 1 mL methylprednisolone acetate (40 mg/mL) + mepivacaine 2% [12]). After US-guided steroid injections, 89% [95% confidence interval (CI): 66–100%] of patients were treated successfully, whereas 83% (95% CI: 70–93%) were treated successfully with surgery. The success rate was not significantly different between the two techniques ($p = 0.56$).

Other Treatment Options

Four papers were identified that discussed alternative management strategies for MP: botox [39], acupuncture [40], kinesio taping [41] and muscle energy technique [42].

Botox Dhull et al. [39] looked at the use of botox injections in 20 diabetic patients. The participants were injected with 50 units of botulinum toxin intradermally. The toxin injections were distributed using a 30G needle across the

anterolateral portion of the thigh. A 10-point VAS pain score was recorded at baseline, 2-, 6-, and 12 weeks post-botox regime. VAS at baseline was 7.5 ± 1.2, 1.8 ± 0.6 at 2 weeks, 1.3 ± 0.6 at 6 weeks and 2.7 ± 1.6 at 12 weeks. Mean VAS decrease was significant at all stages: $p < 0.0001$ at all stages.

Acupuncture Alexander [40] looked at the use of electroacupuncture in 10 patients, which involved the delivery of a pulsed current with a biphasic spike waveform and a dense-disperse programme of 20/100 Hz. Traditional Chinese acupuncture points were used. Daytime and night-time VAS scores were measured at baseline, 3 months and at periodic follow-ups. All patients had a > 50% reduction in VAS at 3 months and at the end of the follow-up period. Patients had a 92% reduction in VAS daytime scores and a 94% reduction in VAS night-time score.

Kinesio Taping Kalichman et al. [41] looked at the use of kinesio taping in 10 patients. The method used was in accordance with the kinesio taping manual [45]. Participants were asked to remove hair from the inguinal area and lateral side of the hip. Two strips of tape were applied: the first was a Y-shaped strip anchored approximately 2 cm above the lateral end of the inguinal ligament with two tails on two sides of the symptomatic area. Tape tension was controlled at 50–75% using mechanical correction. The second strip was I-shaped (approximately 10–12 cm length) running along the inguinal ligament with a tension-on-base technique of 15–25% in a space correction technique, anchored on the lateral side of the anterior superior iliac spine. A 100-point VAS score was used to measure the quality of life and the effect of MP symptoms on patients at baseline and after 4 weeks of rehabilitation. Mean VAS quality of life score decreased from 69.4 ± 23.4 to 35.3 ± 25.2 ($p = 0.002$) and mean VAS MP symptoms score decreased from 58.6 ± 17.6 to 32.0 ± 24.8 ($p = 0.0003$). Both reductions were significant at 4 weeks. Three patients reported a complete recovery of MP symptoms after treatment, four reported modest improvement in symptoms and none of the patients reported worsening of symptoms.

Muscle Energy Technique Mahmoud et al. [42] designed a RCT looking at the use of a muscle energy technique versus conventional exercises alone in 30 postpartum women with MP. The JADAD score for this RCT was 4. A total of 15 women were assigned to the muscle energy technique group and 15 were assigned to the control group. The muscle energy technique involved the delivery of post-isometric relaxation in two positions. In the first position, the patients lay on their back with the symptomatic limb slightly off the edge of the bed. At the same time, the therapist grasped the femur distally, just proximal to the knee of the symptomatic side. Then, the therapist passively extended the patient's hip until feeling the edge of the restrictive barrier (i.e. the point where the therapist felt the first resistance to the movement). In the second position, patients lay on their back with the symptomatic limb positioned at 75° of hip and knee flexion. With the proper positioning, the therapist adducted the patient's hip until the edge of the restrictive barrier. The control group involved education on physiotherapy techniques and the use of flexibility exercises for the hip flexors. Pain was measured using an 11-point scale and the range of motion was assessed using a prone knee bend measurement and a pelvic compression test for simulating pain. Mean pain scores decreased from 7.93 ± 1.3 to 2.4 ± 0.9 ($p = 0.001$), while the range of motion was improved in the patients, with a prone knee bend degree improvement of 80.86 ± 6.7 to 129.86 ± 6.3 ($p = 0.001$) and a pelvic compression test going from 15 positive painful stimuli to 12 negative stimuli ($p = 0.001$). Pain reduction and prone knee bend changes were significant between intervention and control groups, while the pelvic compression test results were not.

DISCUSSION

This review has sought to overview the current knowledge about diagnosis and management for MP. Seldom is it true in medicine that there is one diagnostic tool that is used alone when

making a diagnosis. Often a clinician utilises multiple aids and draws to a most likely diagnosis using their judgement. When considering the diagnostic pathway of MP, it is clear that clinical examination, imaging and electrophysiology are all valuable.

While three bedside tests have been described in the literature, the Tinel test, neurodynamic testing and the pelvic compression test, no research was found that attempted to compare these tests and identify if one was superior. Often these would be supplemented into papers without considering the overall accuracy of such tests. While all three tests have in some capacity shown that they are useful, this gap in the literature is one that may be of value in the future. With growing pressures on healthcare systems to shorten waiting times or to produce time efficient appointments, identifying the single best bedside test may be invaluable in speeding up the diagnostic pathway of MP. An RCT of the three bedside tests is lacking in the literature.

Although there has been no direct comparison study between the two, US imaging is probably better than MRI in visualising the LFCN. However, it would be incorrect to suggest that either imaging modality is better than the other in identifying the pathology.

A similar line of thinking can be applied to electrophysiology studies. The SNAP amplitude seems to be the best available electrophysiological parameter in the diagnosis of MP compared to the SNAP of the unaffected side. SSEPs can also be used but it would also be wrong to conclude that either SNAP or SSEP is superior to the other in identifying the pathology.

As with most management strategies in medicine, the goal of treatment is to produce the greatest outcomes with the least invasive treatment option. It is clear that conservative management and/or injection therapy will prove to be adequate management for the majority of patients with MP. If unsuccessful, an interventional technique might be offered. In surgical management strategies, there exists a hierarchy in which neurolysis strategies remain considered less invasive than neurectomy.

There is a growing scope of literature looking at alternative management strategies to MP. Methods such as acupuncture, botox and kinesio taping have all been discussed, though admittedly in a modest capacity. The potential role for these management strategies remains untested, though preliminary results appear positive, and these strategies may further be used to bridge the gap between minimally invasive management strategies and surgical options. Ultimately, further research in larger cohorts is required for all these proposed strategies, and RCTs are the next logical progression to adoption.

A potential limitation of this review, which should be considered when interpreting our results, is that we relied on a single database—albeit the largest in the medical literature—to identify relevant studies. While this approach offers comprehensive coverage, it may still exclude valuable insights from other databases or sources that could provide additional perspectives or context to our findings.

CONCLUSION

Despite the longstanding history of MP, there remains limited comprehensive research discussing the diagnosis and management. It is clear that no one diagnostic tool is valuable independently. While the research shows that US and SNAP are superior modalities to their counterparts, it remains true that neither are perfect. As in most facets of medicine, it is the job of the clinician to use all available diagnostic aids to make the diagnosis. Once that diagnosis is made, the management strategy is typical of any condition, wherein a patient will move up the intervention ladder from the least invasive to the most invasive procedure.

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Declarations

Conflict of Interest. Giustino Varrassi is an Editor-in-Chief and Panagiotis Zis is an Editorial Board member of *Pain and Therapy*. Neither were involved in the selection of peer reviewers for the manuscript nor any of the subsequent editorial decisions. Mohammed S Ahmed and Despina Hadjiconstanti declare no conflicts of interest.

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