RACGP

Commonwealth of Australia

Copyright Act 1968

Notice for paragraph 49 (7A) (c) of the *Copyright Act 1968*

Warning

This material has been provided to you under section 49 of the *Copyright Act 1968* (the ***Act***) for the purposes of research or study. The contents of the material may be subject to copyright protection under the Act. Further dealings by you with this material may be a copyright infringement.

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

EDITOR'S CHOICE

Antibiotic treatment in patients with low-back pain associated with Modic changes Type 1 (bone oedema): a pilot study

H B Albert,[1] C Manniche,[1] J S Sorensen,[1] B W Deleuran[2]

[1] The Back Research Center, Funen, University of Southern Denmark, Denmark; [2] Department of Rheumatology, Aarhus University Hospital and The Institute of Medical Microbiology and Immunology, Aarhus University, Aarhus, Denmark

Correspondence to: Hanne Albert, The Back Research Center, Lindevej 5, 5750 Ringe, Denmark; haal@shf.fyns-amt.dk

Accepted 4 July 2008
Published Online First 21 August 2008

ABSTRACT

Objective: The aim of this study was to assess the clinical effect of antibiotic treatment in a cohort of patients with low-back pain (LBP) and Modic changes Type 1 (bone oedema) following a lumbar herniated disc.

Design: This was a prospective uncontrolled trial of 32 LBP patients who had Modic changes and were treated with *Amoxicillin-clavulanate* (500 mg/125 mg) 3 × day for 90 days. All patients had previously participated in a randomised controlled trial (RCT) that investigated active conservative treatment for a lumbar herniated disc (n = 166). All patients in that RCT who had Modic changes and LBP at 14 months follow-up (n = 37) were invited to participate in this subsequent antibiotic trial but five did not meet the inclusion criteria.

Results: 29 patients completed the treatment, as three patients dropped out due to severe diarrhoea. At the end of treatment and at long-term follow-up (mean 10.8 months) there was both clinically important and statistically significant ($p \leqslant 0.001$) improvement in all outcome measures: LBP intensity, number of days with pain, disease-specific and patient-specific function, and global perceived effect.

Conclusions: In this uncontrolled trial, the clinical effect of antibiotic treatment was large in a group of patients with Modic changes suffering from persistent LBP following a disc herniation. These results provide tentative support for a hypothesis that bacterial infection may play a role in LBP with Modic changes and indicate the need for randomised controlled trials to test this hypothesis.

Modic changes (bone oedema) in vertebrae are an imaging finding recently identified as a prevalent pathoanatomical finding that is commonly associated with low-back pain (LBP).[1 2] Modic changes are only visible on magnetic resonance images (MRI)[3] and three subtypes have been identified (Types 1 to 3). From histological studies of material harvested during surgery, Modic changes Type 1 involve disruption and fissuring of the endplate with regions of degeneration, regeneration, reactive bone formation, endplate oedema and vascular granulation tissue.[3 4] Type 1 are seen on T2-weighted MRI as areas of increased signal intensity and on T1-weighted MRI as low signal intensity extending from the vertebral endplates.

There is an association between Modic changes and LBP.[1 2] A recent systematic review of Modic changes and LBP identified 77 study samples from the general, working, and clinical populations. The median prevalence rate for any type of Modic change was 46% in patients with non-specific LBP and 6% in non-clinical populations. A positive association between Modic changes and non-specific LBP was found in 70% of studies with odds ratios ranging from 2.0 to 19.9.[5]

Infection is one hypothetical cause of Modic changes Type 1.[6] Both Van Goethem *et al*[7] and Modic *et al*[8] showed that vertebral endplate signal changes resembling Modic changes Type 1 were a sensitive indicator for spondylodiscitis or disc space infection. Caragee[9] observed that about one-third of patients with pyogenic vertebral osteomyelitis were infected with low-virulent bacteria. When antibiotics were given, the majority recovered and became pain- and symptom-free. Similarly, in nuclear tissue removed under sterile conditions during surgery for lumbar herniated discs, 53% of patients were found to be infected with low-virulent anaerobic organisms (*Propionibacterium acnes* and *Corynebacterium propinquum*) in contrast to no patients who were operated on for other spinal disorders.[10] Stirling *et al*,[10 11] therefore, hypothesised that patients with sciatica sustain a breach in the mechanical integrity of the spinal disc, possibly from minor trauma, which allows access by low-virulent microorganisms.[10]

The aim of this pilot study was to test antibiotic treatment in a group of patients with Modic changes Type 1 and LBP following herniation of a lumbar disc.

