

Allergy against horses: Are curly horses an alternative for horse-allergic riders?

A pilot observational case study

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**Pferdeallergie:
Sind Curly
Horses (Locken-
pferde) eine
Alternative für
pferdeallergi-
sche Reiter?
Eine Pilot-Fall-
Beobachtungs-
Studie**

Key words

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scratch test

Schlüsselwörter

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Summary

Objective: To test the hypothesis that Curly horses possess hypoallergenic properties making them suitable for horse-allergic riders.

Methods: The feasibility of a standard horse prick test, compared with the Curly horse scratch test, was first studied on 4 prestudy phase patients. Subsequently, ten horse-allergic riders, who had previously stopped riding because of horse allergy with resulting bronchial asthma and/or allergic rhinoconjunctivitis, underwent basic lung function diagnostics: allergy testing (standard horse, Curly horses) and spirometry (or body plethysmography). Independently of the allergy test result, an escalated Curly horse contact program was conducted beginning with riding and later on brushing Curly horses

while measuring lung function during and after horse contact.

Results: The prestudy phase data show comparable results between the standard horse prick test and the scratch test using material of a German riding pony and a defined Curly horse mare (ABC 2563). In the main test phase, the skin test with Curly horses resulted in mostly reduced reactions compared to the standard horse prick test. The ten horse-allergic riders did not react significantly to exposure to the horses or reacted very slightly. Nine of 10 patients were found not to react significantly after brushing Curly horses.

Conclusion: We conclude that Curly horses seem to be suitable for horse-allergic riders who want or need to continue riding.

Zusammenfassung

Ziel: Die sogenannten Curly Horses sollen eine hypoallergene Eigenschaft besitzen, die es pferdeallergischen Reitern erlaubt, mit ihnen Umgang zu haben. Dies sollte untersucht werden.

Methodik: Um zu testen, ob ein Standard-Pferde-Pricktest vergleichbare Ergebnisse zu einem Curly-Horse-Scratchtest liefert, wurden diese Methoden zunächst in einer Vorphase an vier Patienten getestet. Im Anschluss wurden zehn pferdeallergische Reiter, die aufgrund ihrer Allergie mit symptomatischen Beschwerden beim Reiten, wie Asthma bronchiale und/oder allergischer Rhinokonjunktivitis, das Reiten aufgegeben hatten, lungenfunktionell untersucht: Allergietestung (Standard Pferd – Curly Horse), Spirometrie oder Ganzkörperplethysmographie. Unabhängig vom allergologischen Testergebnis wurde ein eskalierendes Kontaktprogramm gestartet, in dem zunächst die Pferde nur geritten und später auch ge-

striegelt wurden. Während dessen wurde die Lungenfunktion beim und nach dem Pferdekontakt gemessen.

Ergebnisse: Die Vorphasen-Testergebnisse zeigen vergleichbare Reaktionen zwischen dem Standard-Pricktest Pferd und dem Scratchtest, getestet mit einem Deutschen Reitpony und einer definierten Curly-Horse-Stute (ABC 2563). In der Haupttestphase zeigten die Curly Horses im Hauttest am Patienten meist schwächere Reaktionen als im Standard Pricktest Pferd. Die zehn pferdeallergischen Reiter reagierten nicht signifikant oder nur in geringem Umfang auf Pferdekontakt (Reiten). Neun der zehn Reiter reagierten beim Putzen der Pferde nicht signifikant.

Schlussfolgerung: Der Verfasser kommt zu dem Schluss, dass Curly Horses für pferdeallergische Reiter, die ihren Sport weiter ausüben wollen, geeignet sind.

Introduction

Horse allergy is a sensitization that occurs frequently in humans, mostly following contact with these animals [1–3]. Possible reactions are symptoms of allergic rhinoconjunctivitis, bronchial asthma and allergic exanthema. The 16 proteins identified from horses are located in skin dander, on hairs, in urine and in the saliva. Four allergens have been characterized (Equ c 1–Equ c 4) [4]. Enthusiasts of Curly horses report that the hypoallergenic properties of American Bashkir Curly horses render them suitable for patients with horse allergy to carry on with sport riding.

