

ORIGINAL ARTICLE

A comparison of 13 guinea pig and human anti-tissue transglutaminase antibody ELISA kits

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Aims: Tissue transglutaminase (tTG) is a major autoantigen recognised by IgA anti-endomysial antibodies (IgA EMA). Enzyme linked immunosorbent assays (ELISA) for IgA anti-tissue transglutaminase antibodies (IgA tTG) have therefore been developed as an alternative serological screening test to IgA EMA for coeliac disease (CD). The use of human tTG (h-tTG), as opposed to guinea pig liver tTG (gpl-tTG), in these assays has been reported to produce superior results. This study compared 13 commercial IgA tTG ELISA kits to ascertain their performance characteristics in the diagnosis of CD in patients with biopsy confirmed disease compared with controls. All patients and controls were adults aged 21 years or older.

Methods: Sera from the following groups of patients were tested in each kit: (1) 49 patients with CD confirmed on small bowel biopsies (all IgA EMA positive); (2) 34 patients with small bowel biopsies that were not consistent with CD; and (3) 30 patients with biopsy confirmed inflammatory bowel disease. All controls were negative for IgA EMA and were not IgA deficient. Sensitivities and specificities were determined using both the manufacturers' recommended cut off points and receiver operating characteristic (ROC) analysis derived decision thresholds. The area under the curve (AUC) for each ROC plot was also calculated and compared between kits.

Results: In general, the h-tTG based IgA tTG ELISA kits demonstrated superior performance (especially specificity) compared with the gpl-tTG based kits, although 100% sensitivity and specificity (comparable to the IgA EMA assay) was obtained in only one recombinant h-tTG based kit.

Conclusions: The use of h-tTG in IgA tTG ELISA kits is generally, but not universally, associated with superior performance. Factors other than antigen source are important in determining kit performance.

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The identification of autoantibodies strongly associated with coeliac disease (CD; also known as gluten sensitive enteropathy), in particular IgA anti-endomysial antibodies (IgA EMA), has enabled the development of non-invasive serological screening tests for this condition.^{1–3} The IgA EMA indirect immunofluorescence (IIF) assay has, in subjects with untreated CD, a sensitivity of 84–100% and a specificity of 94–100%, which is superior to the IgA anti-reticulin IIF assay and IgA/IgG antigliadin antibody enzyme linked immunosorbent assays (ELISAs).²

"The use of human tissue transglutaminase has been reported to be associated with fewer false negative and false positive results, and an overall performance closely comparable or equal to the "gold standard" IgA anti-endomysial antibody indirect immunofluorescence assay"

Since Dieterich *et al* described tissue transglutaminase (tTG), an 82–85 kDa ubiquitous enzyme, as the major autoantigen target of IgA EMA,⁴ over 30 publications have appeared using this protein as the basis for an alternative assay to the IgA EMA IIF assay.^{5–38} Most studies used guinea pig liver tTG (gpl-tTG) in ELISA based assays,^{5–15 18–38} but purified erythrocyte²³ and recombinant human tTG (h-tTG)^{13–17 24 27 29 35 38} have also been used in ELISA,^{13 23 24 27 29 38} radioimmunoassay,^{14–17 35} and dot blot²⁷ assays. Because of its ease of use, potential for automation, objectivity in interpretation, and reduced training requirements, there is growing interest in using an ELISA based IgA anti-tTG antibody (IgA tTG) assay as an alternative to the IgA EMA IIF assay.

Although many studies have concluded that the IgA tTG assay has comparable performance to the IgA EMA IIF assay, several have described false negative IgA tTG results in subjects with IgA EMA positive untreated CD,^{4 10–16 19–21 25 26 28–30 32 33 34 36 38} and false positive IgA tTG results in the absence of IgA EMA and CD.^{5 6 9 10 12–16 18 19 22–29 32 33 36 38}

However, most of these studies used gpl-tTG, which has only about 81% homology with h-tTG.³⁹ In contrast, the use of h-tTG has been reported to be associated with fewer false negative and false positive results, and an overall performance closely comparable or equal to the "gold standard" IgA EMA IIF assay.^{13–15 23 24 29 35 38 40} However, because none of these studies has compared gpl-tTG based ELISAs with two or more h-tTG-based ELISAs, it is unclear whether the use of h-tTG alone results in superior performance to the gpl-tTG-based assays.

