Multiple Puncture Tuberculin Reactions

A RUBBER MODEL TO FACILITATE UNIFORM INTERPRETATION*

T. F. B. COLLINS, M.B. B.CH., D.P.H. UNIV. RAND, *Department of Health, Pretoria*

SUMMARY

The multiple puncture tuberculin test plays a vital role in the tuberculosis control programme of the Republic of South Africa, where emphasis is placed on BCG vaccination for the uninfected, and chemotherapy for the infected. Confluent reactions (Heaf grades II, III and IV) are regarded as evidence of specific infection, while papular reactions (Heaf grade I) are usually cross-reactions resulting from some other mycobacterial infection.

A silicone rubber model of the classical Heaf grades, which facilitates uniformity and ease of interpretation of multiple puncture reactions, is described.

S. Afr. Med. J., **47**, 53 (1973).

The tuberculin test has been described as the most important single factor in the control of tuberculosis;[1] the best index of the amount of tuberculosis in a community;[2] the most important test employed in human and veterinary medicine;[3] and an essential tool in the ultimate eradication of tuberculosis.[4] In countries with a serious tuberculosis problem, prevention with BCG vaccine, and isoniazid chemotherapy for healthy infected subjects, are of great importance; and it is necessary to use a test which can be readily and properly performed and interpreted by persons without special qualifications or training.

These conditions are fulfilled by the multiple puncture (Heaf) test, which is used throughout the Republic of South Africa in routine tuberculosis control programmes. It has been found possible to train non-medical personnel to test large groups of subjects quickly, and to recognize significant grades of reaction readily. There is reason to believe from evidence previously published,[1,5] that when a group of healthy young subjects is tuberculin-tested by the multiple puncture method, the majority of those who have been infected with the tubercle bacillus can be identified for purposes of supervised protective therapy, while the balance of the reactors, together with the non-reactors, will mostly benefit from BCG vaccination.

This is a necessary simplification for practical purposes of a complex phenomenon, and it is not claimed that accurate differentiation between infected and non-infected individuals is achieved in every case, or that the method is a satisfactory substitute for the Mantoux test in controlled research studies. Nevertheless, there is a correlation between the two methods. A recent survey carried out in the Transkei by the State Department of Health, the Tuberculosis Research Council and the South African National Tuberculosis Association, in which simultaneous Mantoux and Heaf tests were performed on the same subjects, demonstrated a close correlation between the results of the two tests when the multiple puncture reactions were read according to a scale of points which allows for 9 degrees of reaction (Table I).

*Date received: 17 July 1972.

TABLE I. MULTIPLE PUNCTURE REACTIONS

Heaf grades	Points	Definition
0	0	No palpable reaction
	1	Minute papules at each puncture site, barely palpable, 1 mm or less in diameter, and not to be confused with the scars resulting from trauma
I	2	Discrete papules at the site of each puncture, each about 2 mm in diameter, and not confluent
	3	Papules are larger, tend to coalesce, but do not form a uniform ring of induration
II	4	Individual papules are no longer discernible, but have coalesced to form a continuous ring of induration, leaving the central area unaffected
	5	Papules have coalesced, and in addition the central area is involved, but not to the same extent as the outer ring. It can be distinguished from 6 points by palpating a slight depression in the centre of the reaction
III	6	A smooth swelling, generally dome-shaped and about 15 mm in diameter, with no necrosis
	7	As for 6 points, but with small areas of necrosis limited to the sites of puncture, or, if tending to be confluent, leaving the central area unaffected
IV	8	As for 6 points, but with central necrosis or vesiculation about 6 mm in diameter
	9	More extensive ulceration or vesiculation

Since the danger of developing tuberculous disease is greatest in the period immediately following infection, and there is evidence that infection in children of races most affected by tuberculosis in South Africa occurs to a large extent during the school-going period, it seems likely that a programme of protective chemotherapy aimed at this group will have maximal effect. Moreover, it lends itself to close supervision, provided the interest and enthusiasm of teachers is gained.