Serious scientific clinical studies on this issue are not available. The objective of this first study was to test the hypothesis of the hypoallergenicity of Curly horses under reference conditions.

Methods

Step 1: Prestudy phase (Berlin, Germany)

Four patients with allergy against horses were identified in a pneumological private practice. These patients underwent a prick test (horse, Bencard®, Munich, Germany) and a scratch test. Samples of Curly horses for testing were prepared with: mixed hairs and dander scales from a breed of Curly horses in Tønder, Denmark (C I) and Berlin, Germany (C II) as well as from a Curly mare (ABC register nr. P 2563; C III) and a German riding pony (D) [5, 6] to clarify whether these tests may be used to demonstrate differences in reaction.

Step 2: Pilot study (Klappholz, Germany)

Following the prestudy phase, the author founded a Curly farm (www.curlyfarm.de). To start, two ABC (American Bashkir Curly Horse Registry) mares formed the core of the farm: mare “Scoria’s Dee Lite” (ABC register nr. P 2563) and mare “Hawks Hiawatha” (ABC register nr. 3975). The use of a comparatively pure breeding line seemed to be necessary to avoid contamination with horses of nonpure breeding lines. No other horses were present in the stable.

Patients with anamnestic known allergy against horses, who had given up riding because of symptomatic allergy, volunteered for the study following media coverage of the research. Patients gave written consent for the horse contact and data collection. The patients were clinically investigated concerning their lung function prior to horse contact: anamnesis, spirometry, or – if spirometry could not be clearly interpreted owing to cooperation problems – body plethysmography.

Subsequently, a standard prick test was carried out (horse Bencard®, Munich, Germany) using histamine and saline as control. A scratch test with mixtures of the dander and the horse hairs of the

Abbreviations

Pat nr.	patient number
nr.	number
WHO	World Health Organization
IUIS	International Union of Immunological Societies
FEV1	forced expiratory volume 1 second
PEF	peak expiratory flow
Pred	predicted
SD	standard deviation
ABC	American Bashkir Registry
kDa	kilo Dalton
pI	isoelectric point (SDS page)

two mentioned mares followed. The same assistant always carried out, assessed, and documented by photography the prick and scratch tests in the same manner. The test material was obtained from brushes of the mares and prepared according to a previously published method [5, 6]: a fingertip of the cut-up Curly hair and dander sample, suspended in 1 ml 0.9% sodium chloride solution, was used. After scarification of the forearm skin of 1 cm in diameter the mixed hair/dander solution was applied on the scarification region. This procedure was repeated for every test. Two young, healthy, female riders served as reference riders. For each case of allergy testing (step 1+2), the influence of concomitant medication was excluded (antihistamines, steroids, leukotriene synthesis inhibitors).

Subsequently, the patients came into contact with the horses, comprising 1-h riding without brushing. Later, the contact was intensified: 1-h riding followed by 15 min of horse brushing.

Initially, peak-flow measurements were performed in 15-min steps after the first horse contact (Vitalograph 2110 electronic PEF/FEV1 diary) and documented. Other possible symptoms were also assessed (skin, nose, eyes, and respiration). The end-of-test criterion was a peak flow decrease of more than 20% of the initial value. If this event occurred, treatment with Salbutamol was planned to follow immediately. The test was also repeated with these patients on the following day.

All patients were rechecked 15 min after horse contact.

During the first hours of horse contact, the patients were not allowed to enter the horse stable. This was done to avoid bringing the patients into contact with any other possible influence on their allergy.