We compared 13 commercial IgA tTG ELISA kits, seven gpl-tTG based and six h-tTG based (four recombinant h-tTG), in 49 IgA EMA positive adult patients with CD and 64 adult disease controls to establish the sensitivity and specificity of each

Abbreviations: ABTS, 2,2'-azino-bis-3-ethylbenzthiazolin-6-sulphonic acid; AU, arbitrary units; AUC, area under curve; BSA, bovine serum albumin; CD, coeliac disease; ELISA, enzyme linked immunosorbent assay; gpl-tTG, guinea pig liver tissue transglutaminase; HRP, horseradish peroxidase; h-tTG, human tissue transglutaminase; IBD, inflammatory bowel disease; IgA EMA, IgA anti-endomysial antibody; IgA tTG, IgA anti-tissue transglutaminase antibody; IIF, indirect immunofluorescence; PNPP, paranitrophenyl phosphate; ROC, receiver operating characteristic; TMB, 3,3',5,5' tetramethylbenzidine; tTG, tissue transglutaminase

Table 1 IgA tTG commercial enzyme linked immunosorbent assay kits: manufacturers' kit details

Manufacturer	Source of tTG	Calcium activated tTG	Serum dilution	Incubation times (serum, conjugate) in minutes	Conjugate	Substrate
AESKUUSA/Aesku, Lab Diagnostica (Wendelsheim, Germany)	Recombinant human	NS	1/100	30, 15	HRP antihuman IgA	TMB
The Binding Site (Birmingham, UK)	Guinea pig liver	Yes	1/100	30, 30	Rabbit HRP antihuman IgA	TMB
	Recombinant human	No	1/100	30, 30	Rabbit HRP antihuman IgA	TMB
Eurospital S.p.A (Trieste, Italy)	Guinea pig liver	NS	1/25	60, 60	Sheep HRP antihuman IgA	TMB
	Recombinant human	NS	1/25	60, 60	Sheep HRP antihuman IgA	TMB
Genesis Diagnostics (Littleport, UK)	Guinea pig liver	Yes	1/100	30, 30	Rabbit HRP antihuman IgA	TMB
Immulisa/Immco Diagnostics Inc (Buffalo, New York, USA)	Guinea pig liver	NS	1/50	60, 30	Alkaline phosphatase antihuman IgA	PNPP
Immunopharmacology Research Diagnostics (Catania, Italy)	Guinea pig liver	NS	1/100	30, 30	HRP antihuman IgA†	TMB
QUANTA Lite/Inova (Diagnostics Inc, San Diego, California, USA)	Guinea pig liver	NS	1/100	30, 30	Goat HRP antihuman IgA	TMB
	Purified human erythrocyte	NS	1/100	30, 30	Goat HRP antihuman IgA	TMB
Medizyme/Medipan Diagnostica GmbH (Selchow, Germany)	Guinea pig liver	NS	1/50	60, 30	Sheep HRP antihuman IgA	TMB
Orgentec Diagnostika GmbH (Mainz, Germany)	Purified human	NS	1/100	30, 15	Rabbit HRP antihuman IgA	TMB
Varelisa/Pharmacia & Upjohn Diagnostica GmbH & Co (Freiburg, Germany)	Recombinant human	NS	1/100	30, 30	HRP antihuman IgA	TMB

†In the manufacturer's kit insert, alkaline phosphatase was mentioned under "Principle", but HRP was mentioned under "Reagent supplied". HRP, horseradish peroxidase; NS, not stated; PNPP, paranitrophenyl phosphate; TMB, 3,3',5,5'-tetramethylbenzidine; tTG, tissue transglutaminase.

kit, and thus determine whether the h-tTG based kits consistently outperformed the gpl-tTG based kits, and produced comparable results to the IgA EMA IIF assay.

