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Duck egg tolerance in children with hen's egg allergy

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Conflicts of interest:

There are no known conflicts of interest.

Author contributions:

JE, SC, ZZ, EGA, CP, JA and MEL contributed to the study design and data collection; with JE and MEL ensuring data quality, analysis of results and writing the draft manuscript. All authors reviewed the draft manuscript and approved the final version.

Ethical statement:

Ethical approval was granted on the 23rd December 2015 by NRES Committee South Central (REC number: 15/EE/0287) and on the 8th October 2015 by the University of Southampton ERGO (Submission number: 15566). Informed written consent was obtained from all parents/carers of patients.

Data availability statement:

The data that support the findings of this report are available from the corresponding author upon reasonable request.

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Key messages list:

- This is the first report to describe duck egg tolerance in hen's egg allergic children.
- Duck egg tolerance occurred in 23% (6/26) of our unselected case series.
- Some hen's egg allergic children may be able to tolerate duck egg.

To the Editor,

Hen's egg allergy is a common cause of food allergy in children, affecting 0.5-2.5% of the European population.[1] It has been assumed within the literature a hen's egg allergy is predictive of an allergy to all bird eggs, by cross sensitisation.[2] A handful of case reports[3-5] independently describe allergies to a number of bird eggs; namely duck, goose, ostrich and quail, where the patients were able to tolerate hen's egg. Tolerance to other birds' eggs in hen's egg allergic individuals has not been previously reported. We describe our experience of duck egg tolerance amongst children allergic to hen's egg by reviewing patient notes and obtaining current dietary tolerances as described by parents.

This was a descriptive case note review, recruiting children from the Adam Practice, Poole (a primary care centre) and the children's allergy clinic at Southampton Children's Hospital (a secondary and tertiary centre). We found that a child attending our clinic was safely eating duck egg despite having a current hen's egg allergy, confirmed by SPT results. This triggered a change in our practice to include duck egg prick to prick SPT on children when raw duck egg white was available in clinic. If the duck egg SPT result was <3mm the family was encouraged to introduce duck egg into the child's diet at home, without a formal food challenge. In 2016 we recruited all children seen in clinic between July and November 2015 with a history of current or past hen's egg allergy. Parents were asked to complete a written consent form and questionnaire of current dietary tolerance of hen's and duck egg based on the stages of the egg ladder.[1] We collected clinical data from the medical records and excluded children where there was insufficient information about hen's egg allergy to make a robust diagnosis.

Hen's egg allergy was defined according to standard diagnostic criteria by meeting any one of the following conditions: a positive oral food challenge to hen's egg, history of a convincing clinical reaction to hen's egg and a positive skin prick test to hen's egg white (≥3mm, ALK Albelo) or serum specific IgE >0.35 KU_A/L within 12 months of the clinical reaction, or evidence of >95% likelihood of hen's egg allergy (serum specific IgE ≥6.0 KU_A/L or skin prick test ≥6mm) but with no prior history of oral tolerance or exposure to hen's egg.[6] Sensitisation to hen's AND duck egg was defined as a concordant egg allergy. Conversely, discordant egg allergy was defined as a simultaneous hen's egg SPT ≥3mm and a duck egg SPT <3mm. We used the hen's egg SPT result nearest to the date of the dietary questionnaire to allocate the concordant and discordant groups.

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We created a novel score to quantify dietary tolerance to egg. Based on the answers to the parental questionnaire, each child's dietary tolerance to hen's and duck egg was scored separately using the egg ladder: avoids all forms of egg (score 0), tolerates either baked egg (1), lightly cooked egg (2), or raw egg (3).[1] The dietary discrepancy score (DDS) was the score from the duck egg ladder less the score from the hen's egg ladder. A score > 0 implied discrepancy in consumption, with greater duck than hen's egg tolerance.

The children were grouped according to their SPT results and DDS separately and then analysed to compare clinical and dietary features of discordant against concordant egg allergic children. The statistical tests used included an Independent-Samples T-test, Fisher's Exact test and a Mann-Whitney U-test (SPSS 22.0). 26 children had a hen's egg SPT and a concurrent duck egg SPT, making them eligible for inclusion in this report. Of these 26 children their diagnosis of hen's egg allergy was based upon: positive oral food challenge to hen's egg observed in four children (15.4%), a clinical reaction to hen's egg and a positive SPT result within the last 12 months observed in 19 children (73.1%), or sensitisation to hen's egg with a >95% likelihood of allergy due to hen's egg SPT of ≥6mm observed in three children (11.5%). 20 of the 26 children (76.9%) showed concordance with duck egg according to a ≥3mm SPT wheal to both hen's and duck egg. Six (23.1%) children were discordant with a ≥3mm SPT to hen's egg and <3mm SPT to duck egg. There were no clinical differences between these groups (Table 1).