Table 1

Prestudy test phase (Berlin): prick and scratch test results

Pat nr.	Disease	Pollen allergy	Mould allergy	House dust allergy	Prick horse	Scratch D	Scratch C I	Scratch C II	Scratch C III
1	A; R	+++	+++	++++	+++	+++	+++	+++	+
2	A; R	+++	+++	+	++	+	++	+	-
3	A	+++	-	++	++	+++	+	++	+
4	A	+	-	-	+++	0	-	-	0

A, bronchial asthma; R, allergic rhinoconjunctivitis Scratch D German riding pony; C I, Curly mixed hairs Tønder; C II, Curly mixed hairs Berlin, C III, Curly mare Dee Lite (ABC Register nr: P 2563); 0, not carried out

Allergy test: - = negative (+) = < 3 mm ø; + = > 3–4 mm ø; ++ = > 4–5 mm ø; +++ = > 5–6 mm ø; ++++ = > 6 mm ø.

Pollen test material: grass, rye, mugwort, nettle, plantain, alder, hazel, birch, beech, oak, ragweed

Mould test material: alternaria, cladosporium, aspergillus, penicilium

House dust test material: mite Dermatophagoides pteronyssinus, mite Dermatophagoides farinae, Acarus siro, Lepidoglyphus destr., Tyrophagus putres

Histamine: = + + +, NaCl = - in Pat. 1–4

In conclusion, after clarifying the method of testing horse-allergic patients with different horse breeds by scratch test, we subsequently tested horse-allergic riders with a prick and scratch test with a standard horse and a Curly horse. Independently of these test results, we measured lung function data during and after riding and brushing Curly horses.

Results

Prestudy phase in Berlin, Germany

The results of the first test series of the prestudy phase are presented in Table 1.

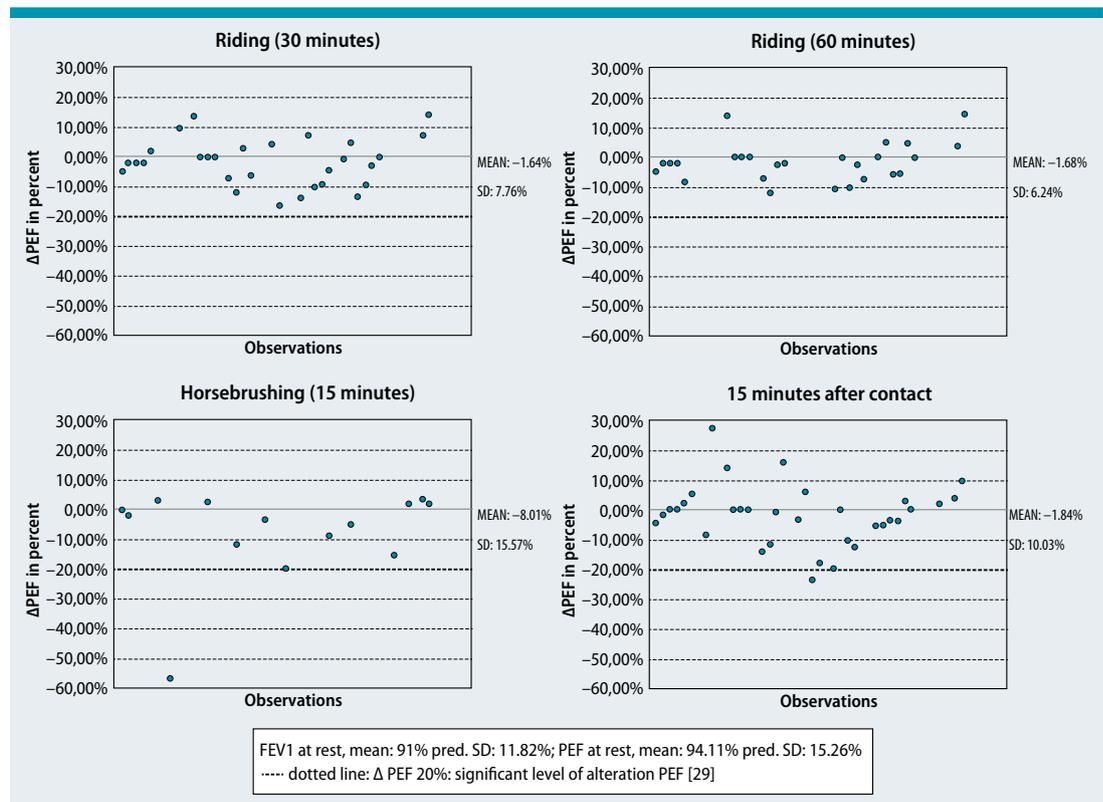
All 4 patients tested demonstrated a clear positive