METHODS

Patients

One hundred and thirteen sera were selected from samples submitted to: Division of Immunology, Queensland Health Pathology Services, Royal Brisbane and Princess Alexandra Hospitals; Central Sydney Immunology Laboratory; and Department of Immunology, Sullivian Nicolaides Pathology. These comprised sera from the following patients who were aged 21 years or older: (1) 49 patients with typical histological changes of CD on small bowel biopsy,^{3,41} who had previously been found to have a positive IgA EMA, 38 of whom had never been on a gluten free diet, and 11 of whom were poorly compliant or non-compliant with the diet and had an abnormal small bowel biopsy close to the time of blood sampling; (2) 34 subjects who had been investigated with upper gastrointestinal fibreoptic endoscopy and small bowel biopsy for possible CD and were found not to have histological changes consistent with CD (non-CD controls, with the following results on small bowel biopsy (no evidence of villous atrophy in all cases): normal duodenum (n = 27), duodenal ulcer (n = 3), dilated Brunner's glands (n = 1), non-specific duodenitis (n = 1), fibrotic and thickened small bowel (n = 1), and gastric atrophy (n = 1)); and (3) 30 subjects with biopsy confirmed inflammatory bowel disease (IBD controls).

All sera were retested for IgA EMA at the start of the study to ensure that the sera from patients with CD had not degraded during storage at -70°C. Total serum IgA values were also measured in all 64 non-CD and IBD control sera by nephelometry (Behring Diagnostics, Frankfurt, Germany). All 64 controls had values within the normal range for adults (1.24–4.16 g/litre), thus excluding IgA deficiency as a potential cause for negative results.

IgA EMA IIF assay

The IgA EMA assay was performed by IIF using cryostat sections of monkey oesophagus (The Binding Site, Birmingham, UK), as described previously² at a screening dilution of 1/4. All slides were viewed by two independent observers and a positive or negative result was determined by consensus.

IgA tTG ELISA

The manufacturer's instructions (table 1) were followed for all 13 IgA tTG ELISA kits. All specimens were tested in duplicate.

Bovine serum albumin and gelatin coated ELISA plates

To investigate the possibility of IgA anti-bovine serum albumin (BSA) antibodies producing false positive IgA tTG results, ELISA plates (Costar, Corning Inc, New York, USA) were coated with 250 µl of 5% BSA (Sigma Chemical Co, St Louis, Missouri, USA) or 1% gelatin (Bio-Rad, Hercules, California, USA). Serum diluted 1/100 in Tween/phosphate buffered saline was incubated for one hour at room temperature. After three washes, horseradish peroxidase (HRP) labelled goat antihuman IgA (Silenus Labs, Melbourne, Australia), at a dilution of 1/500, was added and the plates were incubated for one hour (room temperature). ABTS (2,2'-azino-bis-3-ethylbenzthiazolin-6-sulphonic acid) substrate (Medical Innovations, Sydney, Australia) was added for 15 minutes, and absorbances read at 405 nm.

Cut off values

Both the manufacturers' recommended cut off values and decision thresholds determined by receiver operating characteristic (ROC) plots (see below) were used to calculate the sensitivity and specificity of each assay/kit. The IBD controls