MATERIALS AND METHODS

This was a prospective uncontrolled trial of LBP patients who had Modic changes Type 1 (bone oedema). All patients had previously participated in a randomised controlled trial (RCT) comparing two types of active conservative treatment for a lumbar herniated disc (n = 166).[12] All patients in the RCT received a MRI scan at the 14 month follow-up.

Patients were invited to participate in the current trial if their follow-up MRI displayed Modic changes Type 1 in a vertebra adjacent to their previous herniated disc and they had LBP at the time of this follow-up examination. Patients were excluded if they had an allergy to antibiotics, had a current infection or declined participation in the antibiotic trial.

Treatment consisted of *Amoxicillin-clavulanate* (500 mg/125 mg) (Spektramox) three times a day, at 8 hour intervals, for 90 days. Three independent experts in infectious diseases were presented with the bacterial culture results in Stirling's[10] study and requested to suggest the ideal antibiotic. All experts recommended *Amoxicillin-clavulanate*. Treatment was for 90 days as this is the usual duration of antibiotic treatment for

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

Table 1 Outcome measures

Global perceived effect:	This evaluates the global effect of the treatment. The patients compare their baseline status with their status at the follow-up, measured on a 5 point Likert scale.
Roland Morris Questionnaire (RMQ):	A disease-specific questionnaire concerning functional disability. The patient answers 23 questions, and the scale is scored between 0 and 23, where 23 is the worst possible score.
The Self-Perceived Function Scale:	A patient-specific questionnaire concerning functional disability. The patient chooses the three functions that are the most bothersome and scores each on a scale from 0 to 10, where 10 represents their status before symptoms began. The three scores are added, with 0 as the worst possible score.
Days with LBP:	The patient determines how many days within the last 100 days he or she has suffered from LBP.
LBP rating scale:	Measures both pain and function. Here only the pain questionnaire was used. The patient scores, on an 11-point box scale, the present pain and the worst and mean pain within the last 2 weeks. The three scores are added together.
Serum analysis:	Leucocytes, neutrophils, eosinophils, basophils, lymphocytes, monocytes, P/S creatininium, lactate dehydrogenase, alkaline phosphatase, C-reactive protein.

postoperative discitis. During the treatment and follow-up period of this antibiotic trial, the patients received no other treatment except optional mild analgesics.

Outcome measures

All patients had a clinical examination and filled in questionnaires at baseline, at end of treatment and at a follow-up approximately 11 months later. Serum analysis was performed at baseline and at the end of treatment.

The outcome measures were: Global perceived effect, Roland Morris Questionnaire (RMQ),[13] the Self-Perceived Function Scale, days with LBP, the LBP Rating Scale[14] and serum analysis (table 1).

Statistics

To test for differences between baseline, end of treatment and the long-term follow-up measures, Wilcoxon signed-rank tests were performed ($p<0.5$) using SPSS version 13.0 (SPSS, Chicago, Illinois, USA).

Ethics

The study was approved by The Danish Medicine Agency and The Regional Scientific Ethical Committee no. VF20030212, and written informed consent was obtained from all participants prior to participation.

RESULTS

Of the 166 patients in the previous RCT, 37 met the inclusion criteria for the current antibiotic trial (a further six patients had Modic changes but no LBP at 14 months review). The distribution of patients from the two treatment groups in the previous RCT was similar (16% and 18%). Five patients were excluded from the current antibiotic trial, due to: not wanting to take antibiotics for such a long period (n = 3), spontaneous recovery in the waiting period before the study started (n = 1), and loss of contact (n = 1). Therefore, 32 patients enrolled in the study but three dropped out due to severe diarrhoea, leaving 29 patients who completed the antibiotic treatment regime.