reaction to the conventional horse prick test. Three patients responded weakly or had no detectable reaction to the scratch test with samples of the Curly mare “Dee Lite”; they responded to the test with samples from the German riding pony in a comparable way to the standard horse prick test. The results of the scratch tests with mixed Curly material from all the German (Berlin) and Danish (Tønder) sources varied and did not show a clear result.

Study phase in Klappholz, Germany

After installation of the stable system, the results of clinical, allergological, and functional investiga-

Figure 1: Peak expiratory flow variation during and after Curly horse contact compared to resting values



tions before, during, and after the contact with horses were determined.

Seven of 10 patients had a proven history of treated bronchial asthma; 3 out of 10 patients had allergic rhinoconjunctivitis.

All patients had shown middle-to-severe and severe allergologic clinical symptoms at contact with normal horses, ranging from rhinoconjunctivitis to allergic shock with emergency medical treatment required in one patient in the past (Table 2). During the allergy test, all patients had a positive response in the horse and histamine prick test (Bencard®, Munich, Germany), but not in the control test (saline).

The results of the scratch test to Curly horses are much more complex: 3 of 10 patients (pt. nr. 1, 7, 10) did not respond or responded only very slightly in the test with samples of the two Curly mares, whereas 3 other patients (pt. nr. 2, 3, 8) clearly responded to these two horses in the scratch test. Among the latter group was the patient who had experienced allergic shock after horse contact in the past (pt. nr. 2).

Four of 10 patients (pt. nr. 4, 5, 6, 9) reacted differently toward the mares in the scratch test, but they always had a weaker reaction to ABC 2563 (Straight Curly) than to ABC 3975 (Microcurl Curly with curly winter coat).

Patients did not respond differently to the scratch test, independently of whether they suffered from bronchial asthma or only from rhinoconjunctivitis.

These differences in response toward exposure to the different Curly horses in the scratch test did not play a significant role during the 32 h of riding for 9 patients and contact time in brushing the curly horses (Fig. 1), because none of these 9 patients exhibited allergic symptoms or a deterioration of the initial findings of normal lung functioning (Fig. 1). Only the patient with former allergic shock (pt. nr. 2) showed a significant decrease in peak expiratory flow after 15 min of horse brushing; the patient was successfully treated with a single dose of two-puff Salbutamol (Fig. 1). The patient did not experience these critical symptoms during horse riding the next day.

The other riders remained without relevant symptoms or a decrease in peak expiratory flow when riding and cleaning the horses. Only patient no. 3 with extensive eczema had partial moderate patchy erythema of the facial skin on the first day that did not appear during contact on the subsequent test days.

Discussion

This first pilot observation study showed that two ABC-registered Curly horses caused much weaker skin allergic reactions in horse-allergic riders than did horses of other tested breeds (commercial horse prick horse allergen extract, German riding pony). Only in a few cases were the reactions of the patients similar. To test reactions to an individual horse

Pat Nr.	Diagnosis / reported symptoms (horse contact)	Horse prick (Bencard)	Scratch ABC horse P2563 (1)a	Scratch ABC horse 3975 (2)b
1	A; R; horse contact: A	+++	(+)	-
2	A; R; horse contact: SK+R+E	+++	+++	+++
3	A, R; horse contact: E	+++	+++	+++
4	A; R; horse contact: R	++++	++	+++
5	A; R; horse contact: A+R	++++	+	+++
6	A; R; horse contact: A+R	++++ PS	(+)	++
7	R; horse contact: R+E	++++ PS	(+)	+
8	R; horse contact: R+E	++++ PS	+++	+++
9	A; R; horse contact: R+E	++++ PS	+	++
10	R; horse contact: R	+++	-	-
Control 1	-	-	-	-
Control 2	-	-	-	-

