

AN ASSESSMENT OF VAGOTOMY BY MEANS OF THE INSULIN TEST USING DIFFERENT CRITERIA OF A POSITIVE RESPONSE*

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The clinical use of the insulin test after vagotomy was first described by Hollander in 1946.¹ Two years later he clearly defined that a positive response is indicated by a well-defined rise in the free acidity curve following injection of insulin, i.e. two or more successive points on the curve must be distinctly above the baseline established by the resting specimens, and at least one of these points should be elevated by 20 mEq. or more above the control values.² The test was designed to determine whether any functionally effective secretory nerves continue to pass to the stomach following vagotomy. He denied that the test will determine whether or not the ulcer will recur at some future date. Since then more seems to have been read into the test than was originally intended by Hollander himself.

In 1964 Ross and Kay³ stated that a positive insulin response did not necessarily reflect a clinically inadequate vagotomy. From an analysis of their data obtained from insulin tests performed on 100 patients after vagotomy, they noted that the timing of the positive insulin responses varied in different patients. They also showed that when the insulin test was performed on patients with intact vagi, the positive response occurred within 45 minutes of insulin administration. They therefore separated their postvagotomy patients into two groups: the first group consisted of patients in whom a positive response occurred in the first 45 minutes (early positive) after the injection of insulin; the second group consisted of those patients in whom the response occurred between 45 and 120 minutes (late positive) after injection of insulin. They suggested that those patients showing late positive response had had an adequate vagotomy.

Johnson *et al.*⁴ used one hour as the critical time in the subdivision of positive secretory responses into early and late groups because of the much higher incidence of recurrent ulceration in the patients whose tests were positive up to one hour. Sixty-eight percent of the patients showing a positive response in the first hour developed recurrent ulceration, while the incidence of recurrent ulceration in patients showing a positive response after the first hour was 24%.

This paper reviews the results of routine insulin tests done on an unselected series of 46 White patients who had truncal vagotomies and drainage procedures performed for duodenal ulceration in the professorial surgical unit of Johannesburg Hospital. The tests were done on about the 10th postoperative day. Tests performed in the investigation of patients suffering from postoperative symptoms are not included in the above groups of patients.

TECHNIQUE OF TEST

The patient is starved overnight. At 8 a.m. a nasogastric tube, with a radio-opaque tip, is passed under radiological control into the dependent part of the stomach. The

stomach is completely emptied by aspiration and the aspirate is discarded. The basal secretion is then aspirated over 15 minutes and the volume and acidity determined. The latter is determined by titrating the aspirate with N/10 sodium hydroxide, using Topfer's reagent and phenolphthaleine as indicators of free and total acid respectively. The fasting blood-sugar level is estimated during this time. Twenty units of soluble insulin are given intravenously. For the next 90 minutes the stomach is aspirated every 15 minutes and the samples are tested for volume and the concentration of free and total acid as described above. The blood-sugar level is estimated at 15-minute intervals. Only if the blood-sugar level falls below 50 mg./100 ml. can one be sure that there is an adequate vagal stimulus.

This test is a modification of the test as described by Hollander who continued aspirating the stomach for 2 hours after the injection of insulin.

RESULTS

Of the 46 patients tested, 33 had a negative test indicating a complete vagotomy (Table I). Twenty-one of these patients have been followed-up and none has developed a recurrent ulcer.

TABLE I. INCIDENCE OF INCOMPLETE VAGOTOMY AND RECURRENT ULCERATION USING A SLIGHT MODIFICATION OF HOLLANDER'S CRITERIA² OF THE INSULIN TEST*

Type response	Number	Recurrent ulcers
Negative response	33 (71.7%)	0
Positive response	13 (28.3%)	3
Total	46	3

*The tests were terminated after 90 minutes and not 120 minutes as described by Hollander.

There were 13 patients who had a positive test indicating an incomplete vagotomy. Three of the latter patients developed recurrent ulceration which was proved at laparotomy. One patient developed a jejunal ulcer 28 months after a vagotomy and gastrojejunostomy. The two other patients developed recurrent duodenal ulcer 22 and 7 months respectively after a vagotomy and pyloroplasty.

Three of the 13 patients showing a positive response to insulin were lost to follow-up. The remaining 7 patients are well over a period of between 1 and 2 years after their operation.

DISCUSSION

The incidence of incomplete vagotomy in this series is 28.3%. Ross and Kay, in their collected data, reported a mean incidence of 31% positive insulin responses.³ More recently Bank *et al.* stated that they had a 28% incidence of positive responses to insulin.⁵

*This article should be read in conjunction with another on the same subject in this issue—Editor.

