Two Sciatic Type Syndromes that Resemble Disc Prolapse

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Abstract: *Background*: The recognition of distinctive forms of common low back pain remains a problem. The aim of this study was to define two sciatic type syndromes, which mimic lumbar disc protrusion, but do not exhibit nerve root compression.

Methods: This is a revision of the original diagnostic classification, which had been produced by cluster analysis. By adopting the 9-subgroup rather than the 7-subgrouping solution, two seemingly useful sciatic type syndromes were revealed. These two extra syndromes are inspected alongside classical L5 and S1 prolapsed disc subgroups. These are compared in terms of 25 previously short listed clinical features that had been selected by discriminant analysis as best for describing low back pain in general.

Results: One of the "new" sciatic type syndromes was seen in patients with a relatively young age of onset of their problems with mean 23.0 ± SD 8.7 years (overall it was 30.6 ± SD 14.1 years). On average it took 19.4 ± 11.0 years until this group were seen in our hospital rheumatology department based back pain clinic, though such patients would previously have seen other practitioners. The patients with the other new sciatic type syndrome had older age of onset (mean 51.5 ± SD 10.8 years) and were predominantly female (78%).

Discussion: Our original study was conducted completely separately from, and in an era when McKenzie was evolving his mechanical diagnostic system. It is now suspected that his concept of "disc like syndromes that might not need surgery" might help explain the clinical relevance of our two additional sciaticaform subgroups. That these two syndromes had cladistically derived from a single previously combined syndrome which had been subsumed into an L5 disc like conglomerate perhaps explains why they can appear so similar clinically, and yet may need to be distinguished therapeutically and prognostically.

Conclusions: These diagnostic revisions could hopefully improve clinical insight into non-specific low back pain. They help identify two sciatic type syndromes that appear similar to those with disc prolapse but do not demonstrate signs of nerve root compression. It remains to be seen whether these truly reflect any of the McKenzie entities, and if not, what they might actually mean.

Keywords: Low back pain, sciatic type syndromes, classification, cluster analysis, McKenzie.

1. INTRODUCTION

One of the greatest advances in back pain research was made by Mixter and Barr [1] in 1934 with the recognition of the prolapsed intervertebral disc. There was then a tendency to over diagnose the syndrome and operate on too many cases, as expounded by St. Clair Strange [2] with his presidential address, "Debunking the disc" at the Royal Society of Medicine in 1966. This raises the question of what was happening in those patients who showed no disc prolapse at the time of surgery; were they perhaps cases of separate syndromes?

The recognition of distinctive forms of common low back pain (LBP) remains a pervasive problem, with different practitioners believing in different concepts. Whilst some underlying pathologies are indeed clearly evident, for some cases, there may be no such definitive mechanisms evident despite interrogation, examination, blood tests and imaging.

For these reasons we originally used cluster analysis [3,4] to try and identify naturally occurring groupings for possible LBP syndromes. This data based approach was used to try and avoid subjective bias. Further more, if generally well recognised syndromes were indeed distinguished by such automated pattern recognition methods, it might be hoped that the other less obviously explained patterns might also prove to be meaningful.

The aim of this present report was to extend the earlier cluster analysis conclusions in the light of observations about the way in which two extra syndromes were expressed if one disc prolapse conglomerate syndrome in particular was subdivided.

The original study was based upon the hope that the powerful computer analysis that was becoming available might help rationalise the scenario rather than add to the perplexity. However it is beyond the scope of this paper to discuss the plethora of syndromes and the diagnostic confusion before and since that era that has plagued clinical practice.

Classifications are only as meaningful as the constituent diagnoses and those in turn depend on

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showing causal pathology. But it is still possible to anticipate the manifestation of distinct entities prior to such fulsome causal insight. Therein resides a particular potential for cluster analysis techniques.

This paper presents what is thought to be a useful improvement of an earlier such cluster analysis. The classification is of the more common forms of low back pain with or without pain felt passing further downwards into the leg.

In essence, one of the previous rather amorphous sciatic subgroups was split to leave a more distinctive L5 nerve root compression syndrome due to prolapsed intervertebral disc. In so doing, the process hived off two syndromes, which are described below in clinical terms. It is hoped that by recognising and describing these two sciatic disc like syndromes that the hypothesis will contribute to the field of back pain research as well as enhance clinical practice.

2. METHODS

The original method was to analyse patient data from within a randomised controlled therapeutic trial of shortwave diathermy, extension exercises and traction [5]. The basic therapeutic trial had been designed to allow for this further study in the hope of showing that a certain subgroup type of low back pain or another, which had not been prespecified, might respond well to one form of treatment whereas other syndromes might not.

Now the original cluster analyses are re-examined, using insight gained from the passage of time as well as specific prompts from trying to understand the work of McKenzie [6,7]. It was understood that McKenzie had highlighted particular forms of back pain associated with leg pain/sciatica, which resembled nerve root compression due to prolapsed intervertebral disc (NRC/PID) that would not require immediate disc surgery. This allowed for the fact that the sciatic pain of NRC/PID could subside of its own accord in some instances.