A, bronchial asthma; R allergic rhinoconjunctivitis; E, eczema; SK, allergic shock; PS, Pseudopodia
Anamnestic data:
Allergy test: - = neg; (+) = < 3 mm ø; + = > 3–4 mm ø; ++ = > 4–5 mm ø; +++ = > 5–6 mm ø;
++++ = > 6 mm ø
In every case (patients and controls) the histamine testing was positive and the control (sodium chloride) was negative.
aABC horse P 2563: mare "Scoria's Dee Lite" Canadian breed: straight hair Curly (moderate curly);
bABC horse 3975: mare "Hawks Hiawatha" Swedish breed: Microcurl hairs (Curly winter coat)

(ABC mares P 2563, 3975) we had to use the scratch test method instead of a standardized prick test because prick tests for our individual horses are not available. We tried to compensate for this drawback by following a standardized procedure in every test using the same material and technique by the same technician.

When horse-allergic riders were exposed to Curly horses by riding and brushing, they displayed considerably weaker allergic reactions than their previous experience with horses. Each patient included in this case study had been diagnosed as being allergic to horses and had given up riding or contact with horses because of unacceptable allergic symptoms during or after horse contact.

The relevant fall of peak expiratory flow during and after horse contact occurred in only 1 of 10 patients within 32 h of riding and contact time (brushing horses).

How can these findings be explained or interpreted? An allergy against exposure to horses can be defined as a reaction of the human body caused by exaggerated defense response of the immune system after

contact with horses initiating typical inflammation processes and causing various symptoms.

This definition implies that horse allergy is only present when, on the one hand, the allergy test is positive and, on the other hand, the typical symptoms of allergy can be proven: either allergic rhinoconjunctivitis and/or bronchial asthma, Quincke's edema, or allergic contact urticaria.

Frequency of horse allergy

Horse allergy frequency following horse contact is scarcely investigated [1–3, 7, 8]. The data of Tutluoglu et al. [1] demonstrate a sensitization risk for horse hair in people employed to work with horses. Liccardi et al. [3] in a recently published study found that of 3,235 patients subjected to a prick test, 2,097 has at least one positive result. Of these patients, 113 (5.38 %) had a positive response to horse scales; 60 of them had had no horse contact at all and 23 only occasionally; only 30 of these 113 patients reported regular horse contact. Furthermore, 9 patients showed monosensitization with 6 having rhinitis symptoms and 3 complaining of bronchial asthma together with rhinitis. Accompanying sensitization consisted of allergies against house dust, pollen, cats, and dogs. Besides the unexpected contact to horse-related equipment (e.g., blankets, brushes, mattresses, riding clothes), a cross-reactivity between horse allergy and other furry animals was thought to be a possible explanation [9–14]. Both lipocalins and serum albumin are believed to be the source of demonstrated cross-reactivity between horse, cow, pig, dog, cat, mouse, rabbit, and guinea pig [9–14].

In another study [7], Al-Temni et al. found that in a prick test series using a Bencard test kit, 17.4 % of the 384 symptomatic patients proved to be allergic to horses. The second series used a test kit from Allergy Laboratories Inc. (Oklahoma City, OK 73109, USA) and found only 2.6 % of the 305 patients tested positive to horse dander scales.

Liccardi et al. [2] reported in 2009 that out of 1,201 skin prick test-positive patients (baseline population, 1,822 tested atopic individuals), 3.43 % were

positive in the prick test to horses. Of the 35 positive horse-allergic patients, 20 were symptomatic (rhinitis, bronchial asthma).