TABLE II. INCIDENCE OF INCOMPLETE VAGOTOMY USING THE CRITERIA SUGGESTED BY ROSS AND KAY^{2*}

Type response	Number	Recurrent ulcers
Negative	33	0
Positive response within first 45 min.	6	1
Positive response within second 45 min.	7	2

*Patients showing a positive response within the second 45 minutes were regarded as having had an adequate vagotomy by them. In this group showing a late positive response there were 2 recurrent ulcers in the present series.

As can be seen from Table II, two of the patients showing a late positive response to insulin—i.e. after 45 minutes—developed recurrent ulceration. This is contrary to the experience of Ross and Kay who found that none of their patients showing a late positive response to insulin developed recurrent ulceration.

When the first hour was used, as suggested by Johnson *et al.*,⁴ there was still one patient (Table III) who developed a recurrent ulcer despite the fact that he showed a positive response after one hour. This is in keeping with the findings of Johnson *et al.*, who showed that a positive response in the second hour after the injection of insulin is often associated with a substantial residual vagal trunk and with an unacceptably high incidence of recurrent ulceration.

TABLE III. THE INCIDENCE OF INCOMPLETE VAGOTOMY USING THE CRITERIA SUGGESTED BY JOHNSON *et al.*^{4*}

Type response	Number	Recurrent ulcers
Negative	33	0
Positive insulin response in the first hour	9	2
Positive insulin response after the first hour	4	1

*They found that the highest incidence of recurrent ulceration was in the first hour. One patient showing a positive response after the first hour developed a recurrent ulcer.

Bank *et al.*⁵ had one patient who developed a recurrent ulcer although he showed a late positive response with the insulin test. Because of these difficulties they have used 5 parameters of the insulin test. These criteria are: (i) a rise in volume of gastric aspirate after insulin as compared with the basal hour; (ii) a basal secretion greater than 2 mEq. free HCl per hour; (iii) a rise in free acid concentration greater than 20 mEq./litre; (iv) a rise in free acid concentration in the first hour after insulin; and (v) a rise in free or total acid output greater than 1.5 mEq./hour or 2 mEq./hour respectively in any one hour after insulin. They found that the patients who had a positive insulin test and who developed recurrent ulceration had at least 4 of the 5 criteria. When these multiple criteria are applied to 13 patients showing a positive insulin test in the present series, it is found that 8 patients have at least 4 of the criteria required for a positive test. Two of these patients have so far developed recurrent ulceration. One patient who, on the insulin test, showed only 2 of the 5 criteria, developed a major haemorrhage from his duodenal ulcer 7 months later.

The multiple criteria of the insulin test were next ap-

plied to a new group of 9 patients investigated for dyspepsia following a vagotomy and drainage procedure in the past. Four of the patients in this group had a positive response to insulin, using Hollander's criteria. Two of these patients, showing a positive response, were found to have recurrent ulceration at laparotomy. One of these patients had 4, while the other patient had only 3, of the 5 multiple criteria suggested by Bank *et al.*⁵

Two other patients, also showing a positive insulin test, presented with upper gastro-intestinal bleeds but were not operated upon. One of these patients had 4 of the 5 multiple criteria, but both the gastroscopy and barium meal were normal. This patient was asymptomatic 6 months later. The other patient who had 2 of the 5 multiple criteria was thought to have an active duodenal ulcer on barium meal. This patient died of a cerebral thrombosis 2 years later without a recurrence of the gastro-intestinal haemorrhage.

None of the 5 patients with a negative Hollander's test was found to have recurrent ulceration radiologically, nor did they have recurrent ulcers at their subsequent follow-up examinations.

CONCLUSIONS

None of the present criteria of assessing the insulin test is completely valid. Many of the patients who have a positive response to the insulin test, when adopting Hollander's criteria, do not develop recurrent ulceration. The various modifications of Hollander's criteria have proved no more reliable in the present series of patients tested, in that some of the patients showing negative responses according to a modification of Hollander's criteria have subsequently developed recurrent ulceration.

It is felt that the insulin test should not be done as a routine after a vagotomy and drainage procedure. Firstly, it is not without risk as there has recently been a death,⁶ probably as a result of the insulin test. Secondly, when the test is positive it implies only an increased risk of ulceration.

The insulin test has its greatest usefulness in the investigation of dyspepsia after a vagotomy and drainage procedure. At this time a barium meal examination is often difficult to interpret because of the previous gastroenterostomy or pyloroplasty. A negative insulin test is strong evidence against recurrent ulceration; conversely, a positive test is suggestive of recurrent ulceration.

SUMMARY

The results of 46 insulin tests after a vagotomy and drainage procedure for a duodenal ulcer are reviewed. None of the more recent interpretations of the insulin test has been of greater value than Hollander's original criteria in assessing the risk of recurrent ulceration.

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