In our original cluster analyses, all solutions yielding between four and fifteen subgroups were examined in detail [3,8,9]. There were several borderline statistical reasons using Wilks Lambda and Error Sum of Squares/Trace for selecting a 9-subgroup classification, though clinically it was suspected that the 7-subgroup solution would suffice.

It was recently noticed however that one of the syndromes associated with sciatica in the 7-subgroup solution was three times as common as the one associated with an absent ankle reflex. The latter clearly represented patients with S1 NRC/PID. The much larger sciatic group without loss of ankle reflex included cases with L5 NRC/PID. The frequency of L5 and S1 problems tends to be roughly equal [10] and so it seems that other types of case must be contained within that much larger group which had no loss of knee or ankle reflex. When the cluster analysis program was instructed to recognise 9 rather than 7 subgroups, it produced the two extra syndromes almost entirely from that larger sciatic entity mentioned above. In subdividing the “oversized” grouping, the distinct L5 and S1 NRC/PID syndrome proportions became more equally balanced.

The original study was performed in the back pain clinic of a hospital based rheumatology department in London. Most cases were referred from local general practice in primary care. 576 consecutive patients seen over a two-year period were considered for entry into the trial. To participate, informed consent was required. They also had to have on-going low back pain problems. Patients were excluded if pregnant, if a particular treatment was specifically required, if they lived too far away to attend for treatment three times a week, or if it was suspected that they might have serious “red flag” pathologies. Physician discretion was also permitted. The characteristics of these participants have been described in detail elsewhere [3-5].

Thus the data set now reviewed relates to a statistical diagnostic analysis undertaken on a subset of 301 out of the 400 patients participating in the randomized controlled therapeutic trial. The particular 301 patients had all had a more comprehensive set of clinical details recorded as a consequence of having been seen by this articles author. This was over and above all 400 having been seen on a routine basis by the clinic metrologist who had been trained to the particular protocol in two clinical development phases as well as the associated large industrial back pain study [3,4].

Aspects of patient history, examination, blood tests and x-rays were observed. Also factor analyses were performed on the data to provide hybrid “indices” of pain profiles, disability, functional restriction, pain/movement relationships, and the radiological findings. The factors help to define conceptual themes, reduce the number of measures and reduce multi co-linearity. Those factors which were used at this stage of the study are briefly described in Table **1**.

Table 1: Clinical Features of the Two New Sciatic Syndromes are Compared with the Classic L5 and S1 Nerve Root Compression Due to Prolapsed Intervertebral Disc Presentations. The 25 Clinical Features have a Cryptic Variable Name Given in Capitals, and this is Followed by a Brief Explanation. The Descriptions also Show how the Indices are Scored, and the Clinical Item Showing Best Correlation with that Index is Underlined. The Results are Only Given for the Four Subgroups of Present Interest. In the Top of each Cell of the Table the Classification Function Coefficient (Clas. Funct. Coef.) is Shown for each Clinical Feature. That Coefficient Score Contributes to a Patient's Back Pain Sub Group Diagnosis. Under that is Given the Rank of that Score Comparing those for all Nine Subgroups. Then under that the Actual Prevalence of the Clinical Feature within each Subgroup is given in Terms of Percentage for Binary (yes/no) Variables or Mean Score ± Standard Deviation for Continuous Variables. The Overall Prevalence is Given in the "Total" Column on the Right Hand Side of the Table. Abbreviations: ila = Press Ilio Lumbar Angle; SLR = Straight Leg Raise; FST = Femoral Stretch Test

Clinical Features	Sub Group	9	3	8	1	Total
	Name Suggestions	Younger McKSciatic	L5 NRC/PID	S1 NRC/PID	Older McKSciatic	
	No. of Cases	46	23	29	36	301
Male Gender= male	Clas. Funct. Coef. Rank Prevalence	1.4 7th 43%	1.6 2nd 70%	2.8 1st 67%	0.3 9th 28%	48%
Onset Age at ONSET of back pain (Initial episode) in years		0.2 9th 23.0± 8.7	0.3 5th 32.4± 12.2	0.3 4th 31.3± 12.4	0.5 1st 51.5± 10.8	30.6±14.1
Aged Duration of back pain (on set to AGE now) in years		0.3 1st 19.4± 11.0	0.2 4th 7.4± 7.0	0.3 3rd 13.3± 13.8	0.2 5th 5.9± 7.6	10.6± 11.0
Short Seen quickly (< 1 month) this episode		1.8 3rd 39%	3.2 2nd 65%	1.6 4th 42%	0.1 9th 8%	30%
Incoth INCidentOTHer- other injuries excluding direct lumbar trauma (initial episode)		1.9 2nd 67%	2.3 1st 57%	0.2 9th 50%	0.9 7th 36%	47%
TRM Direct lumbar TRauMa (Initial episode)		0.7 6th 11%	1.3 5th 9%	0.2 9th 13%	0.7 7th 3%	15%
DVR Diurnal VaRiation in back pain		4.7 3rd 78%	3.5 7th 52%	4.8 2nd 58%	3.2 8th 44%	60%
SLPO Difficultly getting Off to SLeeP		2.9 2nd 54%	1.9 6th 35%	- 0.4 9th 46%	1.8 7th 42%	47%
STY SeveriTY of disability (0 to 4; 0= no disability, 4= worst)		5.3 2nd 2.2± 0.9	6.4 1st 2.7± 0.6	5.3 3rd 2.4± .7	4.9 4th 1.8± .7	2.0± .9
SCIAT SCIATica to mid calf & below		3.8 6th 52%	4.3 5th 61%	5.7 3rd 96%	7.0 1st 97%	62%
TLT TiLT of iliac crest and/or shoulders (1 point each, max=2)		1.6 8th 0.5± 0.6	2.6 2nd 0.7± 0.7	2.1 4th 0.8± 0.7	2.2 3rd 0.7± 0.8	0.5± 0.7
PAIN A PAIN on lumbar extension, rotation, laterlflexn, hip rotns (1 point each, max = 4)		1.0 9th 1.5± 0.9	1.4 6th 1.8± 1.0	3.4 1st 2.8± 1.1	1.8 5th 1.9± 1.2	2.3± 1.3
PAIN B PAIN on lumbar flexion, SLR, FST, supine back arching (1 point each, max=4)		1.7 7th 1.6± 1.1	2.4 4th 2.5± .9	3.2 1st 3.1± .9	1.7 6th 1.5± 1.2	2.1± 1.4