Of the 29 patients who completed the antibiotic treatment, 10 (34%) were female, mean age 45.7 (SD 11.1) years and 19 (66%) were male, mean age 47.7 (8.2) years. The original disc lesions were as follows: four (14%) patients had a bulge, 12 (41%) a focal protrusion, five (17%) a broad-based protrusion, seven (24%) an extrusion, and one (3%) a sequestrated disc, according to the Fardon and Milette nomenclature.[15]

The outcome measurements at baseline, at end of treatment, and at follow-up are described in table 2.

All outcome measures (disease-specific function, patient-specific function, global perceived health, and LBP) showed statistically significant improvements both at the end of the treatment period and at the long-term follow-up. Using the measure of global perceived health, at the end of treatment, 15 (52%) of the patients reported that they were much better or cured, seven (24%) were moderately better, and seven (24%) reported they were unchanged. None experienced a worsening of symptoms.

The patients' improvement of disease-specific function was measured using the Roland Morris Questionnaire (RMQ). A reduction in RMQ score is regarded as clinically important if it exceeds 30% of the patient's original score.[16] In our cohort, approximately two-thirds of the patients reduced their RMQ scores more than 30% (table 3). Furthermore, a 30% reduction in the average baseline RMQ score of this cohort would have been 2.6 RMQ points and the observed average reduction of 3.1 RMQ points exceeded that estimate.

Table 3 The percentage of patients whose Roland Morris Questionnaire (RMQ) scores were clinically improved, unchanged or worse

	A	B	C
	Clinically improved **= ⩾ 30% improvement on RMQ, or a value of 0**	***Unchanged*** **= Between 30% improvement and 30% worsening**	***Clinically worse*** **= ⩾ 30% worsening on RMQ**
After end of treatment	18 (62%)	10 (34.5%)	1 (3.5%)
Long-term follow-up	18 (62%)	9 (31%)	2 (7%)

Table 2 The scores of the outcome measures; level of LPB, days with LBP, and physical function

Variable	Baseline	End of treatment	Follow-up	Significant difference between baseline and long-term follow up
Patient-specific function scale (n = 28)	14	21	21	p<0.001
Scale 0–30 (30 is best)	10.5–18.5	17.5–24.5	13–25	
Days with low-back pain during the last 100 days (n = 27)	100	35	20	p<0.001
Scale 0–100 (0 is best)	25–100	7–35	10–84	
low-back pain (n = 29)	9	5	5	p<0.001
Scale 0–30 (0 is best)	6–15	1.5–9.5	2.5–12	
Roland Morris Questionnaire (n = 29)	8	4	5	p<0.001
Scale 0–23 (0 is best)	4.5–13.5	0.5–9	1–10	

The median scores at baseline, at end of treatment, and at long-term follow-up a mean of 10.8 months after end of treatment are presented (median and 25th and 75th percentiles).