Novembre et al. [8] described similar prick test results from 23,460 children; 624 (2.7 %) showed sensitization to horses. In 2004, Kürschner [15] and Jugert, using Pharmacia CAP assays, found that out of 50 anamnistically established patients with horse allergy, only 40 cases had a positive and in 33 cases a relevant CAP level (> 2) for horse. Only 2 patients showed isolated horse allergy, the others were polyvalent allergic.

Horse allergens

In the case of horse allergy, patients with allergic disposition react to the following known and partially characterized allergens (see **Table 3**):

- Major allergen Equ c 1, a glycoprotein belonging to the family of lipocalin that contains several allergens (mouse, rat, cow, and cockroach), was isolated from horse hair and dander. This polypeptide has a molecular mass of 25 kDa [16]. The highest concentrations of Equ c 1 were found in saliva, urine, and hair dander of adult horses (cited from [16, 17]). Lascombe and coworkers [18] determined the crystalline structure of Equ c 1.
- Allergens Equ c 2.0101 and Equ c 2.0102 with molecular mass of 17 kDa also belong to the lipocalin family [19, 20] and possess isoelectric points (pI) of 3.4 and 3.5, respectively.
- Allergen Equ c 3 has been isolated from the perspiration of horses by using thiophilic adsorption chromatography of separated proteins with a molecular mass of 63 kDa for Equ c 3 and a pI of 3.8 [21]; the serum albumin of the horse [20, IUIS].
- Allergen Equ c 4 with 17, 20.5 kDa [21, IUIS]
- Allergen Equ c 5 with 16.7 kDa [21] (this allergen was deleted by IUIS on 30 August 2012)

Therapy for horse allergy

Horse-allergic patients do not only suffer from allergy against horses but most often also from allergens of other sources [3, 7, 8, 15]. Without having had direct contact with living horses, patients with allergic disposition may also be sensitized by products made from horse-related equipment, contact with horse-riders' clothing, or even occupationally via the air from stables up to a distance of 500 m [22]. A cross-sensitization may also be the source of allergic reaction.

Before therapy for horse allergy, a comprehensive allergological work-up has to be carried out. Kürschner and Jugert found that patients without proven allergy against horses claimed to have one [15]. Following the diagnosis of a horse allergy, one first has to decide on the necessity of a desensitization therapy. The efficacy of such a therapy has been

Overview of horse allergens and their molecular weights (after [13] and IUIS)				
New nomenclature	Old nomenclature	Weight (kDa)	pI	Reference
Equ c 1	Equ c 1	25	4.57	16, 17, 18
Equ c 2	Equ c 3	17	3.8	19, 20
	Equ c 2			19
Equ c 3	Antigen 3	65		11
Equ c 4	Equ c 4	17, 20.5	3.8	21
Equ c 5		16.7	5.25	21

Equ c 5 was deleted by IUIS on 30 August 2012

Table 3

shown by Fernandez-Tavora [23], who desensitized 24 patients without complications using an extract of horse scales (Alutard SQ®). Immonen et al. [24] found the 18mer peptide p 143-160 from the immunodominant region of Equ c 1 as a potential candidate for peptide-based immunotherapy of horse-sensitized persons.

However, there may be a potential alternative for horse-allergic patients: riding Curly horses.

Special situation with Curly horses

The so-called “horses with curls” are attributed with hypoallergenicity. This judgment is not based on a scientific clinical study but only on a single case study [15] and the experience of riders (www.abcregistry.org; www.curlyhorses.org).

The origin of this breed is not clear [25]. They may originate from Russian horses (Lokai not Bashkir) or from Latin American/Spanish horses [25] or even be an indigenous Northern American breed.

To obtain a relatively pure breed by closed studbooks, Curly horses are listed in the ABCR register (American Bashkir Curly Horse Registry). After 2000, Curly horses are also registered in the ICHO register (International Curly Horse Organization), allowing breeding to produce a larger variability of the exterior characteristics.