Table 1 continued…

Clinical Features	Sub Group	9	3	8	1	Total
	Name Suggestions	Younger McKSciatic	L5 NRC/PID	S1 NRC/PID	Older McKSciatic	
	No. of Cases	46	23	29	36	301
BILAT A (BILATerality A) BILATeral pain on lumbar flexion, extens, latflexn, rotations (1 point each, max=4)		- 0.0 5th 0.4± 0.6	0.1 4th 0.5± 0.9	-1.0 9th 0.4± 0.9	- 0.6 8th 0.4± 0.8	0.7± 1.1
BILAT B (BILATerality B) Tests on both sides hurt: press iliolumb angles, SLR, FST, hip rotations (max=4)		0.8 4th 0.7± 0.9	- 0.3 9th 0.5± 0.7	0.6 6th 1.1± 1.0	0.2 8th 0.4± 0.6	1.0± 1.1
IP B (IPsilaterality B) Tests on rest pain side hurt: press iliolumb angles, SLR, FST, hip rotns (max=4)		1.5 4th 1.5± 1.2	1.3 6th 2.0± 1.1	0.8 8th 2.2± .9	1.3 7th 1.6± 1.2	1.5± 1.2
IP D (IPsilaterality D) Veer and/or hitch to rest pain side. (max=2)		2.9 5th 0.0± 0.2	12.8 1st 1.3± 0.5	1.8 8th 0.3± 0.5	2.9 4th 0.1± 0.3	0.2± 0.5
CON A (CONtralaterality A) Test hurts side opposite rest pain:any lumb bend, ila, SLR, FST, hip rotns max=5		1.1 7th 0.2± 0.4	0.9 8th 0.2± 0.4	1.5 3rd 0.3± 0.6	1.2 5th 0.2± 0.6	0.4± 0.8
CON C (CONtralaterality C) Lumbar rotations and/or lateral flexions induce pain on the opposite side (max=2)		0.8 7th 0.2± 0.4	0.7 8th 0.2± 0.4	1.8 3rd 0.5± 0.7	1.5 4th 0.2± 0.5	0.4± 0.7
RSW Repeated SWitch of rest pain side in past		0.7 5th 13%	- 0.7 8th 13%	0.1 6th 25%	-1.4 9th 0%	32%
SLR Straight Leg Raise, lowest side in degrees (Clas. Func. Coef. in tens of degrees)		3.0 4th 65± 20	2.8 5th 50± 17	2.4 9th 39± 16	3.1 2nd 72± 18	60± 22
DSTUCK STUCK Downing's leg twist test. (modified test)		2.6 8th 35%	3.0 5th 30%	3.7 3rd 46%	3.5 4th 44%	44%
AJABN Ankle Jerk ABNormal (loss of reflex)		-0.1 8th 2%	-1.6 9th 4%	27.0 1st 96%	1.7 4th 8%	12%
XSC X-Ray showing Scoliosis in lumbar spine		2.4 5th 54%	3.2 2nd 52%	1.7 9th 63%	3.0 3rd 72%	54%
XADM Xray showing Anterior Disc Marks (i.e.ostephytes).		1.9 2nd 80%	.8 5th 61%	1.9 1st 79%	1.2 3rd 86%	61%

With regard to the cluster analyses, it was the Iterative Relocate "Shape" algorithm that was finally utilised from the "Clustan" suite of programs [3]. This emphasised diagnostic aspects that were clinically meaningful and yet at the same time was diametrically opposite to the algorithms that tended to highlight the statistical aspects of back pain severity ("Size"). The Clustan manual and associated sources need to be consulted in order to further explore the theoretical mode of functioning and potential capabilities of such statistical methods.

It should be noted that the numbering given for the subgroups has no aetiological implications and merely represents the order in which a case of that syndrome happened to be seen for the first time in the clinic. The diagnostic subgroups are described in terms of the 25 most important symptoms and signs along with indices derived from factor analyses. These were the variables that survived discriminant analysis procedures reducing down from the initial set of more than 400 items. This discriminant analysis checks if the variables signify-cantly discriminate between the diagnostic groups.