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

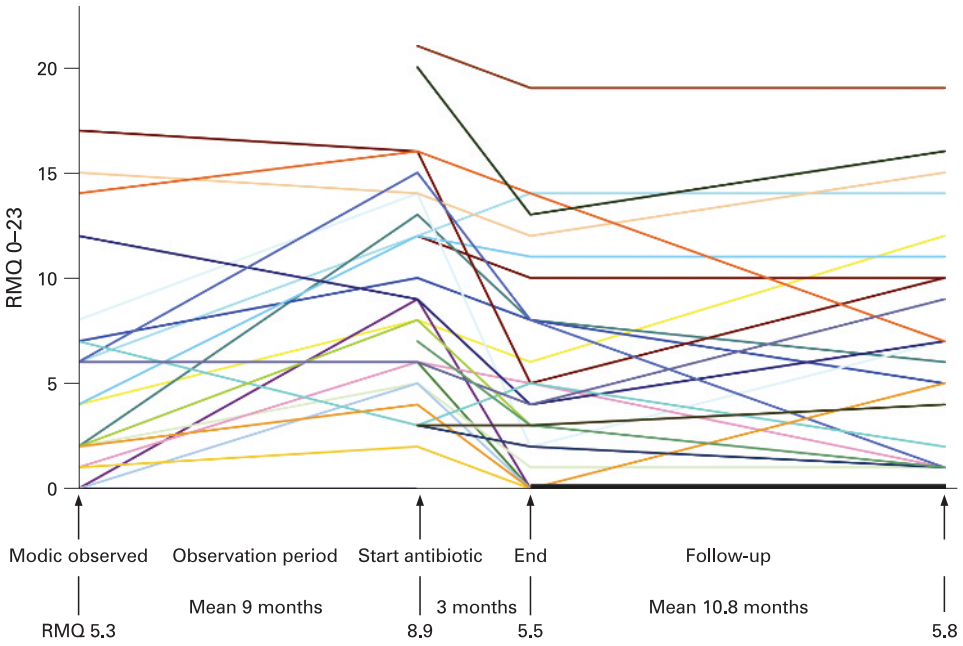

Figure 1 Each line represents the Roland Morris Questionnaire (RMQ) scores for each patient measured at four different points in time: the first point when eligibility for inclusion in the antibiotic trial was identified, the second point at the start of antibiotic treatment, the third point at the end of antibiotic treatment, and the fourth point at the follow-up (mean 10.8 months) after antibiotic treatment.The thick black line from end of antibiotic treatment to long-term follow-up represents many patients with the value 0.

The clinical importance of this improvement in function is reinforced by the observation that, prior to commencement of antibiotic treatment, the RMQ scores of people in this cohort were worsening over time. Modic changes were first observed in participants when they were reviewed at the 14 month follow-up of the previous RCT. At this time the patients had a mean RMQ of 5.3. Patients then waited for varying time periods for the commencement of the current antibiotic study. The mean waiting period was 9 months and during this period the average functional level measured on this scale worsened from a mean of 5.3 to 8.9. However, the mean functional level at the end of the antibiotic treatment and at long-term follow-up showed both clinically important and statistically significant improvement (fig 1).

The serum analysis revealed that only a few patients exceeded the reference values, indicating that no aggressive infection was present. There were only modest changes from baseline to the end of treatment. Unfortunately, during the study period the laboratory changed the methods of analysis for lactate dehydrogenase and also alkaline phosphatase; therefore values of the first method are presented for the respective number of patients, likewise with the second method (table 4).

DISCUSSION

Modic changes (bone oedema) observed on MRI are associated with LBP,[1 2 17 18] but the pathogenesis of Modic changes remains unclear. Both mechanical stress and infection secondary to disc herniation have been hypothesised as pathological pathways.[6] In this pilot study of the infection hypothesis, antibiotic treatment appeared to be effective in patients with LBP and Modic changes Type 1. We included patients whose only known illness was a previous disc herniation with present Modic changes and LBP. Patients' health status improved on all outcome measures: global perceived health, disease-specific and patient-specific disability, pain in the lumbar area and number of days with pain.

It is often reported that LBP fluctuates, and, by nature, patients normally seek medical assistance when the pain is at its worst. Therefore, the positive results observed in many cohort studies may be due to spontaneous recovery and/or regression towards the mean. In order to minimise this, we only recruited patients at a prescheduled follow-up examination 14 months after experiencing a herniated lumbar disc. No patients were recruited when seeking medical assistance for an acute

