Easy probability estimation of the diagnosis of early axial spondyloarthritis by summing up scores

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Abstract

Objectives. Several sets of criteria for the diagnosis of axial SpA (including non-radiographic axial spondyloarthritis) have been proposed in the literature in which scores were attributed to relevant findings and the diagnosis requests a minimal sum of these scores. To quantitatively estimate the probability of axial SpA, multiplying the likelihood ratios of all relevant findings was proposed by Rudwaleit et al. in 2004. The objective of our proposal is to combine the advantages of both, i.e. to estimate the probability by summing up scores instead of multiplying likelihood ratios.

Methods. An easy way to estimate the probability of axial spondyloarthritis is to use the logarithms of the likelihood ratios as scores attributed to relevant findings and to use the sum of these scores for the probability estimation.

Results. A list of whole-numbered scores for relevant findings is presented, and also threshold sum values necessary for a definite and for a probable diagnosis of axial SpA as well as a threshold below which the diagnosis of axial spondyloarthritis can be excluded. In a diagram, the probability of axial spondyloarthritis is given for sum values between these thresholds.

Conclusion. By the method proposed, the advantages of both, the easy summing up of scores and the quantitative calculation of the diagnosis probability, are combined. Our method also makes it easier to estimate which additional tests are necessary to come to a definite diagnosis.

Key words: axial spondyloarthritis, diagnosis, probability estimation.

Introduction

As a means of making the diagnosis of early axial SpA including non-radiographic axial SpA, (i.e. axial SpA without radiographic sacroiliitis), several sets of criteria were proposed in the literature in which scores from ½ to 1½ [1–5] or from 1 to 3 [6–8] have been attributed to the relevant findings. According to these criteria, the diagnosis of SpA can be made if the sum of relevant scores exceeds a certain threshold requested for this diagnosis.

The advantage of these proposals is their simplicity. However, they do not allow quantitative estimation of the probability of the disease. They allow only a qualitative yes or no answer to the question of whether the diagnosis is probable or not.

A method for quantitative estimation of the probability of axial SpA in a patient with chronic back pain, age at onset <45 years and no definite X-ray changes in the sacroiliac joints was proposed in 2004 by Rudwaleit et al. [9, 10]. They made use of the likelihood ratios (LRs) of test results relevant for the diagnosis. A LR is the likelihood of a given test result in a person with a disease compared with the likelihood of this result in a person without the disease [11]. The LRs LR⁺ = sensitivity/(1 – specificity) for any positive finding (derived from the sensitivity and specificity of the tests) and LR⁻ = (1 – sensitivity)/specificity for any negative finding are multiplied, and the post-test probability Ppost is calculated from the pre-test probability Ppre and the LR product ΠLR according to the following equation:

\[ P_{post} = \frac{\Pi_{LR} \times P_{pre}}{1 + (\Pi_{LR} - 1) \times P_{pre}} \] (1)

The objective of our proposal is to combine the advantages of both, i.e. to estimate the probability by summing up scores attributed to the clinical, laboratory and imaging features instead of multiplying their LRs.
Methods

Our proposal makes use of the fact that multiplying a number of factors is equivalent to adding their logarithms (the reason why logarithm tables were widely in use in engineering before the advent of mechanical and electronic calculators). Accordingly, Eq. (1) can also be written in the form

$$P_{post} = \frac{e^{\sum \ln LR} \times P_{pre}}{1 + e^{\sum \ln LR - 1} \times P_{pre}} \quad (2)$$

with $\sum \ln LR$ being the sum of the natural logarithms of the LR values.

In order to get whole-numbered scores without losing too much accuracy, we call $10 \ln LR$ the score of a finding. We make use of the LRs derived by Rudwaleit et al. [9, 10] from sensitivity and specificity values found in the literature for diagnosing axial SpA. Relevant SpA features include clinical features (inflammatory back pain, enthesitis, arthritides, dactylitis, acute anterior uveitis, psoriasis, IBD, positive family history and good response to NSAIDs), associated laboratory findings (acute phase reactants, HLA-B27) and sacroiliitis shown by MRI.