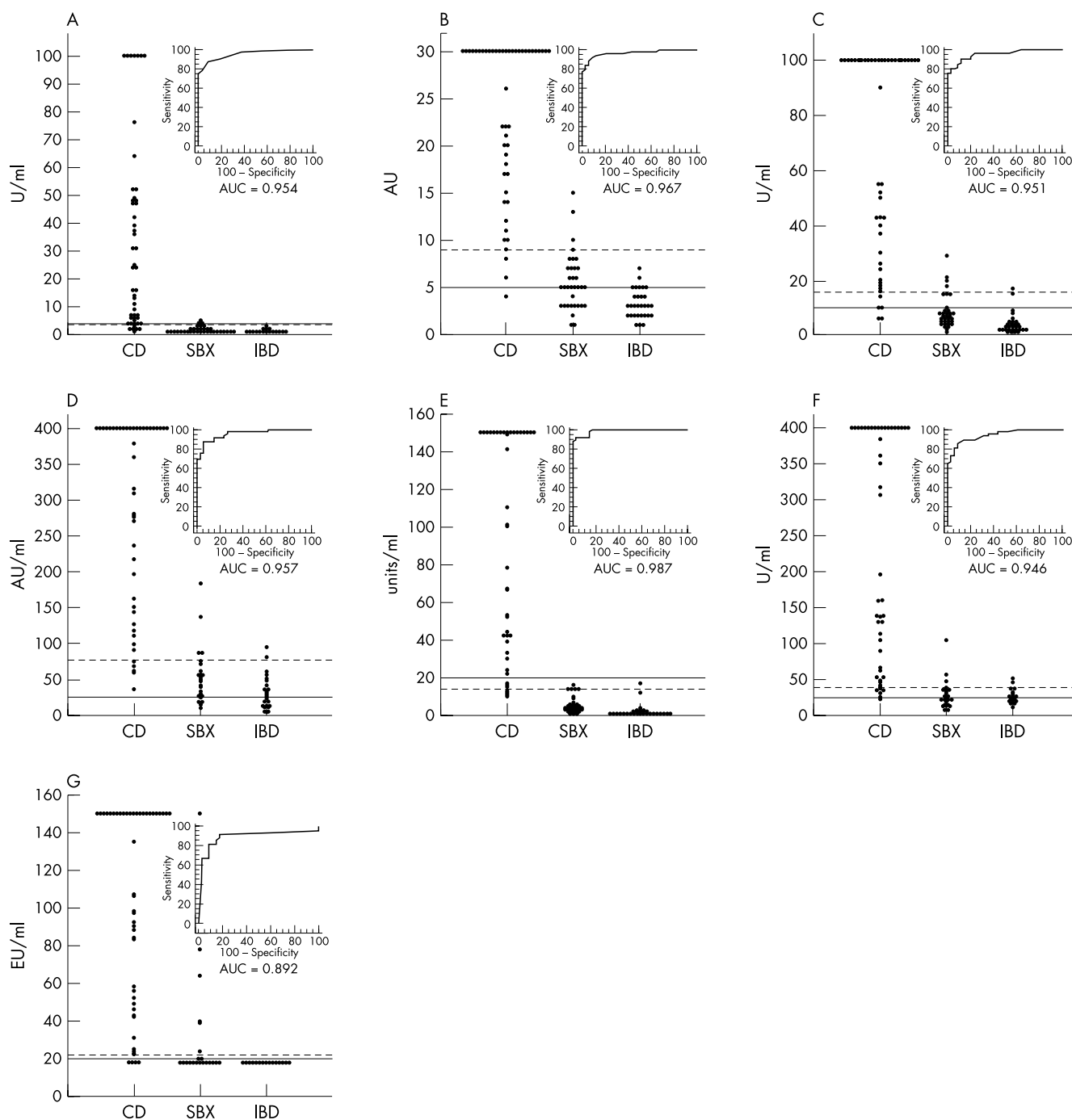


Figure 1 IgA anti-tissue transglutaminase (tTG) antibody values of the patients with coeliac disease (CD), and the non-CD (SBX) and inflammatory bowel disease (IBD) controls in the seven purified guinea pig liver tTG based enzyme linked immunosorbent assay (ELISA) kits, with corresponding receiver operating characteristic (ROC) curves and area under curve (AUC) estimations. The solid lines represent the manufacturers' recommended cut off values and the broken lines represent the ROC plot analysis derived decision thresholds. (A) The Binding Site, (B) Eurospital, (C) Genesis Diagnostics, (D) Immunopharmacology Research Diagnostics, (E) QUANTA Lite (Inova), (F) Medizyme (Medipan Diagnostica), (G) Immulisa (Immco).

were not used in the calculation of specificity because some had not undergone small bowel biopsy to exclude CD.

ROC plot analysis

ROC plot analysis was performed on each kit using the Accuroc software package (Accumetric Corporation, McGill University Health Centre, Montreal, Quebec, Canada) to determine a decision threshold and area under curve (AUC) estimation. The IBD controls were not included in the ROC analysis because some had not undergone small bowel biopsy to exclude CD. The AUC was calculated using the trapezoid rule.⁴²⁻⁴³ Comparisons between the AUCs of each kit were performed by the non-parametric method for correlated samples, as previously described by DeLong *et al.*⁴⁴

RESULTS

The IgA tTG values of the patients with CD and the non-CD and IBD controls measured with the 13 kits are shown in fig 1 (gpl-tTG based kits) and fig 2 (h-tTG based kits) with corresponding ROC curves and AUC estimations. The numbers of sera from patients with CD, and the non-CD and IBD controls that were positive in each assay, using both the manufacturers' and ROC analysis derived decision thresholds, are shown in table 2 (gpl-tTG based kits) and table 3 (h-tTG based kits), with corresponding sensitivities and specificities. Table 4 shows the AUC comparisons between kits, with a significant difference denoted by a p value of < 0.05.