Table 4 The serum analyses at baseline and end of treatment

	Reference values	Mean baseline value	No. of patients exceeding reference values (total n = 29)	Mean values at end of treatment	No. of patients exceeding reference values (total n = 29)
Haemoglobin	8.0–11.0 mmol/l	9.4	0	9.1	2
Leucocytes	3.0–10.0 × 10^9/l	6.7	1	7.1	3
Neutrophils	1.5–7.5 × 10^9/l	4.1	0	4.2	1
Eosinophils	0.04–0.5 × 10^9/l	0.2	0	0.22	1
Basophils	<0.2 × 10^9/l	0.03	0	0.03	1
Lymphocytes	1.0–3.5 × 10^9/l	2.0	0	2.22	2
Monocytes	0.2–0.8 × 10^9/l	0.6	3	0.59	1
P/S Creatininium	62–134 µmol/l	90	0	87	0
Lactate dehydrogenase, original 'method (n = 13)	150–500 U/l	372	0	393	0
Lactate dehydrogenase, new method (n = 16)	105–205 U/l	214	7	227	8
Alkaline phosphatase, original method (n = 13)	80–275 U/l	194	0	–	0
Alkaline phosphatase, new method (n = 16)	35–105 U/l	82	3	73	2
C-reactive protein	<10 mg/l		5		3

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

exacerbation of their condition, and all patients were observed for a further mean of 9 months before the antibiotic treatment was initiated. During this period only one patient experienced a spontaneous recovery. Furthermore, the observation that, on average, patients experienced a worsening of their condition during the 9 months observation period but demonstrated improvement after antibiotic treatment would suggest spontaneous recovery was highly unlikely.

The improvement could be a result of the natural cause of Modic changes. Unfortunately the knowledge about this is scarce. A few longitudinal studies [2 4 17 19] describe over a period of 14–72 months that 48% to 86% of the Modic changes remain stable and 14% to 52% convert into another type of Modic change. This very slow natural cause makes it is less likely that the changes in this study are attributed to the natural cause.

The positive results of the antibiotic treatment support the hypothesis that some Modic changes may result from a low-virulent bacterial infection.[6] Modic identified five patients in 1984 with suspected infection in the disc and in the vertebral end plates.[8] They were treated with antibiotics for 4 weeks and rescanned. A change in the signal in the central area within the disc was observed suggesting healing and degeneration. Stirling *et al*[10] cultured nuclear tissue removed under sterile conditions during surgery for lumbar herniated discs. Of these, 53% were infected with low-virulent anaerobic organisms (*Propionibacterium acnes* and *Corynebacterium propinquum*) in contrast to none of those patients who underwent surgery for other spinal disorders. These bacteria are found in all individuals on their skin and in their oral cavities. They frequently invade the circulatory system (for example during tooth brushing), where they do not present any health risks due to the aerobic environment in the bloodstream.[20–23] They can, however, impose a health risk in patients with a special environment, for example, in individuals with a prosthetic device.

In a herniated disc, nuclear material may migrate into the spinal canal. Within a short time, new capillarisation takes place in and around the extruded nuclear material[24–27] and inflammation occurs with an increased presence of macrophages.[26–28] In this particular environment we hypothesise that anaerobic bacteria may enter the disc, resulting in a low-virulent and slowly developing infection. As intervertebral discs are avascular, they are an ideal environment for the growth of anaerobic bacteria and local inflammation in adjacent bone may result due to production of cytokines. Due to the low virulence of these bacteria, tissue reactions are slow and therefore poorly illuminated on MRI. Also, the infection will not spread to aerobic tissues, which may explain why Modic changes are usually observed in close proximity to the site of a disc herniation. Adding credibility to this pathoanatomical model is the observation that patients with a normal disc contour do not develop Modic changes and that larger disc lesions result in more frequent Modic changes.[2]

Many antibiotics, especially tetracycline derivates, have an anti-inflammatory effect, via TNFα inhibition, and are therefore able to reduce pain. The positive effect observed in the current trial could be attributed to the anti-inflammatory effect rather than to an antibiotic effect. However, *Amoxicillin-clavulanate* (Spektramox) was chosen in part due to its extremely low anti-inflammatory effect[29 30] and therefore we believe that the antibiotic effect is more likely to be responsible for the positive outcomes observed in this study.

