ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

A Radiofrequency Treatment Pathway for Cluneal Nerve Disorders

Martin Knight[1]*, Indu Karangoda[2], Rahim Nadeem Ahmed[3], Thomas D'Angelo[4], James Inklebarger[5], Babar Abbas[6] and Jamshid Dehmeshki[7]

[1]Consultant Endoscopic Spine Surgeon, Senior Lecturer Manchester University, The Medical Director, The Spinal Foundation, The Weymouth Hospital, London, UK

[2]Consultant in Anaesthesia and Intensive Care Medicine, Lewisham and Greenwich NHS Trust, University Hospital Lewisham, London, UK

[3]College Tutor (RCoA UK), Consultant Anaesthesia and Intensive Care Medicine, Croydon University Hospital, London, UK

[4]Radiology Department, Fawkham Manor Hospital, UK

[5]Faculty of the London College of Osteopathic Medicine, London, UK

[6]Senior Lecturer, Faculty of Science, School of Life Sciences, Kingston University, UK

[7]Professor of Medical Image Computing and Image Analysis, Faculty of Science, Engineering and Computing, School of Computer Science and Mathematics, Department of Computer Science, Kingston University, UK

***Corresponding Author**: Martin Knight, Consultant Endoscopic Spine Surgeon, Senior Lecturer Manchester University, The Medical Director, The Spinal Foundation, The Weymouth Hospital, London, UK.

Received: January 22, 2020; **Published:** February 17, 2020

Abstract

The Cluneal cutaneous nerves suffer an entrapment syndrome presenting as Trigger Points along the iliac crest. The clinical "tell-tale" is the replication of the predominant presenting symptoms by provocation of these Trigger Points where the Cluneal nerves cross the pelvic rim thus reproducing symptoms of low back pain radiating into the buttock, groin or thigh or as "sciatica".

Cluneal nerve irritation may arise from spinal malposture and malrotation of the of the pelvis and irritant angulation of the Cluneal nerves as they pass over the iliac crest or from the irritation of their nerve roots.

The diagnosis of the source can be refined by injecting provocative trigger points with local anaesthetic and steroids. Where the injection effectively reduces the predominant presenting symptom, then we recommend an immediate course of correction of spinal malposture, pelvic alignment and core muscle hardening with Muscle Balance Physiotherapy and Reformer Pilates.

Where the symptoms recur, long-term relief may accrue from radiofrequency ablation of the irritated Cluneal Nerves (CRFA) as they pass over the iliac crest. This study is the first provide a Radiofrequency based treatment protocol and technique to comprehensively treat the entrapment trigger points.

Failure to appreciate their role as a symptom generator may lead to inappropriate spinal surgery.

The treatment of the Cluneal Nerve trigger points and Muscle Balance Physiotherapy reversed the symptoms in 5/33 cases over a prolonged period. Where a marked but transient reduction in symptoms occurred, treatment with impedance guided aware state Cluneal Nerve Radiofrequency Ablation provided excellent or good results in 26/28 (93%) patients during their follow-up period of 12 - 42 months.

During the same period 8 patients presented with similar symptoms but failed to respond to Cluneal Nerve injection but did respond to CT Guided Nerve Root Blocks and successfully underwent Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty at pain provocative segments L3 - S1 with excellent or good outcomes.

A comprehensive treatment protocol has been derived for the holistic treatment of Cluneal nerve trigger points together with a clinically derived classification of the Cluneal nerve Trigger Points.

Keywords: *Cluneal Nerve Trigger Points; Low Back Pain; Sciatica; Failed Back Surgery; Radiofrequency Ablation*

Background

Anatomy

Maigne., *et al*. 1989 [1] described the presence of the lateral cutaneous branches of the dorsal rami of nerves at the thoraco-lumbar junction and Lu., *et al*. 1998 [2], described the anatomic relationship of the Cluneal nerves to the posterior iliac crest and the thoraco-lumbar fascia. They found that the superior Cluneal nerves are constrained within a tunnel consisting of the thoracolumbar fascia and the superior rim of the iliac crest as they pass over the iliac crest with the remainder piercing an orifice or fissure in the thoraco-lumbar fascia. Throughout, anatomical nomenclature has varied [3-9] with Superior Cluneal nerves loosely classified as originating from L1 - 3 [10,11] and the Medial Cluneal cutaneous nerves arising at L4 - S1 passing over the posterior pelvic rim or perforating the Sacro-tuberous and Long Posterior Sacroiliac Ligament [3,12].

On clinical grounds, the lead author classified Trigger Points related to the leashes of Cluneal Nerves into the three groups as shown in figure 1 This grouping excludes the inferior (infra-pelvic) Cluneal nerves. Some of the Superior Cluneal nerves pass over the iliac crest in two leashes around a landmark lipoma forming the Superior Cluneal Trigger Points. The more lateral elements of the Superior Cluneal nerves produce Lateral Cluneal Nerve Trigger Points located above, on or below the iliac crest, lateral to the iliac crest tubercle and are variable in position.

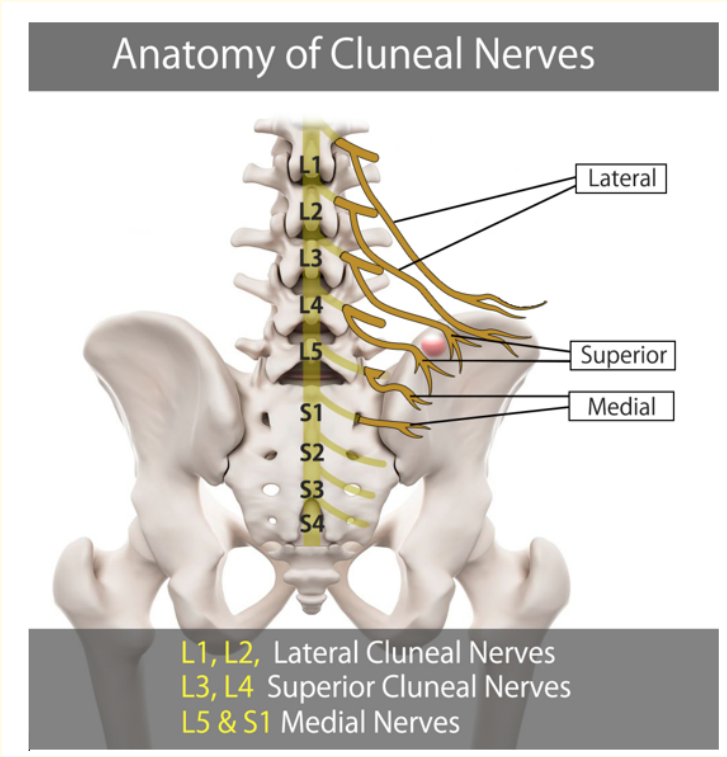

Figure 1: *Anatomy of Cluneal Nerves.*

The Medial Cluneal Nerves (MCN) cross the posterior iliac crest or perforate the Long Posterior Sacroiliac Ligament (LPSL) or Sacrotuberous ligament to form the Medial Cluneal Nerve Trigger Points closely approximating the sacro-iliac joint [3].

Pathogenesis

Cluneal nerve irritation may arise from focal entrapment about the iliac crest but may also be a manifestation of irritation of the nerve root in the epidural space or foramen.

In our clinical experience, Cluneal Nerve Trigger Point (TP) irritation commonly presents in patients with malrotation (nutation) of the pelvis.