The recombinant h-tTG based Varelista (Pharmacia & Upjohn Diagnostics, GmbH & Co, Freiburg, Germany) and

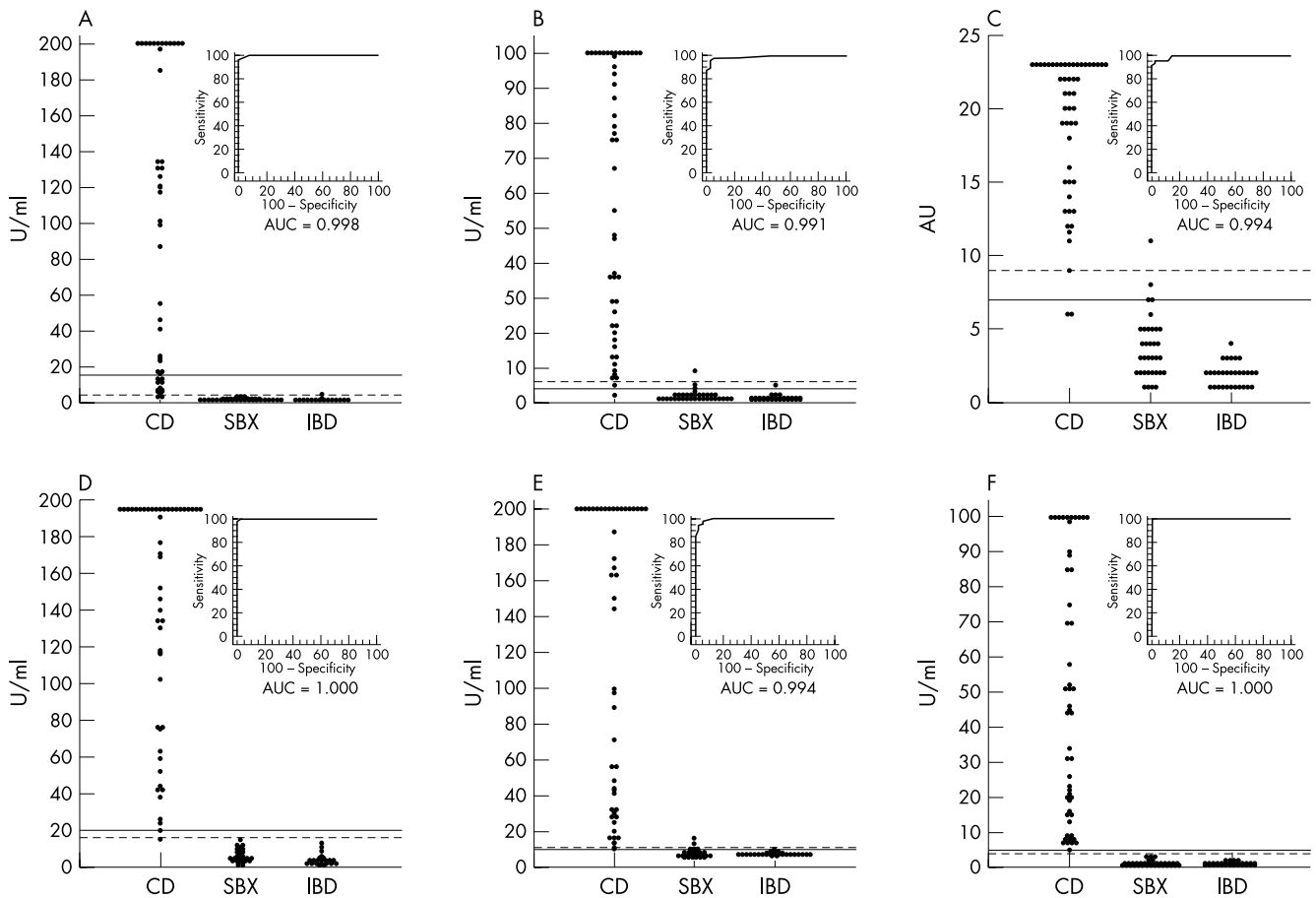


Figure 2 IgA anti-tissue transglutaminase (tTG) antibody values of the patients with coeliac disease (CD), and the non-CD (SBX) and inflammatory bowel disease (IBD) controls in the six human tTG based enzyme linked immunosorbent assay (ELISA) kits, with corresponding receiver operating characteristic (ROC) curves and area under curve (AUC) estimations. The solid lines represent the manufacturers' recommended cut off values and the broken lines represent the ROC plot analysis derived decision thresholds. (A) AESKULISA (Aesku.Lab), (B) The Binding Site, (C) Eurospital, (D) QUANTA Lite (Inova), (E) Orgentec, (F) Varelista (Pharmacia & Upjohn).

purified erythrocyte h-tTG based QUANTA Lite (Inova Diagnostic Inc, San Diego, California, USA) kits performed best, with sensitivities of 100% and 98%, specificities of 100% and 100% (using the manufacturers' cut off values), and AUC estimations of 1.000 and 1.000, respectively (fig 2; table 3).