We acknowledge that bacteria may not be the only cause of Modic changes, and that Modic changes may be the end stage of a number of pathological pathways. For example, in some cases there may be a biomechanical aspect, where a degenerated disc with diminished resistance to shear forces may result in Modic changes. However, the results of the current study tentatively suggest that antibiotic treatment could benefit some patients suffering from LBP and Modic changes. Clearly, this study is an observation of a highly selected patient group, and these results need to be tested in randomised controlled trials using antibiotics and placebo treatment. Further insight could be gained from biopsy studies of discs to identify any bacteria associated with Modic changes and provide greater precision in determining ideal antibiotic treatment.

Peer review: fair review articles

The rationale for "peer review: fair review" articles is to ensure that research is not buried simply because it is too challenging and too controversial. There are many examples of papers that were not accepted the first time they were submitted, but were accepted elsewhere and have made a great difference to clinical practice (Khan KM, Stovitz SD, Pluim B, *et al*. Addressing conflicts of interest and clouding of objectivity: *BJSM*'s "Peer review: fair review" section. *Br J Sports Med* 2008;**42**:79). *BJSM* is committed to encouraging debate and providing a "safe place" for ideas that are supported by evidence, but considered "too radical" elsewhere.

Competing interests: None.

REFERENCES

1. **Kjaer P,** Leboeuf-Yde C, Korsholm L, *et al*. Magnetic resonance imaging and low-back pain in adults. A diagnostic imaging study of 40 year-old men and women. *Spine* 2005;**30**:1173–80.
2. **Albert HB,** Manniche C. Modic changes following lumbar disc herniation. *Eur Spine J* 2007;**16**:977–82.
3. **Modic MT,** Masaryk TJ, Ross JS, *et al*. Imaging of degenerative disk disease. *Radiology* 1988;**168**:177–86.
4. **Modic MT,** Steinberg PM, Ross JS, *et al*. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. *Radiology* 1988;**166**:193–9.
5. **Jensen TS,** Karppinen J, Sorensen JS, *et al*. Prevalence of vertebral endplate signal (Modic) changes and their association with non-specific low-back pain - A systematic literature review. *Eur Spine J*. Published Online First: 12 September 2008. doi: 10.1007/s00586-008-0770-2.
6. **Albert HB,** Kjaer P, Jensen TS, *et al*. Modic changes, possible causes and relation to low-back pain. *Med Hypotheses* 2008;**70**:361–8.
7. **Van Goethem JWM,** Parizel PM, van den Hauwe L, *et al*. The value of MRI in the diagnosis of postoperative spondylodiscitis. *Neuroradiology* 2000;**42**:580–5.
8. **Modic MT,** Pavlicek W, Weinstein MA, *et al*. Magnetic resonance imaging of intervertebral disk disease. Clinical and pulse sequence considerations. *Radiology* 1984;**152**:103–11.
9. **Carragee EJ.** Pyogenic vertebral osteomyelitis. *J Bone Joint Surg Am* 1997;**79**:874–80.
10. **Stirling A,** Worthington T, Rafiq M, *et al*. Association between sciatica and Propionibacterium acnes. *Lancet* 2001;**357**:2024–5.
11. **Stirling AJ,** Jiggins M. *Association between Sciatica and Skin Commensals*. Cleveland, USA: International Society for the Study of the Lumbar Spine, 2002.
12. **Albert HB.** *Conservative treatment of patients with sciatica- a randomized controlled trial* [dissertation]. Odense: Faculty of Health Sciences, University of Southern Denmark, 2004.
13. **Albert HB,** Jensen AM, Dahl D, *et al*. [Criteria validation of the Roland Morris questionnaire. A Danish translation of the international scale for the assessment of functional level in patients with low-back pain and sciatica]. *Ugeskr Laeger* 2003;**165**:1875–80. (In Danish.)
14. **Manniche C,** Asmussen K, Lauritsen B, *et al*. low-back pain Rating Scale: validation of a tool for assessment of low-back pain. *Pain* 1994;**57**:317–26.
15. **Fardon DF,** Milette PC. Nomenclature and classification of lumbar disc pathology. *Spine* 2001;**26**:E93–E113.
16. **Ostelo RW,** Deyo RA, Stratford P, *et al*. Interpreting change scores for pain and functional status in low-back pain towards international consensus regarding minimal important change. *Spine* 2008;**33**:90–4.