THE TUBERCULOSIS CONTROL PROGRAMME IN SOUTH AFRICA

The present policy, which provides for ambulatory treatment for suitable patients (regardless of state of disease), and earlier discharge for those admitted to hospital, emphasizes preventive and protective measures.[6]

BCG vaccine is offered to as many newborn babies and eligible pre-school children as can be reached, and is also given to non-infected scholars during school programmes, which involve the initial tuberculin testing of all pupils in a school and the annual testing of newcomers thereafter. Subjects with significant tuberculin reactions receive 200 or 300 mg of isoniazid administered by teachers once daily on school days only, for a year. Only those pupils reported by the teaching staff to be sick, off-colour or frequently absent, are investigated further (irrespective of tuberculin reaction), since it has been found that radiological abnormalities are relatively infrequent when screening of all significant reactors has been undertaken. The vast majority of such lesions are simple glandular enlargements or uncomplicated primary complexes, for which monotherapy with isoniazid has been shown to be adequate.[7] In the poorer areas, the school tuberculosis programme is coupled with assisted self-help feeding schemes, because there is convincing evidence that undernutrition is an important factor in the epidemiology of the disease.[8,9]

Reports from a region where this programme has been under way for some years, indicate that there has been a noticeable improvement in general health and scholastic achievement.[10] On retesting of infected scholars following the period of chemotherapy, considerable numbers had reverted to a non-reactor state. In such cases, BCG vaccine is administered.

MODEL OF CLASSICAL REACTIONS

The Chest Clinic of the Hexham General Hospital introduced an illustrated postcard intended for the use of mothers of children who had been Heaf-tested.[11] It carries a series of coloured illustrations of multiple puncture reactions, and an instruction to the parent to 'tick which picture is most like your reaction after 3 days, then drop this card in a letterbox'.

In South Africa sets of coloured photographs of the 4 Heaf grades of reaction have been used to assist field personnel, but because the tactile sense is also important in interpretation, a soft rubber model of the classical reactions has been prepared (Fig. 1).

This enables the reader to decide by comparison which of the classical reactions is the nearest to the reaction in the subject tested. Weybridge PPD, 2 mg/ml, has been adopted as the standard antigen, and is supplied free of charge to personnel engaged in tuberculin testing.

The original models of the classical reactions were made in plasticine, each of the 4 grades represented being the average size and shape of many hundreds of actual reactions in each category. From these models moulds were cast in plaster of Paris.

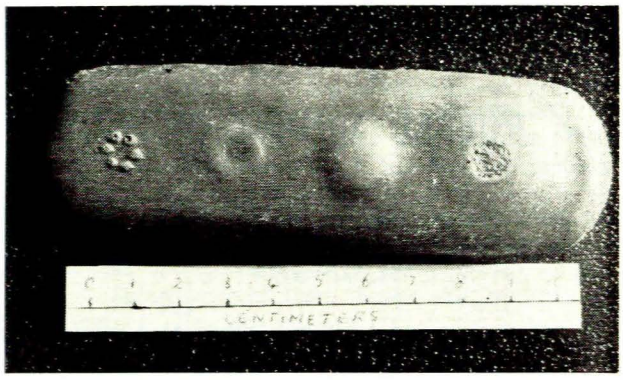

Fig. 1. Silicone rubber model depicting the classical Heaf grades.

A number of plastic materials were tried for the soft models made from the moulds, since it was desirable that they should look and feel like human skin. Eventually, a silicone rubber, room-temperature vulcanizing compound, mould-making Material B, manufactured by Wacker-Chemie GmbH of Germany, and supplied by Hoechst South Africa (Pty) Ltd, was chosen as being most suitable. It is used in conjunction with a catalyst (Catalyst T), which enables the pot life and vulcanizing time to be varied within wide limits, depending on the amount used. Inert pigments can also be added to give the required colouring. The final product is flexible, unbreakable, and feels similar to skin.

DISCUSSION

These rubber models have proved to be of great assistance to nurses and others in the reading and interpretation of multiple puncture tuberculin reactions.

Palmer and Long[12] in 1966 suggested that the terms 'positive' and 'negative' should not be used to describe tuberculin reactions unless qualified, since minor degrees of reaction to mammalian PPD in healthy subjects are almost invariably cross-reactions arising from infection with mycobacteria, other than the human or bovine tubercle bacilli. 'Significant' and 'insignificant,' or 'specific' and 'non-specific,' were proposed as terms to describe reactions which are indicative of infection with *Mycobacterium tuberculosis hominis* or *bovis,* and other mycobacteria, respectively.[1] However, in order to simplify the interpretation of reactions by field personnel, multiple puncture tuberculin reactions were later classified as 'papular' (Heaf grade I) or 'confluent' (Heaf grades II, III and IV) in South Africa, where surveys using the scale of points described in Table I enabled histograms to be constructed, in which the bimodal distribution differentiates between the confluent reactions of infection and papular cross-reactions due to non-specific infection.[5]