We looked at the relationship between hen's and duck egg SPT in the same individual (Figure 1). The hen's egg SPT results of discordant children (with lower duck egg SPT by definition) were spread across a range from 3mm – 8mm and were not limited to lower values for hen's egg SPT. This would suggest that duck egg discordancy is independent of hen's egg allergy.

We received parental dietary questionnaires from all of the 26 children, and calculated the DDS based on this parental report. Three children had an unknown dietary tolerance and therefore 23 children had a DDS calculated. By this analysis there were five (21.7%) discordant children, four with a documented dietary tolerance to duck egg greater than hen's egg, and an additional child with equal dietary tolerance to hen's and duck egg, where the duck egg SPT was <3mm. Amongst the five children with duck egg SPT <3mm, the median DDS was +1 (range 0 to +2) whilst the concordant group (duck egg SPT >3mm) contained 18 children (78.3%) with a median DDS of 0 (range -1 to 0). Duck egg children with duck egg SPT <3mm were more likely to be duck egg tolerant (p=0.001).

Our report is the first to describe duck egg tolerance in hen's egg allergic children, occurring in 23% of our cohort. Our results suggest that duck egg tolerance is independent of hen's egg allergy, rather than occupying a step on the egg ladder towards the resolution of hen's egg allergy.[1] Despite this seeming prevalence, there are only a handful of case reports describing a discordant egg allergy,

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including hen's egg tolerant patients allergic to duck, goose and quail eggs.[3-5] These case reports present unique cases with no suggestion of this clinical picture having a greater prevalence among the population. Langeland[2] described serological cross reactivity between bird egg allergens that has led to the belief that hen's egg allergy cross reacts with the eggs of other bird species, but the clinical phenotype may be more complex as suggested by recent discrepant SPT results with other bird egg species.[7] Taxonomy may help our understanding of cross reactivity between bird species. Although both hens and ducks are part of the *Galloanserae* superorder of fowl, the hen (*Gallus domesticus*) is a member of the Galliforme order (along with quail), whilst ducks *(Anas domesticus*) are members of the Anseriforme order (along with geese).[8] Immunoblotting studies have identified differences in the ovalbumin protein found in duck's compared with that of hen's including differences in electrophoretic mobility and unique epitopes.[3,4,5]

Our results are hampered by retrospective data collection and data from parental reports, which has the potential for bias. This was a small, unselected cohort of children who had received a duck egg SPT and had not been confirmed as duck egg allergic by oral food challenge. The duck egg SPT was conducted according to the availability of reagent in clinic, so we were not unduly biased by inadvertent patient selection. As this is the first report into duck egg, rather than hen's egg, there is no research into the use, sensitivity and specificity of duck egg prick to prick SPT as a measure of allergy. A future prospective study should repeat the measure of tolerance with gold standard oral food challenges to support their findings. Our investigations and findings were based on the data for hen's egg as there is no data available on specific allergens within duck egg and so future research should target this.

We describe six cases of duck egg tolerance in children with hen's egg allergy, suggesting that duck egg tolerance in hen's egg allergic children is not confined to isolated cases and may be quite common. Duck egg SPT may be a marker of duck egg tolerance in our cohort and after further study could be used as a guide to the introduction of duck egg into the diet. The dietary introduction of duck egg in discordant egg allergy, may reduce their dietary restrictions and subsequent oral aversion to baked, lightly cooked and raw egg foods. This may help with the introduction of hen's egg as natural dietary tolerance develops. Further prospective work is required to enunciate tolerance using gold standard food challenges and the reliability of duck egg prick to prick SPT as a biomarker.

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Table 1 *Comparison of the clinical features of the concordant and discordant egg allergic groups.*

Variable	Concordant (n=20)	Discordant (n=6)	p value
Duck egg SPT	≥3mm	<3mm	-
Age at consent, (years)	**Mean** 7.11 (**SD** 3.58)	**Mean** 5.79 (**SD** 3.88)	0.442[1]
Male, n (%)	7/20 (35.0%)	1/6 (16.7%)	0.628[2]
Asthma, n (%)	10/19 (53.0%)	3/5 (60.0%)	1.000[2]
Allergic Rhinitis, n (%)	10/20 (50.0%)	1/4 (25.0%)	0.736[2]
Eczema, n (%)	17/20 (85.0%)	3/6 (50.0%)	0.112[2]
Other current food allergies[3]	16/20 (80.0%)	6/6 (100.0%)	0.542[2]
Other previous food allergy	10/19 (52.6%)	2/6 (33.3%)	0.645[2]
Dietary questionnaire returned	20/20 (100.0%)	6/6 (100.0%)	-

[1]Independent-Samples T-test as age was normally distributed for our population.