Of the seven gpl-tTG based kits (fig 1; table 2), the QUANTA Lite kit performed best, with 86% sensitivity and 100% specificity using the manufacturer's cut off value of 20 arbitrary units/ml, and an AUC of 0.987. Applying the ROC analysis derived decision threshold of 14.1 arbitrary units/ml improved sensitivity to 92% but reduced specificity to 97%.

Table 2 IgA EMA and IgA tTG results in patients with CD and controls using the manufacturers' cut off points and ROC plot analysis derived decision thresholds for the seven guinea pig liver tTG based ELISA kits

Assay type/Manufacturer	Manufacturer's cut off point			ROC plot analysis				
	Cut off	CD (sensitivity)	Non-CD controls (specificity)	IBD controls	Threshold	CD (sensitivity)	Non-CD controls (specificity)	IBD controls
IgA EMA IIF/The Binding Site	1/4	49/49 (100%)	0/34 (100%)	0/30	NA	NA	NA	NA
Guinea pig liver tTG based ELISA/The Binding Site	4 U/ml	43/49 (88%)	3/34 (91%)	0/30	3.5 U/ml	43/49 (88%)	3/34 (91%)	0/30
Guinea pig liver tTG based ELISA/Eurospital	5 AU	48/49 (98%)	22/34 (35%)	7/30	9 AU	46/49 (94%)	4/34 (88%)	0/30
Guinea pig liver tTG based ELISA/Genesis Diagnostics	10 U/ml	47/49 (96%)	8/34 (76%)	2/30	15.3 U/ml	44/49 (90%)	4/34 (88%)	1/30
Guinea pig liver tTG based ELISA/ImmLisa	20 EU/ml	45/49 (92%)	8/34 (76%)	0/30	22.2 EU/ml	44/49 (90%)	6/34 (82%)	0/30
Guinea pig liver tTG based ELISA/Immunopharmacology Research Diagnostics	25 AU	49/49 (100%)	30/34 (12%)	16/30	76.4 AU	43/49 (88%)	4/34 (88%)	2/30
Guinea pig liver tTG based ELISA/QUANTA Lite	20 units/ml	42/49 (86%)	0/34 (100%)	0/30	14.1 units/ml	45/49 (92%)	1/34 (97%)	1/30
Guinea pig liver tTG based ELISA/Medizyme	25 U/ml	48/49 (98%)	16/34 (53%)	15/30	38.5 U/ml	43/49 (88%)	4/34 (88%)	2/30

Results equal to or greater than the cut off/threshold were considered positive. Specificity was calculated using only the non-CD controls (see text). AU, arbitrary units; CD, coeliac disease; ELISA, enzyme linked immunosorbent assay; IBD, inflammatory bowel disease; IgA EMA, IgA anti-endomysial antibody; IgA tTG, IgA anti-tissue transglutaminase antibody; IIF, indirect immunofluorescence; NA, not applicable; tTG, tissue transglutaminase; ROC, receiver operating characteristic.

Table 3 IgA EMA and IgA tTG results in patients with CD and controls using manufacturers' cut off points and ROC plot analysis derived decision thresholds for the six human tTG based ELISA kits