Studies in which differential tuberculin testing using simultaneous multiple puncture tests with avian and mammalian PPD showed a close correlation between mammalian reactions of Heaf grade II and above, and

those in which the mammalian PPD produced a stronger reaction than avian PPD, suggest that only confluent reactions are significant of specific infection.[1] This experience was recently confirmed by Galbraith *et al.*[13] who, in an avian and mammalian PPD study of 289 child Heaf reactors at initial testing, found that only 12% of the grade I reactors were likely to have had a previous infection with *M. tuberculosis* (including 4% in whom avian and mammalian reactions were equal to ± 1 mm). In 56 children with grade II reactions, the proportion likely to have been specifically infected was 38%, and of 20 grade III and IV reactors, all were likely to have been specifically infected. These authors agree that negative and grade I reactions should be regarded as not significant, and grades II, and III and IV, as significant.

Ross and Willison[14] found that strongly positive tuberculin reactors at school have a greater chance of developing notifiable tuberculous disease than do those with weak reactions, a notable feature of their study being that among Heaf grade I reactors the frequency of tuberculous notifications was extremely low; and *Tubercle*, in a leading article on the Heaf test,[15] stated that there seems little doubt that in Great Britain most grade I Heaf reactions in young people do not indicate tuberculous infection.

Confusion has existed about the definition of the 4 grades of reaction defined by Heaf,[16] and this was probably aggravated to a certain extent by incorrect coloured illustrations enclosed with earlier models of the multiple puncture apparatus. In particular, difficulty has been experienced with reactions around grade II (3, 4 and 5 points), and this has probably led to large numbers of children receiving protective chemotherapy unnecessarily.

It was in an attempt to eliminate this difficulty that the rubber model was introduced. The classical examples of the 4 grades of the model are not always seen in practice, but it is relatively easy to select which of the 4 most closely corresponds to the reaction in the subject tested, and label it accordingly. In this way, is is believed that the model will set a national standard for interpretation of multiple puncture tuberculin reactions, in addition to assisting invidual field workers in reading the tests.

This article is published with the permission of the Secretary for Health.

We should like to thank Dr W. Wright, Director of Planning, South African National Tuberculosis Association; Dr J. Collis, Senior Lecturer, and Mr A. E. Freeme, of the Prosthetics Department, School of Dentistry, University of the Witwatersrand; and Mr M. J. Hancock, of Orthopaedic Suppliers (Pty) Ltd, Johannesburg, for their co-operation and assistance in the search for a suitable material for the models.

Messrs Glaxo-Allenburys (SA) (Pty) Ltd, kindly donated material for the first 100 models.

REFERENCES

1. Collins, T. F. B. (1968): S. Afr. Med. J., **42**, 1285.
2. Leading Article (1967): Lancet, **2**, 599.
3. Pepys, J. (1962): *Nursing Mirror*, 29 June 1962, p. 243.
4. Hsu, K. H. K., Carreon, A. T., Jeu, F. and Jenkins, D. E. (1964): Dis. Chest, **46**, 648.
5. Collins, T. F. B. (1970): S. Afr. Med. J., **44**, 1287.
6. *Idem* (1972): *Ibid.*, **46**, 260.
7. Nestadt, A. and Harrison, I. (1964): Lancet, **1**, 1068.
8. Smythe, P. M., Schonland, M., Brereton-Stiles, G. G., Coovadia, H. M., Grace, H. J., Loening, W. E. K., Mafoyane, A., Parent, M. A. and Vos, G. H. (1971): *Ibid.*, **2**, 939.
9. Geefhuysen, J., Rosen, E. U., Katz, J., Ipp, T. and Metz, J. (1971): Brit. Med. J., **4**, 527.
10. Pirrie, G. S. (1971): Personal communication.
11. Wollaston, F. L. (1971): Personal communication.
12. Palmer, C. E. and Long, M. W. (1966): Amer. Rev. Resp. Dis., **94**, 553.
13. Galbraith, N. S., Hanson, A., Shoulman, R., Andrews, D. W. and Lee, D. B. (1972): Brit. Med. J., **1**, 647.
14. Ross, J. D. and Willison, J. C. (1971): Tubercle (Edinb.), **52**, 258.
15. Leading Article (1970): *Ibid.*, **51**, 207.
16. Heaf, F. (1951): Lancet, **2**, 151.