[2]Fisher's Exact test.

[3]Based on SPT results, sensitisation levels for each allergen.

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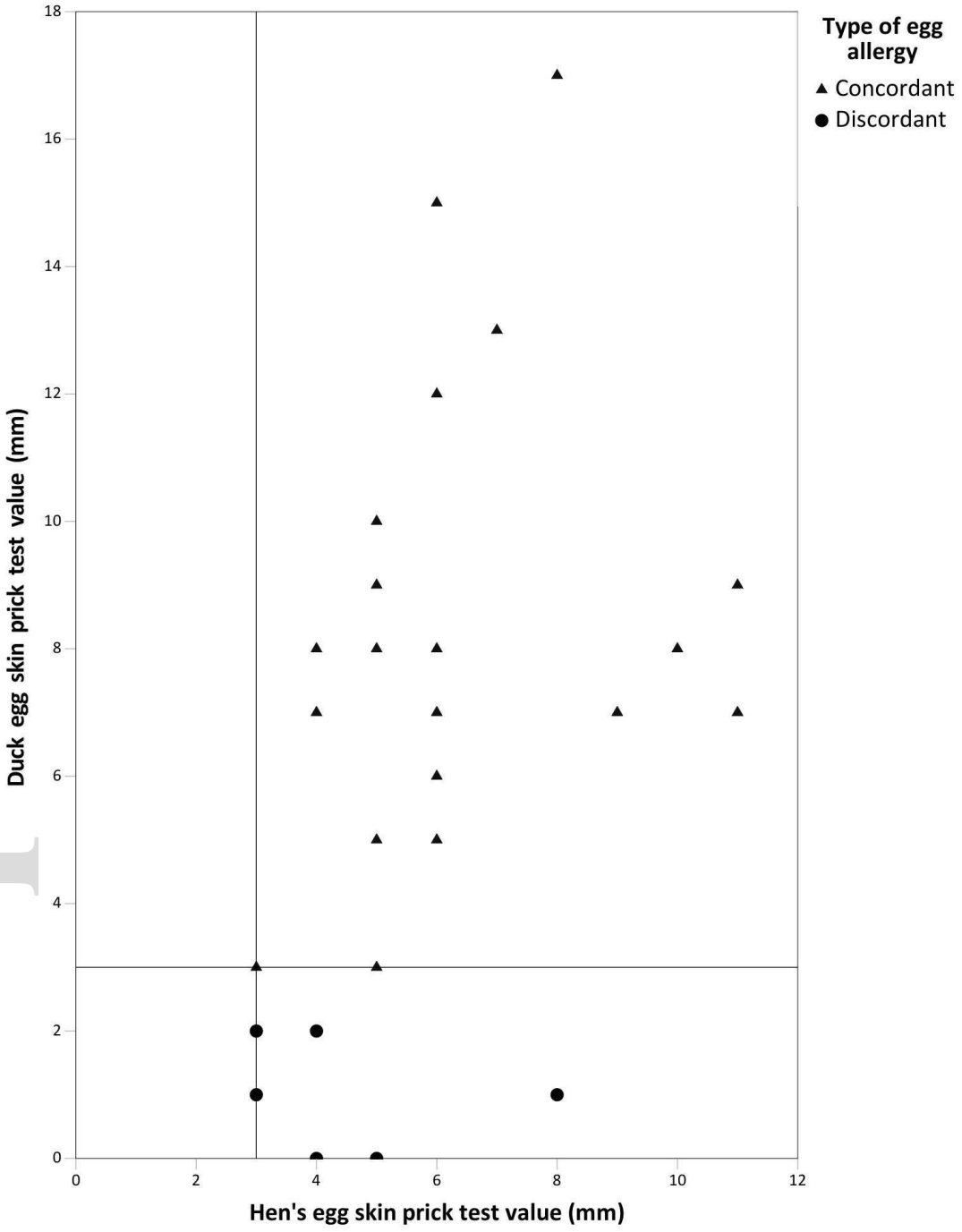
Figure 1 *Scatter plot representing the hen's egg and corresponding duck egg skin prick test values performed at a similar date. The reference lines represent the ≥3mm threshold for sensitisation. This figure does not show correlation between the two types of skin prick test values but illustrates that the distribution of values for the concordant and discordant groups.*



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