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

17. **Mitra D,** Cassar-Pullicino VN, McCall IW, *et al*. Longitudinal study of vertebral type-1 end-plate changes on MR of the lumbar spine. *Eur Radiol* 2004;**14**:1574–81.
18. **Toyone T,** Takahashi K, Kitahara H, *et al*. Vertebral bone-marrow changes in degenerative lumbar disc disease. An MRI study of 74 patients with low-back pain. *J Bone Joint Surg Br* 1994;**76**:757–64.
19. **Kuisma M,** Karppinen J, Niinimäki J, *et al*. A three-year follow-up of lumbar spine endplate (Modic) changes. *Spine* 2006;**31**:1714–18.
20. **Bhanji S,** Williams B, Sheller B, *et al*. Transient bacteremia induced by tooth brushing a comparison of the Sonicare toothbrush with a conventional toothbrush. *Pediatr Dent* 2002;**24**:295–9.
21. **Farrar MD,** Ingham E. Acne: Inflammation. *Clinics in Dermatology* 2004;**22**:380–4.
22. **Fiehn NE,** Gutschik E, Larsen T, *et al*. Identity of streptococcal blood isolates and oral isolates from two patients with infective endocarditis. *J Clin Microbiol* 1995;**33**:1399–401.
23. **Roberts GJ,** Holzel HS, Sury MR, *et al*. Dental bacteremia in children. *Pediatr Cardiol* 1997;**18**:24–7.
24. **Doita M,** Kanatani T, Harada T, *et al*. Immunohistologic study of the ruptured intervertebral disc of the lumbar spine. *Spine* 1996;**21**:235–41.
25. **Hirabayashi S,** Kumano K, Tsuiki T, *et al*. A dorsally displaced free fragment of lumbar disc herniation and its interesting histologic findings. A case report. *Spine* 1990;**15**:1231–3.
26. **Ito T,** Yamada M, Ikuta F, *et al*. Histologic evidence of absorption of sequestration-type herniated disc. *Spine* 1996;**21**:230–4.
27. **Lindblom K,** Hultquist G. Absorption of protruded disc tissue. *J Bone Joint Surg* 1950;**32-A**:557–60.
28. **Gronblad M,** Virri J, Tolonen J, *et al*. A controlled immunohistochemical study of inflammatory cells in disc herniation tissue. *Spine* 1994;**19**:2744–51.
29. **Hahm KB,** Lee KJ, Kim YS, *et al*. Quantitative and qualitative usefulness of reamipide in eradication regimen of Helicobacter pylori. *Dig Dis Sci* 1998;**43**:192S–197S.
30. **Tamaoki J,** Kondo M, Kohri K, *et al*. Macrolide antibiotics protect against immune complex-induced lung injury in rats: Role of nitric oxide from alveolar macrophages. *J Immunol* 1999;**163**:2909–15.

Access the latest content chosen by our Editors

BMJ Journals editors select an article from each issue to be made free online immediately on publication. Other material is free after 12 months to non-subscribers. Access the Editor's Choice from the home page—or expand your horizons and see what the other BMJ Journals editors have chosen by following the links on any BMJ Journal home page.

Downloaded from bjsm.bmj.com on May 12, 2013 - Published by group.bmj.com

Antibiotic treatment in patients with low-back pain associated with Modic changes Type 1 (bone oedema): a pilot study

H B Albert, C Manniche, J S Sorensen, et al.

Br J Sports Med 2008 42: 969-973 originally published online August 21, 2008
doi: 10.1136/bjsm.2008.050369

Updated information and services can be found at:
http://bjsm.bmj.com/content/42/12/969.full.html

These include:

References This article cites 27 articles, 5 of which can be accessed free at:
http://bjsm.bmj.com/content/42/12/969.full.html#ref-list-1

Article cited in:
http://bjsm.bmj.com/content/42/12/969.full.html#related-urls

Email alerting service Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections Articles on similar topics can be found in the following collections

Musculoskeletal syndromes (315 articles)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/