The (LPSL) has close anatomical relationship with the erector spinae muscle, sacro-tuberous ligament and superficial layers of the thoracolumbar fascia. It is under tension during sacro-iliac joint (SIJ) counternutation (posterior rotation) and slack during nutation [12]. Counternutation may arise in flat back postures or scoliosis causing entrapment irritation of the Medial Cluneal TPs over the LPSL or posterior iliac crest [3].

Anterior nutation is frequently associated with obesity related protrusion of the abdominal wall and contents, inadequately rehabilitated abdominal wall surgery, spinal surgery with poor sagittal balance, iliac bone graft harvesting [4], and results in repetitive strain or trauma to the Thoracolumbar fascia and irritation of any or all the Cluneal TPs. Once the irritation has caused swelling of the nerve then it becomes a self-perpetuating entrapment syndrome with irritation in the osseo-fibrous sheath or soft tissues and persistent swelling of the nerves and encompassing tissues above or below the sheath. The irritation leads to pain arising from within the surface of the nerve and changes in axon plasma flow. Nerves are themselves innervated by Nervi Nervorum and impingement may reactively release both substance P and Calcitonin Gene-Related Peptide (CGRP), thereby amplifying C nerve fibre nociception [13,14].

Clinical presentation and treatments

Whilst patients may have pain on antero-posterior displacement of the midline or facet joint structures, the key feature is the focal tenderness over one or more of the Cluneal Nerve TPs, provocation of which in turn replicates some or all of the predominant presenting symptoms.

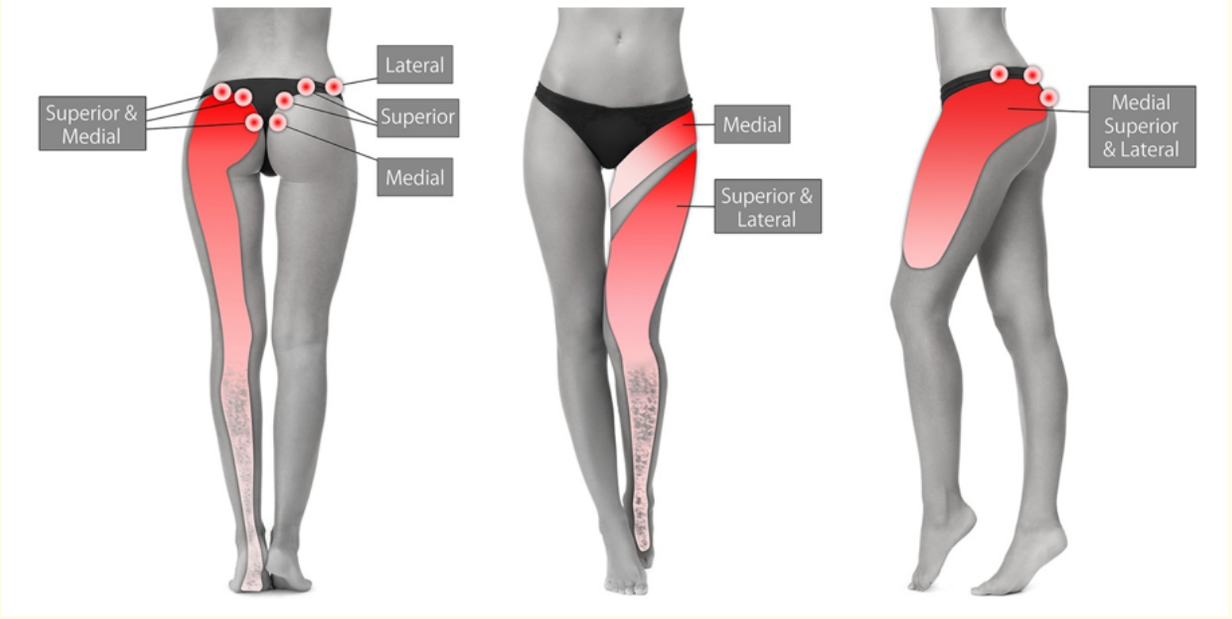

Figure 2: *Cluneal Nerve Trigger Point Symptom Distribution.*

Whilst pain was the predominant feature, paraesthesiae into the limb was a frequent symptom and even extended into the foot. On occasion the symptoms were so marked that there was local allodynia over the pelvic rim and buttock.

Patients with radicular sensory or motor deficit were excluded from this study although in wider practice the combination is found because Cluneal nerve irritation often exists in tandem with axial and foraminal spinal pathology.

The combination of Medial and Superior Cluneal Nerve trigger point irritation can symptoms radiating over the buttock, posterior thigh and occasionally through the calf to the sole of the foot mimicking sciatica.

The superior and lateral leashes of the Cluneal nerves can produce pain and paraesthesiae radiating along the anterolateral thigh and on rarer occasions the symptoms pass into the shin and foot. These again can mimic sciatica.

The Medial Cluneal nerves can produce deep medial groin pain. The Medial Cluneal Nerve trigger point pain is frequently mis-diagnosed as pain arising from the sacro-iliac joint.

Because Cluneal Nerve irritation is usually linked to pelvic malposture (anteversion or retroversion) the pain can increase when sitting, getting out of a chair (mimicking the "instability catch"), or be aggravated by walking or turning in bed and often causes difficulty in standing upright.

Diagnostic therapeutic pathway

To determine the relative contribution to the predominant presenting symptoms of low back pain and buttock pain from axial or Cluneal pain sources, the diagnostic therapeutic pathway shown in Figure 3 was adopted.

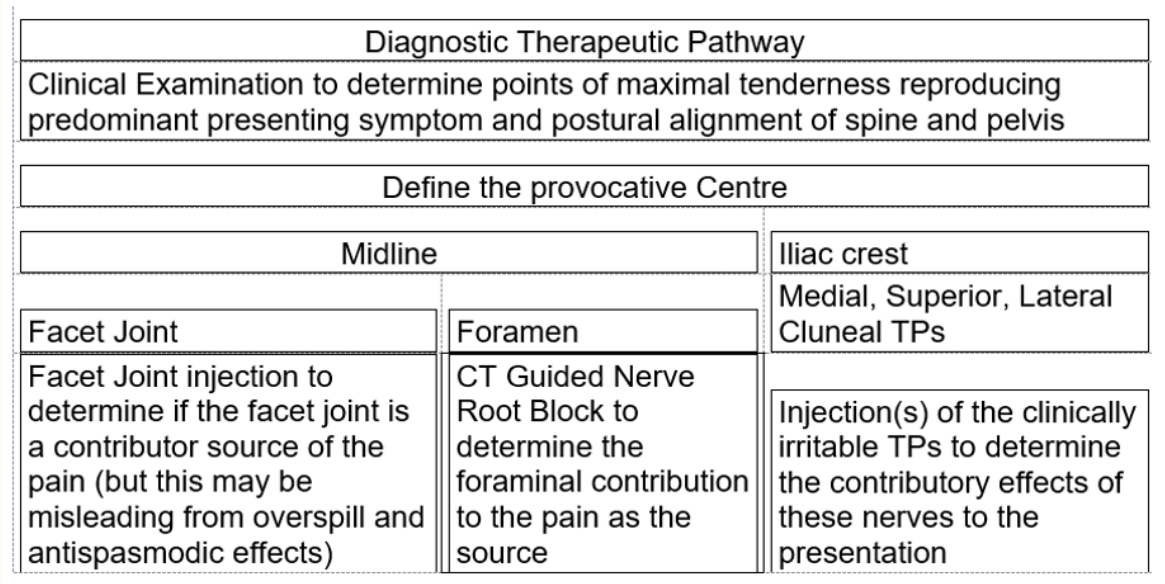

Figure 3: *Diagnostic Therapeutic Pathway.*

If displacement of the facet joint reproduced the predominant presenting symptoms, then it might be considered a progenitor of the pain. However, such displacement irritates the nerve in the foramen where the locus of the pain may really exist. However, many practitioners may choose to inject the facet joint with steroids. Interpretation of any resulting benefit must consider the possibility of overspill of steroids into the foramen either through the capsule or the external portal of the foramen or the effect of a reduction in local deep muscle spasm on the foraminal contents.