Results

The scores of relevant findings derived from the LR values given in Rudwaleit et al. [9, 10] are listed in Table 1. Since the validity of incorporating negative LRs has never been validated, we recommend to ignore negative test results in an early state of possible axial SpA and therefore have included in Table 1 only positive LRs. This is also reasonable because some of the SpA features may not be present at disease onset but may develop later, and their absence in early disease does not mean anything. How the post-test probability of axial SpA depends on the sum of the scores if the pre-test probability is 5% (chronic back pain, i.e. back pain of >3 months duration with age at onset <45 years) is shown in Fig. 1.

As in Rudwaleit et al. [9, 10], we regard a diagnosis of axial SpA as definitive if the probability is at least 90%. This is the case if the sum of the scores is >51. Correspondingly, a diagnosis of probable axial SpA can be made if the sum of the scores is larger than 43 (probability >80%). If the sum of scores is <13 (probability <15%), axial SpA is improbable. For score sums between 13 and 43, additional tests are necessary to come to a decision.

Discussion

Deriving the probability of axial SpA from the score sum by means of Fig. 1 is identical with deriving the probability of axial SpA from the product of LR values as proposed by Rudwaleit et al. [10].

For sacroiliitis on MRI, a positive LR of 9.0 was established in 2004 [9, 10] which was the best estimate at that time. According to recent studies [14, 15], the positive LR may be essentially higher, up to 44.6 with MRI readers specially trained for this purpose. A positive LR of 44.6

| TABLE 1 Relevance of several findings for the diagnosis of axial spondyloarthritis |
|---------------------------------|-----------------|-----------------|
|                                  | LR+ according to [9, 10] | Score if test result is positive |
| Inflammatory type of back pain   | 3.1              | 11              |
| Heel pain (enthesitis)           | 3.4              | 12              |
| Peripheral arthritis             | 4.0              | 14              |
| Dactylitis                       | 4.5              | 15              |
| Iritis or anterior uveitis       | 7.3              | 20              |
| Psoriasis                        | 2.5              | 9               |
| IBD (Crohn’s disease or ulcerative colitis) | 4.0 | 14 |
| Positive family history of axial SpA, reactive arthritis, psoriasis, IBD or anterior uveitis | 6.4 | 19 |
| Good response to NSAIDs          | 5.1              | 16              |
| Raised acute-phase reactants (CRP/ESR) | 2.5 | 9               |
| HLA-B27                          | 9.0              | 22              |
| Sacroiliitis shown by MRI        | 9.0              | 22              |

LR values were taken from Rudwaleit et al. [9, 10]. The scores were calculated from the LR values as $10 \ln(\text{LR})$. Definite axial SpA if sum of scores >51 (probability >90%). Probable axial SpA if score sum >43 (probability >80%). Axial SpA improbable if score sum <13 (probability <15%).

Fig. 1 Dependence of the probability of axial SpA on the sum of scores according to Table 1 for a pre-test probability of 5% (chronic back pain, i.e. back pain of >3 months duration with age at onset <45 years).
would correspond to a score of 38. However, in the very same publication [14], a LR+ of 9.8 derived if a global assessment of sacroiliitis on MRI was considered according to agreement of any two of five readers, a figure that is not very different from the LR of 9.0 proposed in 2004 [10]. Thus, until definite data become available, we stick to the conservative positive LR of 9.0 for sacroiliitis on MRI.

Conclusion

Here we make a proposal on how to simplify the probability calculations of the presence of early axial SpA, in particular non-radiographic axial SpA. Whereas the Assessment of Spondyloarthritis International Society (ASAS) criteria for axial SpA are meant for the classification of groups of patients for studies, the disease probability calculations are meant for diagnosing individual patients.

Summing up the scores given in Table 1 makes it easier to estimate the probability of the diagnosis axial SpA. Summing up whole-numbered scores is more comfortable and does not require a pocket calculator. Our method also makes it easier to estimate which additional tests are necessary to come to a definite diagnosis.

**Rheumatology key message**

- The diagnosis probability of axial SpA can easily be estimated by summing scores.

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**References**