The outer features of Curly horses are described elsewhere (www.abcregistry.org; www.curlyhorses.org). **Figure 2** shows the characteristics of a micro-curl Curly horse.

Sponenberg has shown that the genetic property of the American Curly horse to generate curls is a dominant trait [25, 26]. Using polarization stress analysis, Farrell found that curly hairs exist at birth, having a more oval cross section in contrast to other horses with a round cross section [25].

Bowling in California did not succeed in establishing a Curly-typical constellation in blood typing of 200 Curly horses [25].

It is not known whether the outer properties of this horse breed are responsible for the detected hypoallergenicity. Investigations of the skin of Curly horses by biopsy did not reveal any relevant histological differences to other horses [27]. Only the number of follicular dysplasia was significantly higher. Felix and coworkers compared various horse breeds and demonstrated that the two Bashkir Curly horses investigated did not yield any differences in the Immunoblot test of 20 pooled patients with horse allergy [28]. They found 19 different allergens (from 14 to 130 kDa), much more than the defined allergens of IUIS. They also found a high variation in allergen content of individual horses. They believe that the release of dander in this long-haired animal may be the reason for the perceived low allergenicity.



Figure 2: Curly horse

We cannot confirm this hypothesis based on our scratch test results, in which our microcurl Curly (ABC 3975) with long hairs resulted in more reactions in individual patients than the straight hair curly (ABC P 2563). However, we can confirm that despite a positive reaction in the skin scratch test, the study patients could ride and brush these Curly horses without the severe allergic reactions they previously experienced as a result of horse contact. In addition, the origin of the two Bashkir Curly horses in the study of Felix [28] had not been defined according to the register of origin for Curly horses. Thus, it is not clear which horses were actually used. The work also suffers from a methodological weakness, since the results list only two Bashkir Curly horses and a Russian Bashkir horse, the latter from a breed that is genetically not related to the American Curly horse. In contrast to Felix [28], Kürschner and Jugert [15] detected a reduced amount of allergens in Curly horse epithelia in a single Western blot test.

In this case study, no correlation between the property of Curly hair (microcurl Curly hair and straight Curly hair) and allergic reactions could be established between the two mares. The reason for the low-allergic potential of Curly horses obviously seems not to be linked with the degree of curls of the horses and also not with the severity of the riders' allergic anamnesis. The presence of rhinoconjunctivitis or previous allergic asthma in the anamnesis was not relevant for the reaction in the scratch test.

The results of this study confirm for the first time the empirical findings that previously diagnosed horse-allergic patients suffer from milder or even no allergic symptoms when riding Curly horses. Nevertheless, the results cannot be used to claim that Curly horses lack any allergenic potential.

Although the present study has limitations (it was neither blind nor carried out under controlled con-

ditions for methodological reasons), it can be stated that there are horse-allergic riders who, when riding Curly horses, do not experience, or only mildly, the allergic symptoms they knew from the past.

On the other hand, single riders may still suffer from a clear deterioration in their lung function when in close contact to Curly horses, such as brushing; however, their reaction was still not as severe as that experienced in previous contact with other horses.

In the group of patients tested, on average the scratch test Curly horses showed a weaker reaction than the prick test (horse); the peak expiratory flow data show no relevant decrease after riding – mostly also after brushing – these Curly horses.

These facts indicate that contact of horse-allergic riders with Curly horses can only be recommended under controlled conditions where emergency treatment is immediately available. In conclusion, we recommend that horse allergic riders undergo a scratch test with the individual Curly horse planned for riding, and to check the peak expiratory flow after riding and brushing these horses.

Therefore, our case study shows that Curly horses seem to be suitable for otherwise horse-allergic riders who want or need to continue riding. Further investigations and individual validations are necessary.

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Conflict of interest

The corresponding author states the following: The author is an independent, self-employed physician, whose wife is a registered ABC breeder of Curly horses and the owner of the horses in the case study.

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