Depending upon the MRI scan findings of protrusion, extrusion, sequestration, foraminal/axial stenosis or degenerative/spondylolytic spondylolisthesis, the physician may prioritise the spinal pathology as the causal source of the predominant presenting symptoms and proceed to a CT Guided Nerve Root Block.

Where trigger point tenderness predominates, the surgeon may deem it appropriate to inject the Cluneal Nerves trigger points with steroids.

The benefit achieved determines the next steps in the treatment pathway.

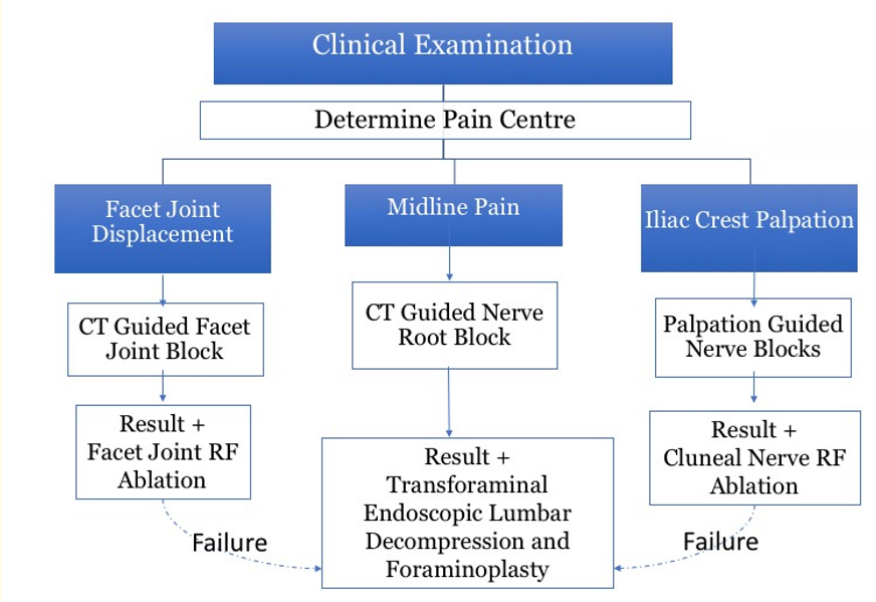

Figure 4: *The treatment Protocol.*

Following the chosen injection, Figure 4 demonstrates the subsequent therapeutic protocol. Should the facet joint injection reduce the presenting symptoms significantly then the subtending nerves to the joint may be ablated [15] or the joint be abraded by the "Denervex" procedure. But if this pathway fails then the patient becomes a candidate for Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty (TELDF) [16].

Similarly, if the midline pain responds to the CT Guided Nerve Root Block, then the patient is a candidate for a TELDF.

If the injection of the Cluneal Nerves trigger points significantly reduces the predominant presenting symptom for 7 - 10 days and the patient has complied with the Muscle Balance Physiotherapy and postural alignment correction, but the symptoms recur then the patient is a candidate for Cluneal Nerve Radiofrequency Ablation (CNRA).

Methodology

Study Construct

A prospective observational sequential cohort study.

Between June 2014 and December 2016 patients with clinical signs of Cluneal Nerve trigger point tenderness were prospectively treated using the step-wise protocol designed to determine whether the Cluneal Nerve trigger points were a relevant contributory factor causing the patient's presentation. The protocol is shown at Figures 3 and 4.

Patients were reviewed at 6 and 12 weeks following their initial Cluneal Nerve trigger point injection or CT Guided Nerve Root Block. During this period patients complied with a supervised course of Muscle Balance Physiotherapy with core stabilisation and postural spine and pelvis corrective re-alignment.

Patient's pain and functionality were assessed using the visual analogue pain score (VAPS), Oswestry Disability Index (ODI) and the Prolo Activity Score and daily pain diaries during the 6 - 12 weeks following each phase of treatment and at the index review in December 2017, 12 - 42 months following their last intervention. Final review was by questionnaire or where symptoms persisted, by phone or physical consultation.

The VAPS evaluation was based upon the pain diary consisting of 3 daily VAS records (recording maximum pain levels during the 72 hours prior to intervention or review) specified for midline low back pain (VAS-back), for pain radiating into the buttock and leg above knee (VAS-Buttock/Thigh) and for pain radiating into the lower leg (VAS- lower leg), the ODI and Prolo scores were assessed on the median for the week prior to intervention or review.

A "Good Clinical Impact" (GCI) was defined by the Spinal Foundation criteria as at least a 50% improvement in pain scores in ALL symptom clusters (back, buttock, groin, thigh and legs) plus at least a 50% improvement in ODI. Failure in any SINGLE cluster denoted failure overall. An "Excellent" result was defined as complete improvement in pain scores and restoration of functionality.

Patient selection

This study was designed to reflect common practice as much as possible in patients of 17 years of age or more, presenting with continuous back and buttock pain and elements of trochanteric, groin, thigh pain or "sciatica" with or without prior back surgery or chronic pain management.

The symptoms were present for 6 months or more prior to consultation despite 3 months of physiotherapy and pain medication.

Patients were evaluated by clinical history, clinical (physical) examination, visual assessment of posture and the effect of correcting the standing posture on the symptoms, weight bearing X-rays and 3T Lumbar MRI scans.

Whilst patient's might have had midline or facet joint displacement discomfort, the key feature was focal tenderness over one or more of the Cluneal Nerve trigger points where pressure replicated the predominant presenting symptoms.

Patients with objective radicular sensory or motor deficit were excluded from this study. (Although in wider practice the combination is found because Cluneal nerve irritation can exist in tandem with axial and foraminal pathology).

The treatment protocol was explained together with the clinical and scan findings and the patient chose their treatment pathway to determine whether primary treatment should focus on the Cluneal Nerve TP irritation or the axial or the foraminal pain generators which might be driving the antalgic compensatory (anteversion or retroversion) malposture.

Patients were also excluded if they were pregnant, evidenced facet joint cysts, severe bony axial or foraminal stenosis, cauda equina syndrome, systemic neuropathy or spinal tumours, blood dyscrasia, allergies, mental handicap or psychiatric condition precluding adequate communication or language problems.

Techniques

Outpatient cluneal nerve injections

The points of maximal tenderness reproducing the predominant presenting symptoms are marked on the skin coincident with the sites of the Lateral, Superior and Medial Cluneal Nerve TPs. The skin was sterilised, and each provocative site injected with subdermal lignocaine 1% both locally and horizontally in line with the nerve. A 22-gauge needle was then advanced to the evocative points and injected with 2 mls of Chirocaine 0.5% and 40mg of Depmedrone in 1 ml in divided doses around each leash and dry dressing(s) applied. Where trigger points were intensely tender then 40mg of Kenalog was added to the Depomedrone for more effective relief. The patient was mobilised and completed a pain diary three times a day until review at 6 weeks. During this period the patient participated in Muscle Balance Physiotherapy and postural alignment re-training. If sustained improvement was achieved, then a further course of Muscle Balance Physiotherapy was recommended to consolidate the benefit.