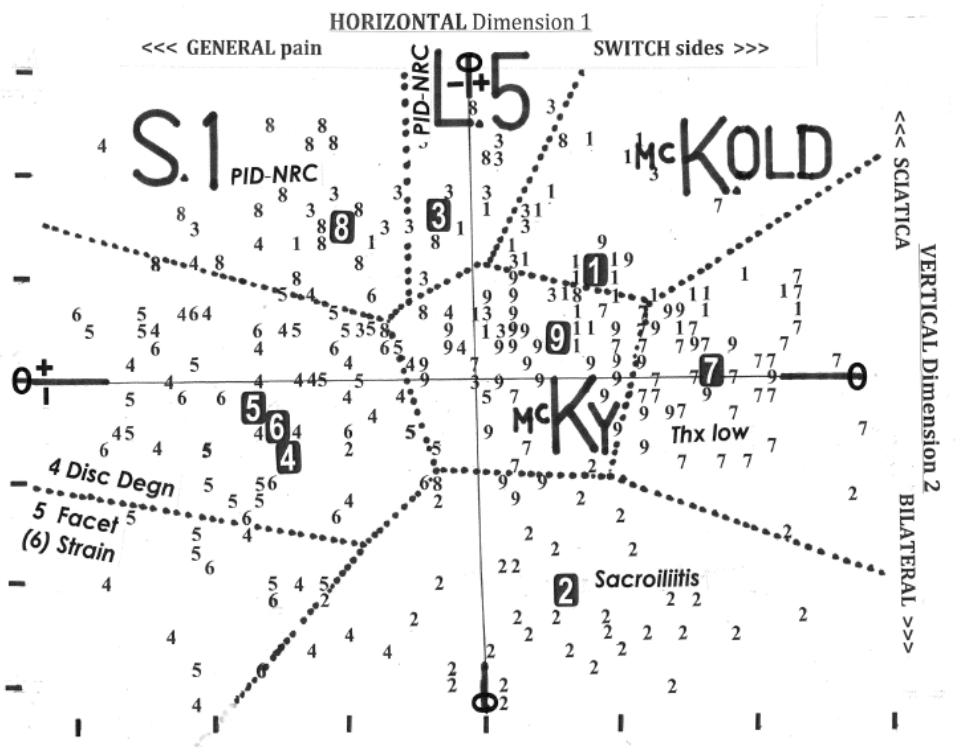

Figure 1: Scatter plot mapping of all 301 cases. Each case is identified using the assigned sub group diagnosis (1-9 of 9). Also shown are the boundaries of the sub group territories and their respective group centroids. The map is plotted on the axes of the first and second principal components and so the mutually exclusive dimensions of the remaining principal components 3 to 12 are not shown. The possible subgroup names are not definitive but are given to assist clinical appraisal, and are as follows: - 1 = Older sciatic ("McK-old"), 2 = sacroiliitis, 3 = PID with L5 NRC, 4 = Bilateral symmetrical (disc degeneration?), 5 = facet joint syndrome, 6 = twist strain, 7 = low thoracic radiating to lumbar, 8 = PID with S1 NRC, 9 = Younger sciatic ("McK-y"). The sixth sub group territory is overlapped and out of view but shows up more distinctively when displayed with the third principal component dimension included.

Also, some items were simply selected as the better of binary or continuous versions of the same variable; others occurred too infrequently to be retained and many served no apparent diagnostic function at all. The crypticlabels used for these variables as given in the text and table are retained as they have been maintained consistently across a wide spread of our publications so as to avoid confusion between what can sometimes appear to be very similar concepts and yet can prove entirely distinct. The capitalisations of letters within the explanations indicates the label derivations and are not typographic errors.

The comparisons are only given for the two new sciatic syndromes and the L5 and S1 NRC/PID subgroups, though the statistics for all 9 syndromes combined are given as the "Total" (i.e. all 301 cases). Three aspects are compared. Firstly, the "Classification Function Coefficient" simply gives the score for that test if positive towards an individual patients most likely diagnosis out of the 9 possible. Comparing this statistic across the syndromes gives an impression of how important that symptom or sign is for that diagnosis. A negative or low score means the syndrome seldom exhibits that feature. Secondly "Rank" shows much the same aspect but allows for the fact that 5 of the 9 subgroup/syndromes are not shown in the table. If it was "1st" out of 9, it suggests that there is something distinctive about that feature for that particular syndrome. Thirdly "Prevalence" indicates the absolute occurrence or in some cases intensity.

After the "simple" comparisons shown in Table **1**, some further characterisations are given in the text using the "principal component abstractions" of the clinical variables. Principal component analysis (PCA) essentially attempts to reduce the data set by separating out a few distinct underlying themes. Why use two very similar correlated tests when one will do? The suspected identity of these principal components is given within the respective text. The detailed structure of the 12 principal components that were used, which summarise the diagnostic features are shown elsewhere [3,11-13]. A graphic representation of how the cases segregate into the nine subgroups is however shown (Figure **1**) on a scatter plot using the two main principal components as coordinates.