Assay type/Manufacturer	Manufacturer's cut off point				ROC plot analysis			
	Cut off	CD (sensitivity)	Non-CD controls (specificity)	IBD controls	Threshold	CD (sensitivity)	Non-CD controls (specificity)	IBD controls
IgA EMA IIF/The Binding Site	1/4	49/49 (100%)	0/34 (100%)	0/30	NA	NA	NA	NA
Human tTG based ELISA/Aesku.Lab	15 U/ml	35/49 (71%)	0/34 (100%)	0/30	4 U/ml	47/49 (96%)	0/34 (100%)	1/30
Human tTG based ELISA/The Binding Site	4 U/ml	48/49 (98%)	3/34 (91%)	1/30	6 U/ml	47/49 (96%)	1/34 (97%)	0/30
Human tTG based ELISA/Eurospital	7 AU	47/49 (96%)	4/34 (88%)	0/30	9 AU	47/49 (96%)	1/34 (97%)	0/30
Human tTG based ELISA/QUANTA Lite	20 U/ml	48/49 (98%)	0/34 (100%)	0/30	16 U/ml	48/49 (98%)	0/34 (100%)	0/30
Human tTG based ELISA/Orgentec	10 U/ml	49/49 (100%)	5/34 (85%)	1/30	11 U/ml	48/49 (98%)	2/34 (94%)	0/30
Human tTG based ELISA/Varelisa	5 U/ml	49/49 (100%)	0/34 (100%)	0/30	4 U/ml	49/49 (100%)	0/34 (100%)	0/30

Results greater than or equal to the cut off/threshold are considered positive. Specificity was calculated using only the non-CD controls (see text). AU, arbitrary units; CD, coeliac disease; ELISA, enzyme linked immunosorbent assay; IBD, inflammatory bowel disease; IgA EMA, IgA anti-endomysial antibody; IgA tTG, IgA anti-tissue transglutaminase antibody; IIF, indirect immunofluorescence; NA, not applicable; tTG, tissue transglutaminase; ROC, receiver operating characteristic.

Table 4 Comparisons between AUC estimations⁴⁴

Guinea pig liver tTG	Binding Site																		
	0.406	Eurospital																	
	0.908	0.494	Genesis																
	0.073	0.014*	0.128	Immco															
	0.034*	0.166	0.026*	0.013*	Quanta Lite														
	0.900	0.518	0.831	0.044*	0.109	IPR													
	0.711	0.286	0.816	0.115	0.020*	0.616	Medizyme												
Human tTG	0.027*	0.093	0.043*	0.008*	0.317	0.051	0.023*	Orgentec											
	0.023*	0.058	0.022*	0.006*	0.102	0.027*	0.014*	0.198	Varelisa										
	0.022*	0.057	0.026*	0.006*	0.123	0.030*	0.016*	0.249	0.264	Aesku.Lab									
	0.056	0.071	0.063	0.007*	0.597	0.067	0.024*	0.678	0.195	0.254	Binding Site								
	0.033*	0.089	0.047*	0.006*	0.427	0.056	0.024*	0.900	0.186	0.301	0.738	Eurospital							
	0.023*	0.057	0.023*	0.006*	0.106	0.027*	0.014*	0.195	0.480	0.278	0.194	0.200	Quanta Lite						

*p<0.05. AUC, area under curve; tTG, tissue transglutaminase.

To exclude the possibility that some reactions to tTG were really reactions to blocking agents used in the ELISA kits, anti-BSA and antigelatin antibodies were determined (data not shown). Sera from one IBD control and two patients with CD reacted significantly on the BSA coated ELISA plates, suggesting the presence of IgA anti-BSA antibodies. However, none of the non-CD controls reacted significantly on the BSA coated plates and no sera reacted on the gelatin coated plates.

DISCUSSION

In this comparison of 13 commercial IgA tTG ELISA kits, we found that the human tTG based kits tested generally demonstrated superior performance (especially specificity) to the gpl-tTG based kits (tables 2,3). However, the use of h-tTG alone was insufficient to confer performance equal to the IgA EMA IIF assay, because only two h-tTG based kits (recombinant h-tTG based Varelisa and purified erythrocyte h-tTG based QUANTA Lite) produced closely comparable results to the IgA EMA IIF assay. Furthermore, two of the gpl-tTG based kits (QUANTA Lite and Eurospital (Trieste, Italy)) had AUC estimations that were not significantly different from the h-tTG kits (figs 1, 2; tables 2, 3). This demonstrates that factors other than antigen source are important in determining kit performance.