Cluneal nerve radiofrequency ablation

The points of maximal tenderness reproducing the predominant presenting symptoms were marked on the skin prior to the intervention with the patient standing in 20^0 of flexion.

The patient was placed prone on a Knight Sheffield radiolucent table (Royal Hallamshire Hospital Bioengineering Department, Sheffield, UK) which flexes the patient at the hips by 20^0 using the power drive and aligns the pelvis optimally to expose the Cluneal Nerves as they enter the buttocks.

The procedure is conducted under Total Intravenous Analgesia (TIVA) [17] with the patient in the aware state. The anaesthetist provides sedation with a continuous injection intravenous remifentanil analgesia and Propofol at sedation levels. The infusions are delivered by the target control Infusion (TCI) Minto model for Remifentanil and Marsh Model for Propofol. Nasal Oxygen is delivered 1-2 lit/min with continuous capnography monitoring and AAGBI monitoring.

The skin was sterilised with Betadine (or Hibitane), where the patient was allergic to iodine) and draped. Each marked provocative site was injected only subdermally, with lignocaine 1% both locally and horizontally along the line of the pelvic rim thus anaesthetising the probe entry point but avoiding anaesthetising the Cluneal Nerves. The line of anaesthesia is ideally placed above or medial to the iliac crest rim. An image intensifier (Ziehm Vision, 23cm Vision 4713 model) was used in the AP alignment (adjusted to compensate for residual pelvic nutation) to ensure an oblique entry trajectory to the points of maximal tenderness. This oblique line of entry allows the probe to trace along the line of the nerve offering ablation at several points of irritation (above/medial to the crest, over the crest and at the presumed point where the nerve was exiting the fascial tunnel or area of soft tissue tethering.

A 10cm 22-gauge Radiofrequency (RF) Cannula with a curved 10mm active tip and its RF electrode (Neurotherm™, Morgan automation LTD, Liss, UK, Medipoint™ GmbH, Hamburg, Germany) was advanced to bring the tip deep to the thoracolumbar fascia at the point where the expected leash of Cluneal Nerves enters their passage through the irritative fascial tunnel and at its point of exit. Ablation may

also be required where the nerves emerge under the gluteal fascia to achieve adequate control of the trigger point sensitivity. The efficacy of the ablation was monitored by applying pressure to the previously provocative zone after ablation had been effected and questioning whether pain still persisted. Ablation was deemed sufficient once the target trigger point was no longer painful.

The medial Superior Cluneal nerve leashes usually split to pass on either side of a palpable “tell-tale” lipoma. Feeling for this may assist guidance to these leashes and the Superior Cluneal TPs. It is necessary to be aware that this nerve splits into multiple groups on either side of the lipoma, if effective ablation is to be secured.

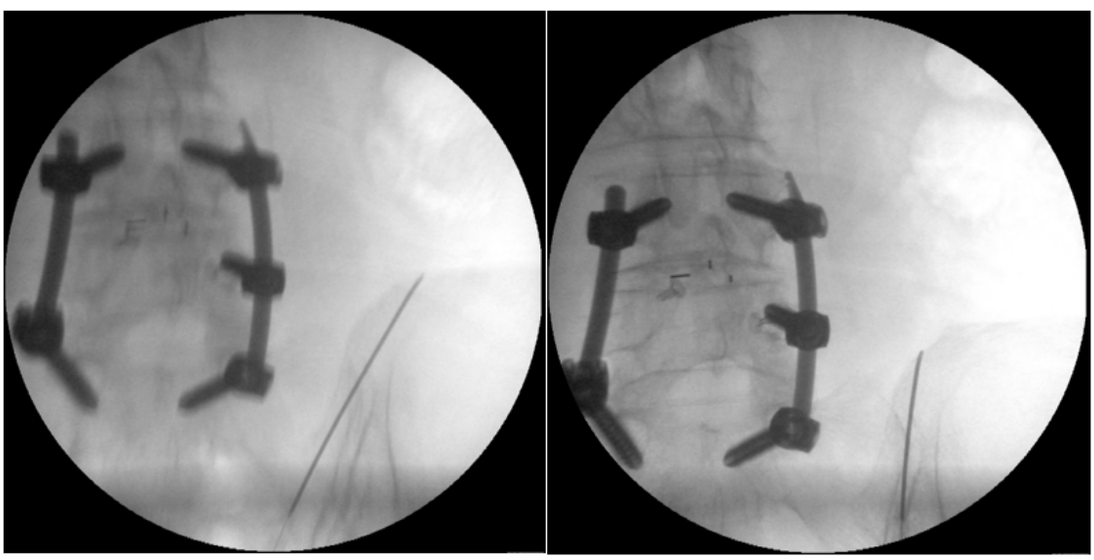

Figure 5: *Cluneal Nerve Ablation probe positioned at points on either side of the "Guideline" lipoma around which pass the superior Cluneal nerves.*

Many patients require bilateral treatment. It is time conserving to insert up to 4 probes thus allowing for synchronous ablation of all 4 sites at once.

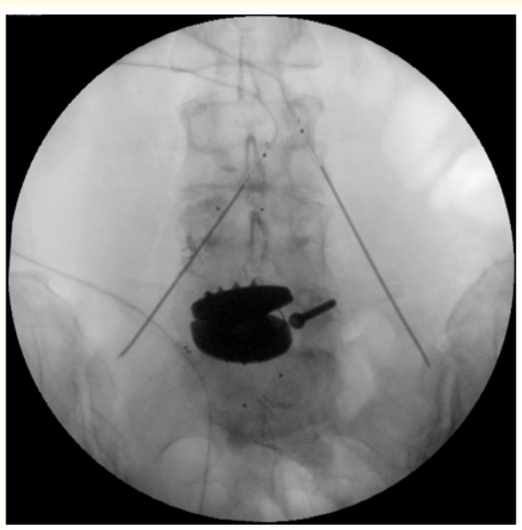

Figure 6: *Radio frequency ablation probes stimulating the medial Cluneal nerves bilaterally.*

The nerves subtending the Medial and Lateral TPs tend to be tethered in soft tissue scarring which can be palpated as resistance to manoeuvring the probe in the trigger point zone. Again, ablation needs to address the Cluneal nerves along their course through the provocative zone.

Positioning of the probe tip is optimised by detecting tissue impedance of 350 - 800 Ω which indicates that the probe is adjacent to the nerve.

Sensory stimulation at 50 Hz up to 1V can be used to further identify the nerve position but at this level paraesthesia may be difficult for the patient to detect under TIVA. Muscle fasciculation at these stimulation levels has not been encountered because of the remoteness to the motor nerves.

At the onset of ablation, the Anaesthetist increases the analgesia and sedation for each 60 second lesioning episode because this can produce an intense sense of burning. The sedation and analgesia are decreased immediately after the lesioning thus allowing the surgeon to re-interrogate the patient's pain sites.

During the ablation sequence the radiofrequency electrode tip temperature is raised to 80 °C for 60 seconds. The procedure is repeated along the line of the leashes until the required 2 - 3 lateral Cluneal TPs, 2 sets of superior Cluneal nerve TPs beside the guidance "tell-tale" lipoma and the 2 - 3 medial Cluneal nerve TPs have been addressed and palpation is no longer provocative.

Results

41 patients who met the inclusion criteria were sequentially included in the diagnostic pathway between June 2014 - December 2016. 8 did not respond to the Cluneal Nerve trigger point injections because their prime pain generators were located in the axial or foraminal spine. They were treated successfully by Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty. 33 patients continued with the Cluneal Nerve treatment protocol and are the subject of this prospective study.