3. RESULTS

Data are only given for the four subgroups out of nine that are of present interest. Thus table **1** shows the clinical features for the two newly identified sciatic type syndromes of younger and older age of onset, along with the two generally well-recognised L5 and S1 nerve root compression presentations. This data was taken from the 9 subgroup classification which was just one of various possible classifications, though it is now the favoured version.

The classification function coefficients are shown in the top of each cell in table **1**. These are multiplied by the numerical value of each clinical feature and then added vertically in the column to give the full score for each syndrome; the highest total score suggests the most likely diagnosis for that patient. These coefficient scores are shown in order to give an impression of how important each clinical feature is for distinguishing each syndrome. Generally, the bigger the coefficient is in relation to the others in the same row, the more typical it is for that particular syndrome. Negative or low scores mean the item is atypical. It should be noted that these classification coefficients can subtly differ from the precise prevalence of the clinical feature because that symptom or sign may be of greater or lesser importance for diagnosing that particular syndrome. Underneath the classification function coefficients, these scores are then ranked by their placing out of the 9 common sub groups. Beneath that the actual occurrence of the feature is given for it in each syndrome which can be compared with the occurrence overall as given in the totals column on the right side of the table.

3.1. Younger Sciatic

The 9 of 9 subgroup started their problems relatively young with mean age at initial onset of 23 years ± SD 9, but they possibly had much disc margin x-ray osteophytosis for their age when eventually seen in the clinic which was on average 19 years (± SD 11) after initial onset. They more often described some sort of precipitating incident, and few could find nothing to blame.

3.2. L5 NRC/PID

Syndrome 3 of 9 was the acute PID with L5 NRC. This group often showed a veer of the spine when standing upright, and/ or a hitch whilst bending their spine forwards. This appears to be the exact opposite of what the S1 NRC/PID shows. The L5 NRC/PID cases were to have been seen quickest with 65% having an appointment within a month though they may have had symptoms starting well before referral. These L5 level cases described more precipitating incidents of any sort though not much direct lumbar trauma. Again this contrasts with the S1 level cases for the classification function coefficient, but in reality the absolute figures are only slightly different at 57% and 50% for INCOTH (Other Incident).

3.3. S1 NRC/PID

Syndrome 8 was the prolapsed disc with first sacral nerve root compression which was best defined by the loss of the ankle reflex. Their problems started about the age of 31 ± 12 years, which is just a bit earlier than for L5 problems at age 32 ± 12.

3.4. Older Sciatic

The 1 of 9 group had older age of onset of back problems (mean 52 years ± SD 11) and these patients were predominantly female (72%). They less often recalled a precipitating incident and the duration of problems till seeing us was intermediate at 6 years ± SD 8. Interestingly the young onset group described diurnal variation in symptoms and the older group hardly at all.

3.5. Generalisation Using Principal Components (PC)

The principal components derived from the overall data of 301 cases to describe the 9 subgroup classification are used to guide the further clinical description of the syndromes. They help give a nuanced clinical perspective and a sense of underlying themes. The details of the construction of the PC themselves are available elsewhere [3].

The first principal component represented severity of back pain and sciatica and yet interestingly the patient's subjective pain score (range 0 – 9) was not selected by the original factor analyses for this dimension. This is possibly because it and the somewhat similar visual analogue pain scales (VAS) are too unreliable and are perhaps affected by too many "non pain" influences [3,14]. This general pain component suggests that the NRC/PID syndromes were more distressing than the new sciatic syndromes. However all four of these subgroups tended to be anterior column pain patterns.

Next, important PCs (2^{nd} & 4^{th}) show that the four sciatic syndromes were less likely to be bilaterally

equally exhibited, i.e. tended to be highly lateralised to one side or the other. The other PC shows that these four sciatic syndromes do not repeatedly switch sides (RSW) as seen so typically with inflammatory pelvispondylitis/ sacroiliitis; thus the on-going problems remain consistently on the same side.

The third PC highlights sideways hitch of the back whilst bending forwards and postural sideways veer whilst standing. This was seen in the L5 NRC/PID group and this was linked with being seen quickly.

With the fifth PC the S1 NRC exclusively shows loss of ankle reflex, but particularly emphasises that all four sciatic syndromes gave drawings of pain down the leg, which seems obvious for sciatic syndromes, though the young onset syndromers tended to draw less extensive pain down the leg than the others.

From the sixth principal component downwards to the twelfth, the differences were marginal for these four sciatic subgroups.

The younger onset sciatic group had the earliest age at onset of their back problems of all 9 subgroups and this was the most potent classification coefficient score for the syndrome itself and yet these facts proved only modestly distinctive in the overall scheme of the classification system. As part of this component, the young onset syndrome also had a long history of back pain by the time they were seen in our clinic. That combination cancels out each other, so that the age of the patient at the time of being seen in our clinic was not that useful a feature for diagnostic purposes. It should be noted that these young onset cases would often have been seen elsewhere by other practitioners by the time they saw us.

Diurnal variation in the symptoms also seems to be slightly more important for this younger onset sciatic group with regard the classification coefficient scores.