Using the manufacturers' cut off values, false positive results were found in three of the six h-tTG based and six of the seven gpl-tTG based IgA tTG kits in our study (table 4). This has also been reported in other studies.^{5 6 9 10 12-16 18 19 22-29 32 33 36 38} However, as in our study, most of these false positive results were detected in gpl-tTG based ELISAs.^{5 6 9 10 12-15 18 19 22-26 28 29 32-34 36 38} These findings raise the

important issue of contaminants in gpl-tTG,^{24 29 38} which may contain other hepatic proteins.^{29 38} On sodium dodecyl sulfate-polyacrylamide gel electrophoresis, the gpl-tTG extract (Sigma T5398; Sigma Chemical Co) used in several gpl-tTG based ELISAs^{5 6 9-11 13-15 18 20-25 29 32 33 36 38} contains multiple bands in addition to the 82-83 kDa tTG band,^{24 29 38} which only accounted for about 30% of the total protein.^{29 38} This may be partially overcome by further purification steps, and should be less of an issue with recombinant h-tTG.^{24 29 38}

However, three of the six h-tTG based kits (two recombinant h-tTG based) evaluated also produced false positive results in the absence of IgA EMA and CD, as previously reported.^{13 14 16 23 24 27} Therefore, other explanations for false positive results are required.

"The methods used to extract and purify tissue derived tissue transglutaminase (tTG), produce and process recombinant tTG, and then coat tTG on to ELISA wells may lead to alterations in the tertiary structure of tTG"

More false positive IgA tTG results were detected in the non-CD controls compared with the IBD controls. A possible explanation may be the presence of IgA anti-BSA antibodies in some of the non-CD control sera, reacting with the BSA used as a blocking agent in some kits.¹⁰ However, Lock and colleagues¹⁰ did not detect significant IgA anti-BSA antibodies in two disease controls tested, and significant IgA anti-BSA antibodies were not demonstrated in our non-CD controls.

False negative results were found in six of the seven gpl based and five of the six h-tTG based kits in IgA EMA positive

Take home messages

- In general, the human tissue transglutaminase (h-tTG) based kits tested demonstrated superior performance (especially specificity) to the guinea pig liver tTG (gpl-tTG) based kits
- Because this was a general and not a universal finding, factors other than antigen source are important in determining kit performance
- Most of the kits performed significantly better when the cut off values/decision thresholds were adjusted via receiver operating characteristic plot analysis, which emphasises the importance of cut off point revalidation by laboratories, using appropriate samples from their referral population

patients with CD (figs 1, 2; tables 2, 3), in agreement with previous reports.^{4 10-16 19-21 25 26 28-30 32-34 36 38} The methods used to extract and purify tissue derived tTG, produce and process recombinant tTG, and then coat tTG on to ELISA wells may lead to alterations in the tertiary structure of tTG. Therefore, conformational epitopes may be lost or formed, with a loss leading to a reduced ability of tTG to bind IgA tTG, thus explaining some of the false negative results.²⁵ Furthermore, the formation of conformational neopeptides may also result in false positive results (see above).

The function and tertiary structure of tTG is also altered by the presence of ionised calcium.⁴⁵ It has been suggested that antibody binding epitopes may be formed or hidden by the presence of ionised calcium in the coating buffer of the IgA tTG ELISA.^{10 46} Sulkanen and colleagues⁶ reported that the pretreatment of tTG with calcium ("calcium activation") dramatically improved the separation between CD and non-CD sera in a gpl-tTG based ELISA, and also increased the binding affinity of tTG to CD sera. However, in our study, the two kits in which the use of "calcium activation" of tTG is recorded (Binding Site gpl-tTG kit and Genesis) did not clearly demonstrate superior performance to the other kits. Furthermore, Lock and colleagues¹⁰ found that the addition of calcium to the coating buffer increased both the signal and background values, and therefore produced no overall improvement in the performance of their in house gpl-tTG based IgA tTG ELISA. Nakachi and colleagues⁴⁶ also reported that the autoantibody binding sites of tTG were formed in a manner that was essentially calcium independent.

Finally, we found that the performances of most of the IgA tTG ELISA kits were significantly improved by adjusting the cut off values/decision thresholds via ROC plot analysis. These discrepancies between the ROC analysis derived decision thresholds and manufacturers' recommended cut off values illustrate the importance of cut off point revalidation by laboratories, using appropriate samples from their referral population. However, the adjustment of the cut off values/decision thresholds via ROC plot analysis would not compensate for less than satisfactory kit performance. Therefore, in selecting an IgA tTG ELISA kit for diagnostic purposes, a laboratory should consider not only the source of tTG antigen, but also the performance of the kit using locally derived cut off values.

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