Study Demographics		S. Dev
Patient	33	
Mean Age	56.6	16.1
Maximum	83	
Minimum	29	
Median	58	
Employable <65	21	
Retired >=65	12	
Males	16	
Symptom Duration (Months) Pre-consultation	58.2	37.1
Post Failed Back Surgery Interval (Months)	29.7	20.0

Table 1: *Group Demographics.*

			Symptom Duration (Months)			
Groups	Patients	Males	Months	S. Dev	Max	Min
Cluneal Injection Only	5	2	33.6	13.1	48.0	24.0
Diagnostic Transient Benefit	28					
No Prior back surgery and CRF	9	4	50.7	47.0	144	14.0
Failed back surgery and CRF	19	10	68.2	33.5	120	18

Table 2: *Duration of Symptoms.*

Failed Pain Management Interventions	
No Prior Injections	3
Failed Epidural(s)	14
Failed Transforaminal Root Block(s)/Rhizotomy	20
Failed Multi-level Facet Joint Ablation(s)	26
Failed Sacro-iliac joint Ablation(s)	18
	78

Table 3: *The number of prior Chronic Pain Management Interventions.*

Failed Back Surgery Interventions		Beneficial
Microdiscectomy	5	5
Instrumented Lumbar Fusion (ILF)	5	1
Microdiscectomy and ILF	7	2
Total Disc Replacement	3	0
Decompression Laminectomy/Spacer	5	1
Microdiscectomy, ILF, Sacro-iliac joint Fusion	2	0
Endoscopic Foraminoplasty	1	1
	28	10

Table 4: *The number of failed back surgical interventions amongst 19 patients.*

Predominant Presenting Symptoms	
Back Pain	23
Buttock Pain	25
Trochanteric Pain	11
Groin Pain	13
Anterior Thigh Pain	11
Posterior Thigh	6
Calf Pain	5

Table 5: *Clinical Presentation.*

The sciatic presentation extending below the knee ± the foot mimicked the L3 (1), L4 (1), L5 (2) and S1(2) nerve roots in this series.

Clinical Patterns	
Back Pain Only	5
Back and Buttock Pain	8
Back, Buttock and Trochanteric Pain	3
Buttock and Trochanteric Pain	5
Back, Buttock and Groin Pain	3
Back, Buttock and Thigh Pain	17
Sciatica	6

Table 6: *The clinical patterns were a combination of the symptoms as shown.*

The Cluneal nerves were locally tender as they cross the iliac crest as leashes of nerves and may be irritated as a single group or in combination as shown in Table 7.

Cluneal Nerve Sheath Involvement	
Combinations with Lateral Nerve Leash	3
Superior Cluneal Leash only	6
Superior and Medial Cluneal Leashes	14
Medial Cluneal Leash only	10

Table 7: *The Cluneal Nerve Leashes involved.*

Clinical Outcome - Duration of Treatment Effect					
Groups		**Months**	**S. Dev**	**Max**	**Min**
No prior back surgery treated by CRFA	9	14.9	3.0	20.0	12.0
Failed back surgery treated by CRFA	19	20.4	6.7	36.0	12.0
Cluneal Injection Only	5	23.6	11.0	42.0	14.0

Table 8: *Duration of Clinical Benefit amongst the 33 patients.*

Clinical Outcome - visual analogue pain score					
	Presentation	**F/U**	**Presentation**	**F/U**	**Group VAPS**
	VAPs	**VAPS**	**VAPs**	**VAPS**	**% Benefit**
	Retired		**Employable**		**33 Patients**
Mean Score	7.42	1.50	7.00	1.00	83
S.Dev	1.56	1.17	1.92	1.05	17
Max	10	3	10	3	100
Min	5	0	4	0	40

Table 9: *The Visual Analogue Pain Scores for the 33 patients.*

The Visual Analogue Pain Score analysis of the outcome in the retired and employable groups at 12 - 42 months following effective lasting injection or Cluneal Nerve Radiofrequency Ablation are shown in Table 9.

Clinical Outcome - Prolo Activity/Workability Score				
Age Group	**Retired**		**Employable**	
Pre and Post treatment	**Pre**	**Post**	**Pre**	**Post**
Able to work at previous occupation or full retirement activity with no restriction of any kind	0	8	0	14
Working at previous occupation or retirement activity on part-time or limited status	0	4	1	6
Able to work or pursue retirement activity but not at previous occupation or retirement activity levels	5	0	7	1
No gainful occupation or retirement activity (able to do housework or limited self-help activities)	5	0	10	0
Invalid (unable to cope with self-help activities without help)	2	0	3	0

Table 10: *Prolo score analysis of Clinical Outcome in the 33 patients.*

CRFA Outcomes and Further Treatment Requirements			
VAPS Improvement			Treatment Required
Excellent	80% Plus	20	Life-Style Self Help Muscle Balance Physiotherapy
Good	70 - 79 %	4	Extra Course of Muscle Balance Physiotherapy (MBP)
Good	50 - 69%	2	Additional Trigger Point Injection and MBP
Fair	40 - 50%	1	Required Cluneal Nerve Radiofrequency Ablation Revision
Poor	30 - 40%	1	Required Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty

Table 11: Analysis of Outcomes following CRFA.

MBP: Muscle Balance Physiotherapy and Reformer Pilates Rehabilitation.

There were no cases of infection, dysaesthesia, numbness or paralysis. 2 patients with marked bilateral symptoms affecting medial, superior and lateral Cluneal Nerves suffered a sustained recurrence of symptoms lasting 4 and 6 weeks respectively and required a steroid injection to temporarily ameliorate symptoms until rehabilitation was completed.

All patients underwent postoperative core stabilisation drills and they were encouraged to make these a constant life-style change.

Discussion

This study is the first report to provide a Radiofrequency based treatment protocol and technique to comprehensively treat Cluneal nerve trigger point pain.

Maigne and Doursounian (1997) [18] reported on open surgical decompression of the Cluneal nerves in nineteen patients suffering from unilateral low back pain projecting in the territory of the Medial Cluneal nerve TPs. With a two year or more follow-up, results were reported as excellent in 13 cases (7 of which had suffered from severe compression), and unsatisfactory in 6 cases (including 4 cases in whom no compression could be demonstrated wherein the diagnosis was probably incorrect).

Alternative treatments have included prolotherapy [19], CT guided [20] or ultrasound guided injections [21] (and for the inferior Cluneal nerve, endoscopic neurolysis [22]).

Clinical awareness

Cluneal nerve irritation is a recently appreciated concept [3-9,23-30] and still requires refinement and greater understanding. There are several authors, using different nomenclatures who report treatment of the superior and middle Cluneal groups [4,5,7,9,25,28-30] and who fail to focus on the relevance of the entrapment TPs as clinical targets.

It is important to appreciate that the Cluneal nerves cross the iliac crest or penetrate the Long Posterior Sacroiliac Ligament (LPSL) as leashes of nerves.

The authors clinical appreciation of the position of these nerves and their Trigger Points is shown in Figure 1. We consider that the nerve groups should be better described as Lateral, Superior, Medial and Inferior Cluneal TPs because of their anatomical location and clinical relevance.

We have not included the Inferior Cluneal Nerves in this study as they did not contribute to the predominant presenting symptoms of our patients.

Figure 1 shows that the superior group cross the crest as shown and usually divide around a small but palpable local lipoma. This proves to be a useful landmark when targeting treatment.

The lateral group may provide trigger points near the mid-point of the iliac crest and lateral to the tubercle. They are more variable in their transit line over the iliac crest, their point of irritation and are therefore more difficult to ablate.