A tilted posture meant that the iliac crests (or shoulders) were not level, as measured by the pendulum tilt gauge. This is to be distinguished from the dynamic hitching or static sideways spinal veer mentioned above. The older onset sciatic group and the S1 NRC/PID had this tilted posture PC the most.

The modified Downing type stuck leg twist test did not seem to be so important for these four sciatic syndromes, presumably because they do not involve the upper lumbar spine from whence the psoas muscle takes its origin [11-13].

Finally, X-ray findings (PCosteophytosis and PCscoliosis) were disappointingly confusing and of marginal assistance. CT and MRI scanners were yet to be developed in that era.

Figure **1** shows a two-dimensional scatter plot, which maps the proximity of the various back pain subgroups in the planes of the top two principal components. This shows how the two new sciatic syndromes nestle in the immediate proximity of the classic L5 nerve root compression subgroup. The two new sciatic syndromes are labeled as McK.y and McK.old for purposes of brevity and to complement the study hypotheses.

4. DISCUSSION

The original low back pain classification has now been slightly enlarged with only minimal statistical improvement but potentially considerable clinical benefit.

Two extra sciatic type syndromes that can mimic prolapsed intervertebral disc are described. Neither of these exhibits nerve root neurological deficit. The focus on the “sciatic type syndromes” means that no attempt is made to describe the others of the nine syndromes that are also intended to help cover the spectrum of commonly occurring types of low back pain.

The classification used features evident at the patient’s initial appointment. Even though there was often a history of some response for better or worse to particular treatments evident from the past history and also from the subsequent therapeutic trial, that information was not utilised. This is because treatment effect sizes were relatively small for classification purposes when compared with those of the initial clinical indicants [3-6]. This was perhaps predictable as there was at the time no known miracle treatment. In any case, such miracle cures would have obviated the need for the therapeutic trial. Moreover, most of the patients were self-selected as having on-going problems which had failed to respond adequately to a succession of past treatments.

Identification of the disc prolapse group with the neurological deficit of S1 nerve root compression from amongst other entities was relatively clear because of the absent ankle reflex which is seemingly reliably observed under these survey circumstances. This neurological sign was found to be the most distinctive feature from amongst all the many clinical variables studied. Another group, which contained some clinically

obvious cases of L5 nerve root compression, was not so distinct statistically. Further more, this group had three times the number of patients compared to the S1 NRC/PID group. This discrepancy was not recognised to be so important at the time of the early analyses. However the indistinct L5 type group, which was too big, was the next to be split successively into 2 then 3 groups when forcing the cluster analysis to produce 8 and then 9 group classifications [3,8,9]. One of the resulting 3 groups produced, clearly retained the true L5 NRC/PID cases and the other two groups became the focus of attention of this paper.

The 7-group classification was originally selected but without much conviction, but an intuitive clinical decision had to be made at the time [3]. But with considerable use of the system thereafter and recent new insights, it now makes the 9-group classification preferable. In particular, the clinical review article by Wetzel and Donelson [6] has latterly given reason to believe that the two new sciatic syndromes were meaningful entities. Those authors reviewed the literature relating to the McKenzie [7] approach to diagnosis and conservative therapy that might help avoid the need for surgical intervention. This emphasised the clinical concept of direction specific testing for centralisation or peripheralisation of pain across the low back and of extent of pain down the leg with repeat lumbar extensions testing. This particular form of testing had not been included in our original study even though extension exercises were one of the associated therapeutic trial regimens.

This paper is also influenced by Spangfort's study[10] of 2,504 disc operations and his review of 160 earlier reports. The average distribution of disc prolapse in his survey was roughly equal with 46.9% at the level L5/S1, 49.8% at L4/L5. There were only 3.3% at higher lumbar levels. It thus seems reasonable to assume that our study should likewise perhaps have shown a more equal prevalence of nerve root compressions at these two levels unless there were some highly unusual selection factors occurring.

It is also interesting to note that Spangfort's work was published as far back as 1972, which was before the availability of CT and MRI, which may explain why some operations were described as "negative" when no disc protrusion was found at the time of surgery. Were these cases of our two young and old sciatic syndromes that resemble NRC/PID? In practice there was insufficient clinical evidence in those reports to enable us to find much overlap between the Spangfort negative and our younger and older onset sciatic syndromes.

With our 9 group classification, there were two men for every woman who had disc prolapse, which is in concordance with Spangfort's study with 70.4% men and 29.6% women. This also agrees with the 52 previous papers he reviewed, with corresponding average overall rates of 66.3% men and 33.7% women. Also Spangfort found that the excess for disc males was similar for herniation at both of the low lumbar levels.

In our study in contrast, the younger onset sciatic syndrome shows that females predominate slightly (57%) and more distinctively so in the older onset sciatic syndrome where 72% were female. Does this imply that they are distinctive syndromes? We were unable to link any history of gynaecological or pregnancy related factors amongst the females to influence our classification system. Further more it could be hoped that the x-rays would have excluded the "red flag" cases with vertebral fractures due to postmenopausal osteoporosis.