The medial group consists of two to three sets of leashes and trigger points and are often mis-diagnosed as sacro-iliac joint pain.

In terms of awareness,19 patients in this study had undergone 28 spinal surgical interventions. In 10 cases, partial benefit was achieved from conventional surgery but concurrent Cluneal Nerve irritation required specific additional treatment of the TPs. In 9 cases, no benefit accrued from the conventional surgery until Cluneal Nerve Radiofrequency Ablation was performed. This raises the question whether the spinal surgery was appropriate or needed. Similarly, of all 33 patients, 30 had undergone 78 chronic pain management interventions (facet joint and sacro-iliac joint injections and ablations, root blocks and Dorsal Root Ganglion ablations and rhizolysis) without benefit. These findings are testimonial to the lack of awareness of Cluneal Nerve TP irritation at this time.

Clinical Presentation

The Cluneal Nerves can produce a range of symptoms from discrete low back pain to widespread symptoms. The most intense pain is usually located at the trigger points and diffusely radiates over the buttock. This is often accompanied by less intense aching felt in the anterior, lateral or posterior thigh or groin. More rarely, less intrusive paraesthesiae may be felt below the knee. These patterns are shown in Figure 2. In this study, the below knee symptoms were noted in six patients, being intermittently lancinating in two cases and mimicking Sciatica. Similar findings were reported by Konno., *et al.* (2017) [27].

Clinically the patient may complain that the pain increases when sitting, getting out of a chair (often interpreted as "spinal instability"), or aggravated by walking, turning in bed or arching or rotating the lumbar spine. Often the patient may stand with a hand on the iliac crest with the spine offset as shown in Figure 7 and have difficulty in standing upright. This posture is often considered to denote pain arising from a disc, facet joint or sacro-iliac joint rather than the presence of painful Cluneal nerves TPs.

Clinically the patient exhibits malposture with forward displacement of the weight bearing line and pelvic anteversion. Self-correction of the posture often achieves some momentary easement of the trigger point and buttock discomfort. Very occasionally patients with a "flat back" posture, (absent lordosis) and intervertebral retrolisthesis may present with Cluneal Nerve TP pain.

The pelvic anteversion may cause concomitant Trochanteric Bursa irritation and pain, sadly treated with steroid injections rather than correction of the malposture.

The medial Cluneal Nerve trigger points are located close the iliac crest or LPSL and may be misdiagnosed as sacro-iliac joint pain as they were in many patients in this study treated in chronic pain management programmes.

The patient often finds the buttock pain is diffuse and there is no piriformis muscle trigger point or spasm.

Figure 7: *Typical Posture and Hand Indicator of Cluneal Pain source.*

Causation

The symptoms of Cluneal nerve TP irritation appears to be linked to malposture arising from malrotation of the pelvis and loss of sagittal balance. Malposture causes the pathway of the Cluneal Nerves through the thoraco-lumbar fascial sheath or the LPSLinto the buttock to kink or become distorted. In turn this leads to irritation and swelling of the nerves, pain and paraesthesiae.

The pelvic anteversion/retroversion may arise as an antalgic stance following trauma, pregnancy or abdominal surgery where postural rehabilitation had not been implemented. More commonly it appears to be linked Degenerative Disc Disease, loss of core strength, concurrent obesity or from malposture following spinal surgery with incomplete correction of sagittal balance or distortion of the nerves around the harvest site [31]. The nutation or counter-nutation of the pelvis distorts the passage of the Cluneal nerves as they enter the buttock and cause the referred symptoms described.

The malrotation of the pelvis is often long established and is therefore difficult to reverse. Consequently, the patient may require months of supervised Muscle Balance Physiotherapy (Alexander Technique) [32-35] and Reformer Pilates [36-39] to restore improved posture on a consistent basis.

The irritation leads to pain arising from within the surface of the nerve and changes in axon plasma flow. Nerves are themselves innervated by Nervi Nervorum and impingement may reactively release both substance P and Calcitonin Gene-Related Peptide (CGRP), thereby amplifying C nerve fibre nociception [13,14].

Diagnostic pathway

The origin of the pain needs to be segregated from an origin in the disc or foramen, the facet joints and sacro-iliac joint and thos tot eh the Cluneal nerve TPs. The clinical pathway requires conventional appraisal of clinical history, weight bearing X-rays and MRI scans with attention to the patient's standing and sitting posture and physical examination.

As shown in Figure 3, where the clinician suspects the facet joints are the source of the pain then these are injected with anaesthetic or steroids and the outcome observed over a 6 week period and the patient inducted into a rehabilitation course of Muscle Balance Physiotherapy [32-35] and Reformer Pilates [36-39] and Denervex ablation, rhysolysis or fusion if the source appears to be confirmed.

Where midline pain or foraminal pain sources are considered to be the incubus of the pain, then a CT Guided Nerve Root Block is employed with the same observational and restorative programme and treated by Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty, conventional decompression or fusion[4]. When the Cluneal Nerve trigger point(s) are the prime source of tenderness then these are injected with steroids as described and the patient enrolled in the same core stabilisation and postural correction programme and in 5/33 patients simple reversed the symptoms. Where transient but significant amelioration of pain is achieved thereby then Cluneal Nerve Radiofrequency Ablation is indicated as shown at Figure 4.

Interpretation [40] of the facet joint injection outcomes are subject to the usual caveats that the benefit may have arisen from steroids that have entered the foramen through the anterior capsule or by lateral overspill and foraminal migration or the apparent benefit may have arisen as a result of diminution in spasm and impaction upon the exiting nerve in the foramen [41,42]. Should Facet Joint Radiofrequency Ablation or Denervex ablation fail then the pain source is likely to be intra-foraminal and the patient can be treated by Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty [16].

Where the clinician focussed upon spinal pathology (protrusion, extrusion, sequestration, foraminal/axial stenosis or degenerative/spondylolytic spondylolisthesis) as the cause of the symptoms and proceeded to CT Guided Nerve Root Block at the suspected segmental levels with a significant but transient beneficial outcome, then the patient can be treated with a Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty [3].

This protocol seeks to minimise costs, interventions and optimise outcomes with real-time patient tailored minimalist therapy. The choice of interventional targets drawn on inert sources such as MRI scans lacks reliability because with age increasing numbers of multiple non-causal pathologies are detected on scans and may have been present for years at the moment the patient presents [42]. The injection step as a diagnostic filter helps to refine the targeting of the cause of the pain.

Where apposite midline surgical therapy and rehabilitation have been conducted Cluneal nerve therapy may be still required to treat continuing residual symptoms arising from the irritated the Cluneal nerves.

This study shows that correct injection of the Cluneal nerve TPs can alleviate symptoms and Muscle Balance Physiotherapy and postural retraining can sustain that benefit.

Where the injection benefits regress then the initial benefit predicates that Cluneal Nerve Radiofrequency Ablation is likely to provide a longer-term remedy if supported by continued patient compliance with Muscle Balance Physiotherapy and Postural retraining

Technique

In this study the irritated nerve TPs were pinpointed by the patient prior to the intervention and then during the aware state intervention. Proximity to the nerve was assisted by tracking tissue impedance using a radiofrequency NeuroTherm probe and patient real-time feedback. Sufficient ablation was indicated by the riddance of pain in the site during the operation, determined by direct palpation.

The diversity of the Cluneal Nerve leashes can make it difficult to address each TP with a single ablation. Serial ablations along the line of the nerve leashes may be required to achieve full pain control. The tell-tale lipoma at the "angle" where the ascending arc of the pelvic rim bends horizontally is a useful guide to the two groups of superior Cluneal Nerve leashes which pass on either side of it. The medial Cluneal nerves pass over the near vertical portion of the iliac crest above the posterior superior iliac spine or LPSL. They are trapped in thickened soft tissues and the presentation is often incorrectly attributed to symptoms arising from the micro-mobile sacro-iliac joint and here again repeated ablations may be required during the procedure to achieve full pain control. Adequate ablation of the Superior Cluneal nerves TP leashes usually requires ablation of the leash at the entry, mid-point and exit through the Thoracolumbar fascial sheath and also in the proximal gluteal region.

Cluneal Nerve Radiofrequency Ablation utilises pin-hole portals and the curved probe tip allows the sources of pain to be traced by means of patient feedback, fluoroscopic and impedance guidance. With experience the reliance upon radiographic imaging doses reduces to less than that of image guided facet joint blocks or ablations.

Outcomes

Cluneal Nerve TP Radiofrequency Ablation (CRFA) has, with essential Muscle Balance Physiotherapy and Reformer Pilates postural rehabilitation, resulted in sustained beneficial outcomes in patients and avoided repeated steroid injection with diminishing returns. This saves patients, healthcare providers and insurers their financial resources.

The symptoms had been endured by the 5 responders to Cluneal Nerves injections alone for 24-28 months. Those requiring CRFA without prior surgery (9) had had their symptoms for 14 - 144 months and those who had undergone prior surgery (19) for 18 - 120 months. The mean pre-interventional visual analogue pain score (VAPS) measured 7.42 in the retired group and 7.00 in the employable age group reducing to 1.50 and 1.00 respectively after treatment with injections or CRFA.

In the CRFA treated group 20 patients had an 80% or greater improvement in VAPS, 4 had a 70-79% improvement and 2 had a 50 - 69% improvement.

The third patient treated with CRFA required additional required additional ablation as part of our learning curve. Another patient had a developing disc protrusion which extruded and subsequently required Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty.

Whilst the Oswestry Disability Index (ODI) measures functionality it seems to mirror the changes in VAPS in our studies. By contrast the Prolo score [44] seeks to assess meaningful gain in work or retirement activity resulting from the pain reduction. The Prolo analysis is shown at Table 10 and shows a substantial improvement in lifestyle or workability in both groups of patients. All but one patients in the invalid group, those in the "no gainful occupation or retirement activity" group or "those able to work or pursue retirement activity but not at previous occupation or retirement activity levels" group - 32 patients in all, transferred to an "ability to work at previous occupation or retirement activity on a part-time or limited basis" group (10) or an "ability to work at previous occupation or full retirement activity without restriction" (22). This analysis offers a meaningful appreciation of the benefit achieved.

The positive outcome results suggest that this protocol and radiofrequency technique can result in a satisfactory sustained restoration of employable age workability or restoration of retirement lifestyle observed over a 12 - 36 month period.

The pinpointing of the pain centres is likely to refine the targeting of pain, reduce repeated transient-benefit injections, reduce the number of incorrectly indicated major open procedures and ultimately reduce the costs to healthcare providers and insurers.

Alternative means of treating Cluneal Nerve trigger point pain have included; Ultrasonographic imaging to assist Cluneal Nerve injection [6,21], Prolotherapy addressing ligaments and facet joints [19], open surgical exploration [45] or microscope assisted surgical release of the medial Cluneal Nerves [46] but with less successful outcomes. Cluneal Nerve Radiofrequency Ablation avoids surgical exploration of irritable nerves and the risk of producing a surgical scar [45,46] in a site likely to be repeatedly irritated by garments and re-envelop and irritate the nerve leashes.

The Authors consider that the importance of postural correction by Muscle Balance Physiotherapy (Alexander Technique) and Reformer Pilates cannot be over-emphasised. It is required to correct the causal often recalcitrant malposture and must be embraced as a life-style choice by the patients if they are to sustain the benefits in the long term.

Complications

There were no cases of infection, dysaesthesia, numbness or paralysis. 2 patients with marked bilateral symptoms affecting medial, superior and lateral Cluneal Nerve TPs suffered a sustained recurrence of symptoms lasting 4 and 6 weeks respectively and required a steroid injection but achieved an overall 50 -70% long-term reduction in pain (One required additional ablation as part of our learning curve when we were more cautious regarding the need to ablate the length of the provocative zone). One patient developed a disc extrusion 9 months after successful CNRFA.

Conclusions

Cluneal cutaneous nerves can produce referred pain arising at entrapment Trigger Points along the iliac crest. Symptoms present as low back pain, buttock, groin or thigh or as "sciatica".

Cluneal nerve irritation may arise from spinal malposture, malrotation of the of the pelvis and irritant angulation of the Cluneal nerves as they pass over the iliac crest or from the irritation of their nerve roots.

The diagnosis of the source can be refined by injecting provocative trigger points with local anaesthetic and steroids. Where the injection effectively reduces the predominant presenting symptom(s), then we recommend an immediate course of correction of spinal malposture, pelvic alignment and core muscle hardening with Muscle Balance Physiotherapy and Reformer Pilates.

Where the symptoms recur, long-term relief may accrue from radiofrequency ablation of the irritated Cluneal Nerves (CRFA) as they pass over the iliac crest. This study is the first provide a Radiofrequency based treatment protocol and technique to comprehensively treat the irritated entrapment trigger points.

Failure to appreciate their role as a symptom generator may lead to inappropriate spinal surgery.

Injection and Muscle Balance Physiotherapy alone reversed the symptoms in 5/33 cases over a prolonged period. Where a marked but transient reduction in symptoms occurred, treatment with impedance guided aware state Cluneal Nerve Radiofrequency Ablation provided excellent or good results in 26/28 (93%) patients during their follow-up period of 12 - 42 months.

During the same period 8 patients presented with similar symptoms but failed to respond to Cluneal Nerve injection but did respond to CT Guided Nerve Root Blocks and successfully underwent Transforaminal Endoscopic Lumbar Decompression and Foraminoplasty at pain provocative segments L3 - S1 with excellent or good outcomes.

A comprehensive treatment protocol has been derived for the holistic treatment of Cluneal nerve trigger points together with a clinically derived classification of the Cluneal nerve Trigger Points.

Bibliography

1. Maigne JY., *et al*. "The lateral cutaneous branches of the dorsal rami of the thoraco-lumbar junction. An anatomical study on 37 dissections". *Surgical and Radiologic Anatomy* 11.4 (1989): 289-293.

2. Lu J., *et al*. "Anatomic considerations of superior cluneal nerve at posterior iliac crest region". *Clinical Orthopaedics and Related Research* 347 (1998): 224-228.

3. Konno T., *et al*. "Anatomical study of middle cluneal nerve entrapment". *Journal of Pain Research* 10 (2017): 1431-1435.

4. Ermis MN., *et al*. "Medial superior cluneal nerve entrapment neuropathy in military personnel diagnosis and etiologic factors". *Journal of back and Musculoskeletal Rehabilitation* 24.3 (2011): 137-144.

5. Kuniya H., *et al*. "Anatomical study of superior cluneal nerve entrapment". *Journal of Neurosurgery Spine* 19.1 (2013): 76-80.

6. Bodner G., *et al*. "Successful Identification and Assessment of the Superior Cluneal Nerves with High-Resolution Sonography". *Pain Physician* 19.3 (2016): 197-202.

7. Iwamoto N., *et al*. "Low Back Pain Caused by Superior Cluneal Nerve Entrapment Neuropathy in Patients with Parkinson Disease". *World Neurosurgery* 87 (2016): 250-254.