We found that the actual age of the patient attending clinic was relatively unimportant for diagnostic purposes. This is why the patient's age is not listed in our table; however, the age can be inferred by adding the duration of morbidity to the age of onset of back problems. For Spangfort's survey the mean age at operation at the lowest level of L5/S1 (n =1089) was 38.7 years, and at L4/5 (n =1023) was 41.9 years, and L3/4 (n = 40) was 45.6 years. This shows disc prolapse surgery occurring later at each higher level. We found a similar phenomenon for the age at presentation of S1 and L5 NRC/PID.

Our cluster analysis showed that duration of problems (low back pain and sciatica not distinguished) was of some importance diagnostically. Our figures showed 7.4 ± 7 years for L5, and 3.3 ± 4 years for S1. In contrast, the duration for the younger sciatic syndrome was much longer at 19.4 ±11 years. The older age of onset group had waited 5.9 ± 8 years. In Spangfort's survey of 15 previous reports, with a total of 1,386 operations, the mean duration of preoperative symptoms was 3.8 years, ranging from 2.3 to 5.5 years, which is similar to our findings.

With regard to cases showing no disc prolapse at surgery; Spangfort studied 347 of these negative cases. They had of course been thought to warrant surgery. We had 46 younger cases and 36 of the older

onset cases that had sciatica but did not appear to have NRC/PID. The Spangfort negative cases were often younger or older than the average age of the confirmed disc protrusion group. The mean rate of negative explorations was 5.7% in the age group 15-49 years, and then increased significantly to 35.0% in the age group 55-59 years. There was little further data on the negatives cases to help show what the younger and older sciatic syndromes might mean.

With regard the McKenzie literature, it has been difficult to find out which of the many subgroups in that classification match our two groups. This is partly because data on the age, sex, precipitating incident and other clinical features seem less readily available.

Bao-GanPeng [15] gives a good review of discogenic low back pain in this context. We have also reviewed the meaning of sciatica generally [16,17]. In turn we look to McKenzie specialists to enlarge on these matters and we hope they may also know of the existence of relevant data. How do the sciatic syndromes relate to the McKenzie concepts of Derangement, Dysfunction and Posture? Who are those "centralizers" that respond well to MDT?

Recently Peterson *et al.* [18,19] have reanalysed their trial of the McKenzie-method (also known as Mechanical Diagnosis and Therapy; MDT) versus spinal manipulation therapy (SM), both of which were regarded as mobilising strategies. They tried to find variables that select for specific response to these treatments. One might summarise their list of predictors to include 1) Age (below 40 years), 2) Duration (symptoms more than 1 year) 3) Pain below the knee/ substantial leg pain/nerve root involvement 4) Male gender 5) Low severity (mild disability, mild back pain 6) low handicap (low number of days on sick leave in the past year/high patient expectations about coping with work tasks six weeks after initiation of treatment), and 7) already improving (high patient expectations to recovery). Petersen [19] concluded that in all subgroups, the probability of success with MDT was superior to that of SM. Although not statistically significant, the presence of nerve root involvement and peripheralisation appear promising effect modifiers in favour of MDT, but the findings need testing in larger studies. In their study they pre-specified 6 indicators for prospective validity purposes in accordance with the recommendations by the PROGRESS group [20] and limited the number of indicators to minimise spurious findings due to chance. We however were exploring as many variables as possible as an initial screening process. Accordingly, we put forward a reasonable number of indicators though these were intended as diagnostic criteria rather than predictors of response to treatments, though we showed that these functions may overlap.

4.1. Study Strengths

The original study was actually of patients with back pain symptoms and signs, and not of some possibly questionable MRI finding as will be discussed in some detail in the text further below.

Cluster analysis itself was used in order to make the classification more objective. In deed, at the time it was felt that every expert had his or her own subjective diagnostic opinions. More over, even the symptoms and signs observed were felt to present bias. It was for this reason that the initial studies were to include as many tests as possible, which were whittled down drastically in number using statistical methods. Although this was an early study of its kind, it was fairly detailed and so the findings may help plan further such research.

4.2. Study Weaknesses

Although the prolapsed disc with nerve root compromise is generally accepted and may partly validate the classification, it does not guarantee that these further two sciatic syndromes recognised in this revision are equally valid. There are also problems with using the terms sciatica, sciatic type, sciaicaform, and leg pain of various extents.

It would have been interesting to have had Magnetic Resonance Imaging and Genomic Studies available for our work and those who came before us, but even now it would not seem to have been essential. The earlier surgical studies mentioned above in this discussion had the advantage at the time of operation of being able to see the anatomy of what was happening to disc and nerve root. There were sufficient clinical nerve root compression evidence of what was happening in our various subgroups. X-ray findings did not appear to help that much once the red flag exclusion criteria had been imposed. And even decades later the immunology and genetics (see below) have still not revolutionised this area of diagnostics.

There are also study design problems. Some considerable time after the study was undertaken, recommended standards have since been proposed for the simpler clinical forms of observational studies. Most

of these requirements had in fact been anticipated, but for example results were not given in terms of "Odds Ratios" which are perhaps not generally geared to the complexities of cluster analysis presentation. Indeed it may be that this complexity has in itself made it difficult to follow the niceties of this present revision.