8. Kim K., *et al*. "Low back pain due to middle cluneal nerve entrapment neuropathy". *European Spine Journal* (2017).

9. Isu T., *et al*. "Superior and Middle Cluneal Nerve Entrapment as a Cause of Low Back Pain". *Neurospine* 15.1 (2018): 25-32.

10. Zhou L., *et al*. "The anatomy of dorsal ramus nerves and its implications in lower back pain". *Neuroscience and Medicine* 3 (2012): 192–201.

11. Tubbs RS LM., *et al*. "Anatomy and landmarks for the superior and middle cluneal nerves: application to posterior iliac crest harvest and entrapment syndromes". *Journal of Neurosurgery Spine* 13 (2010): 356–359.

12. Vleeming A P-GA., *et al*. "The function of the long dorsal sacroiliac ligament: its implication for understanding low back pain". Spine 21.5 (1996): 556-562.

13. Zochodne DW. "Epineurial peptides: a role in neuropathic pain?". *Canadian Journal of Neurological Sciences* 20.1 (1993): 69-72.

14. Teixeira MJ., *et al*. "Concept of acute neuropathic pain. The role of nervi nervorum in the distinction between acute nociceptive and neuropathic pain". *Revista Dor* 17 (2016).

15. Cohen SP., *et al*. "Effectiveness of Lumbar Facet Joint Blocks and Predictive Value before Radiofrequency Denervation: The Facet Treatment Study (FACTS), a Randomized, Controlled Clinical Trial". *Anesthesiology* 129.3 (2018): 517-535.

16. Knight MT., *et al*. "Transforaminal endoscopic lumbar decompression and foraminoplasty: a 10 year prospective survivability outcome study of the treatment of foraminal stenosis and failed back surgery". *International Journal of Spine Surgery* 8 (2014).

17. Knight MTN and Krishnan A. "Spinal Surgery". In: Whitwam JG, McLoy RF, eds. Principles and Practice of Sedation. Oxford: Blackwell Science (1998): 178-181.

18. Maigne JY and Doursounian L. "Entrapment neuropathy of the medial superior cluneal nerve. Nineteen cases surgically treated, with a minimum of 2 years' follow-up". Spine 22.10 (1997): 1156-1159.

19. Inklebarger J GN. "The Management of Cluneal Nerve Referred Pain with Prolotherapy". *Journal of Prolotherapy* 10 (2018): 982-991.

20. Wadhwa V., *et al*. "CT-guided Perineural Injections for Chronic Pelvic Pain". *Radiographics* 36.5 (2016): 1408-1425.

21. Chang KV., *et al*. "Ultrasonographic Technique for Imaging and Injecting the Superior Cluneal Nerve". *American Journal of Physical Medicine and Rehabilitation* 96.6 (2017): e117-e118.

22. Ploteau S., *et al*. "A new endoscopic minimal invasive approach for pudendal nerve and inferior cluneal nerve neurolysis: An anatomical study". *Neurourology and Urodynamics* 37.3 (2018): 971-977.

23. Kuniya H., *et al*. "Prospective study of superior cluneal nerve disorder as a potential cause of low back pain and leg symptoms". *Journal of Orthopaedic Surgery and Research* 9 (2014): 139.

24. Chiba Y., *et al*. "Association between intermittent low-back pain and superior cluneal nerve entrapment neuropathy". *Journal of Neurosurgery Spine* (2015): 1-5.

25. Aota Y. "Entrapment of middle cluneal nerves as an unknown cause of low back pain". *World Journal of Orthopedics* 7.3 (2016): 167-170.

26. Kokubo R., *et al*. "Superior Cluneal Nerve Entrapment Neuropathy and Gluteus Medius Muscle Pain: Their Effect on Very Old Patients with Low Back Pain". *World Neurosurgery* 98 (2017): 132-139.

27. Konno T., *et al*. "Anatomical etiology of "pseudo-sciatica" from superior cluneal nerve entrapment: a laboratory investigation". *Journal of Pain Research* 10 (2017): 2539-2545.

28. Iwanaga J., *et al*. "Anatomic Study of Superior Cluneal Nerves: Application to Low Back Pain and Surgical Approaches to Lumbar Vertebrae". *World Neurosurgery* 116 (2018): e766-e768.

29. Kim K., *et al*. "Low back pain due to middle cluneal nerve entrapment neuropathy". *European Spine Journal* 27.3 (2018): 309-313.

30. Kim K., *et al*. "Low back pain due to superior cluneal nerve entrapment: A clinicopathologic study". *Muscle Nerve* 57.5 (2018): 777-783.

31. Yanow JH., *et al*. "Successful Treatment of Chronic Donor Site Pain". *Anesthesiology and Pain Medicine* 5.5 (2015): e18777.

32. Emami F., *et al*. "Correlations between core muscle geometry, pain intensity, functional disability and postural balance in patients with nonspecific mechanical low back pain". *Medical Engineering and Physics* (2018).

33. Son MS., *et al*. "Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy". *Neurorehabilitation* 41.4 (2017): 739-746.

34. Cabanas-Valdes R., *et al*. "Long-term follow-up of a randomized controlled trial on additional core stability exercises training for improving dynamic sitting balance and trunk control in stroke patients". *Clinical Rehabilitation* 31.11 (2017): 1492-1499.

35. Falbo S., *et al*. "Effects of Physical-Cognitive Dual Task Training on Executive Function and Gait Performance in Older Adults: A Randomized Controlled Trial". *BioMed Research International* 2016 (2016): 5812092.

36. Fayh A., *et al*. "Pilates instruction affects stability and muscle recruitment during the long stretch exercise". *Journal of Bodywork and Movement Therapies* 22.2 (2018): 471-475.

37. Cantergi D., *et al*. "Muscle strategies for leg extensions on a "Reformer" apparatus". *Journal of Electromyography and Kinesiology* 25.2 (2015): 260-264.

38. da Luz MA., *et al*. "Effectiveness of mat Pilates or equipment-based Pilates in patients with chronic non-specific low back pain: a protocol of a randomised controlled trial". *BMC Musculoskeletal Disorders* 14 (2013): 16.

39. Endleman I and Critchley DJ. "Transversus abdominis and obliquus internus activity during pilates exercises: measurement with ultrasound scanning". *Archives of Physical Medicine and Rehabilitation* 89.11 (2008): 2205-2212.

40. Goswami AK., *et al*. "Anatomical concepts in applied surgery of the lumbar spine: an endoscopic view". Heidelberg: Springer-Verlag, 2001.

41. Knight M. "The Evolution of Endoscopic Laser Foraminoplasty". Manchester University, 2003.

42. Knight MTN. "Lumbar foraminal pain sources: an aware state analysis". In: Simunovic Z, ed. Lasers in Surgery and Dentistry. Switzerland: *European Medical Laser Association* (2001): 233-252.

43. Knight MTN., *et al*. "Endoscopic foraminoplasty: a prospective study on 250 consecutive patients with independent evaluation". *Journal of Clinical Laser Medicine and Surgery* 19.2 (2001): 73-81.

44. Porchet F., *et al*. "Relationship between severity of lumbar disc disease and disability scores in sciatica patients". *Neurosurgery* 50.6 (2002): 1253-1259.

45. Morimoto D., *et al*. "Long-term Outcome of Surgical Treatment for Superior Cluneal Nerve Entrapment Neuropathy". *Spine* 42.10 (2017): 783-788.

46. Matsumoto J., *et al*. "Surgical treatment of middle cluneal nerve entrapment neuropathy: technical note". *Journal of Neurosurgery Spine* 29.2 (2018): 208-213.

Volume 11 Issue 3 March 2020