Furthermore there are sensitivity problems when considering all the back pain subgroups. Once the overall number of patients has been separated into increasing numbers of diagnoses, each subgroup size becomes smaller and so a greater number of patients would have been desirable. Furthermore these studies were conducted in London and need to be replicated elsewhere as well.

A practical problem using the present laptop-based system is that it diagnoses the 7-subgroups and still identifies the original conglomerate of L5 NRC/PID, and the young and old sciatic cases. The clinician would still have to use table 1 to try and sort out the two new syndromes. However the young and old age at onset of back problems would often give a high index of suspicion as to which of the new syndromes was implicated. Otherwise a new program using the classification function coefficients for the 9-subgroup classification would need to be implemented.

4.3. Further Research and the Way Forward?

Researchers Yuan *et al.* [21] recently (2017) reported sophisticated studies of genetic links to intervertebral disc degeneration (IDD) which one would hope could be of great potential. But it seems that IDD may simply be a natural process that is not necessarily painful.

Reviewers Chou *et al.* [22] had in 2011 already evaluated whether MRI degenerative changes were associated with chronic low back pain (CLBP). Their literature review sought to summarize studies that (1) evaluated the association between degenerative magnetic resonance imaging (MRI) changes and chronic low back pain (CLBP) and (2) compared surgical and nonsurgical treatment of these degenerative MRI changes. They noted that the role of routine MRI in patients with CLBP was unclear. It was also uncertain whether or not surgical treatment of degenerative MRI changes results in alleviation of back pain.

But the overall strength of evidence across studies was considered to be insufficient to prove a strong link between MRI evidence of IDD and chronic low back pain. Further more no comparative studies of surgical versus nonsurgical treatment of degenerative MRI changes were identified. Even Yuan [21] noted that a number of IDD related factors were not reported in sufficient detail in their study, which limited further analyses.

In returning to this present report, it is hoped that it will help with the vexing problem we faced of deciding how many subgroups of commonly presenting low back pain one should consider. It may also give reason to alter the way in which gene linkages are sought in aetiological studies of different sorts of back pain. But for immediate clinical practice, it may help to distinguish perplexing presentations of low back pain and even cause pause for further thought before unnecessary surgical intervention is recommended.

CONCLUSION

This cluster analysis revision in effect proposes the existence of two sciatic type syndromes that are distinguished from the classical presentation of prolapsed intervertebral disc in the low back causing nerve root compression at the L5 or S1 levels. There was no evidence that could be found that these entities had been identified and clarified in the literature previously. The manner in which these syndromes were identified using the cluster analysis techniques is relatively rare in this field of study.

The causes of the new sciatic syndromes are not obvious, but this is also true for most other forms of non-specific low back pain that practitioners have found difficult to distinguish. These new syndromes superficially appear similar to those with disc prolapse but do not demonstrate obvious nerve root compromise. They also appear to have distinctive age/sex profiles. It remains to be seen whether these sciatic syndromes truly reflect any of the McKenzie entities, and if not, what they might mean. Enough cases of each syndrome were observed to provide clinical description to hopefully allow further such cases to be identified for further study and to clarify causes and define best treatment.

LIST OF ABBREVIATIONS

CT	Computerised Tomography.
MRI	Magnetic Resonance Imaging.
LBP	Low Back Pain.
Clas. Funct. Coef.	Classification Function Coefficient.

L5 PID-NRC	"5th Lumbar" Prolapsed Intervertebral Disc with Nerve Root Compression (Subgroup 3).
S1 PID-NRC"	1st Sacral" Prolapsed Intervertebral Disc with Nerve Root Compression (Subgroup 8).
McKy	McKenzie Younger age onset syndrome (Subgroup 9).
McKold	McKenzie Older age onset syndrome (Subgroup 1).
MDT	Mechanical Diagnosis and Therapy (McKenzie).
Thx low	Low Thoracic Syndrome radiating to lumbar (Subgroup 7).
Sacroiliitis	Inflammatory Sacroiliitis/ Pelvispondylitis (Subgroup 2).
Disc Degn	Disc Degeneration Syndrome with symmetry (Subgroup 4).
Facet	Facet Joint Syndrome (Subgroup 5).

Strain Rotation Strain Syndrome (On opposite sides at upper and lower lumbar levels (Subgroup 6).

The many Cryptic clinical variable labels abbreviations are explained in the table **1** variables column and are commensurate with multiple other publications by this author and colleagues.

ETHICAL APPROVAL

None required. Only anonymous data utilised. No access to patient records was required or possible for this revision of a secondary analysis of a randomised controlled therapeutic trial. Approval for the original trial was given at Guys Hospital, London 1973.

CONSENT TO PUBLISH

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The data referred to in this article are presented in the table of this article. The classification function coefficients to 4 significant figures are retained by and available from the author in the form of print out. The original extensive cluster analyses have no longer been retained.

COMPETING INTERESTS

The author declares that he has no competing interests.

FUNDING

There was no funding for the present article.

AUTHORS CONTRIBUTIONS

Sole author.

STUDY DESIGN

This is an extension of a previously developed cluster analysis classification for common low back pain. It was undertaken so as to help distinguish mimics of classic lumbar prolapsed intervertebral disc with nerve root compression. This article reports some clinical features of two such mimic syndromes.

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