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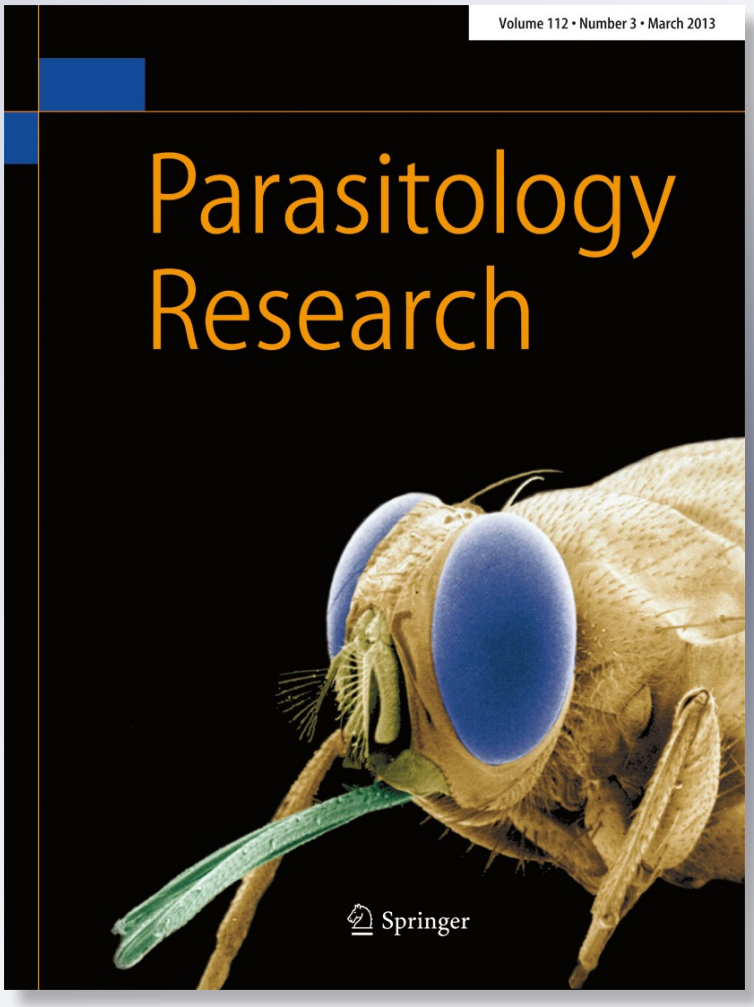

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SHORT COMMUNICATION

Comparative efficacy of commercial combs in removing head lice (*Pediculus humanus capitis*) (Phthiraptera: Pediculidae)

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Abstract The use of a fine comb for removing lice from the head of the human host is a relevant tool both in the diagnosis of infestations and as part of an integrated control strategy of head lice. The effectiveness of a fine comb depends, in part, on the design and material they are built. The aim of this study was to compare in vivo the efficacy of metal and plastic combs that are currently used in the removal of head lice and eggs worldwide. The space between comb teeth and the length was 0.23 and 13 mm in KSL® plastic, 0.3 and 10.7 mm in NOPUCID® plastic, 0.15 and 31 mm in KSL® metal and 0.09 and 37 mm in ASSY® metal. The assays were performed comparing the combs in pairs: (a) KSL® vs. NOPUCID® plastic combs, (b) KSL® vs. ASSY® metal combs and (c) KSL® plastic comb vs. ASSY® metal comb. The most effective plastic comb was KSL®, removing a higher number of individuals of all stages. The most effective metal comb was ASSY®, removing more insects of all stages (except adults). The comparative test between KSL® plastic and ASSY® metal showed that ASSY® was the most effective in removing head lice and their eggs.

Introduction

Pediculosis is produced by *Pediculus humanus capitis* De Geer (head lice) and mainly affects school-aged children both in developed and developing countries (Toloza et al. 2009). Its diagnosis is based on the detection of adults, nymphs and/or viable eggs in the human head, which represents an active infestation and requires an appropriate treatment for its control (Mumcuoglu et al. 2001). It has been reported that the diagnosis of pediculosis was more effective using a fine comb than visual examination, since visual examination underestimates active infestation because lice can be detected only in highly infested children (Mumcuoglu et al. 2001; Balcioglu et al. 2008; Jahnke et al. 2009).

Combs are used not only for diagnosis but also as part of an integrated control strategy. This is especially relevant after the detection of high levels of insecticide resistance in head louse populations from several countries (Burgess 2004; Mougabure Cueto and Picollo 2010; Gallardo et al. 2009). Previous studies have reported no significant differences in the effectiveness of two metal combs (Kurt et al. 2009). However, another study found significant differences between metal and plastic combs in removing eggs, but not mobile stages (Speare et al. 2007). The aim of this study was to compare the efficacy of commercial combs that are currently used in the removal of head lice and their eggs. The assays were performed, comparing the combs in pairs.

Material and methods

KSL® plastic and metal combs were provided by KSL Consulting (Helsinge, Denmark), NOPUCID® plastic comb was provided by ELEA S.A. (Buenos Aires, Argentina), and ASSY® metal comb was purchased in an Argentinean market (Buenos Aires, Argentina). The space between comb teeth in KSL® plastic was 0.23 mm, and the length was 13 mm. NOPUCID® plastic showed 0.3 mm between comb

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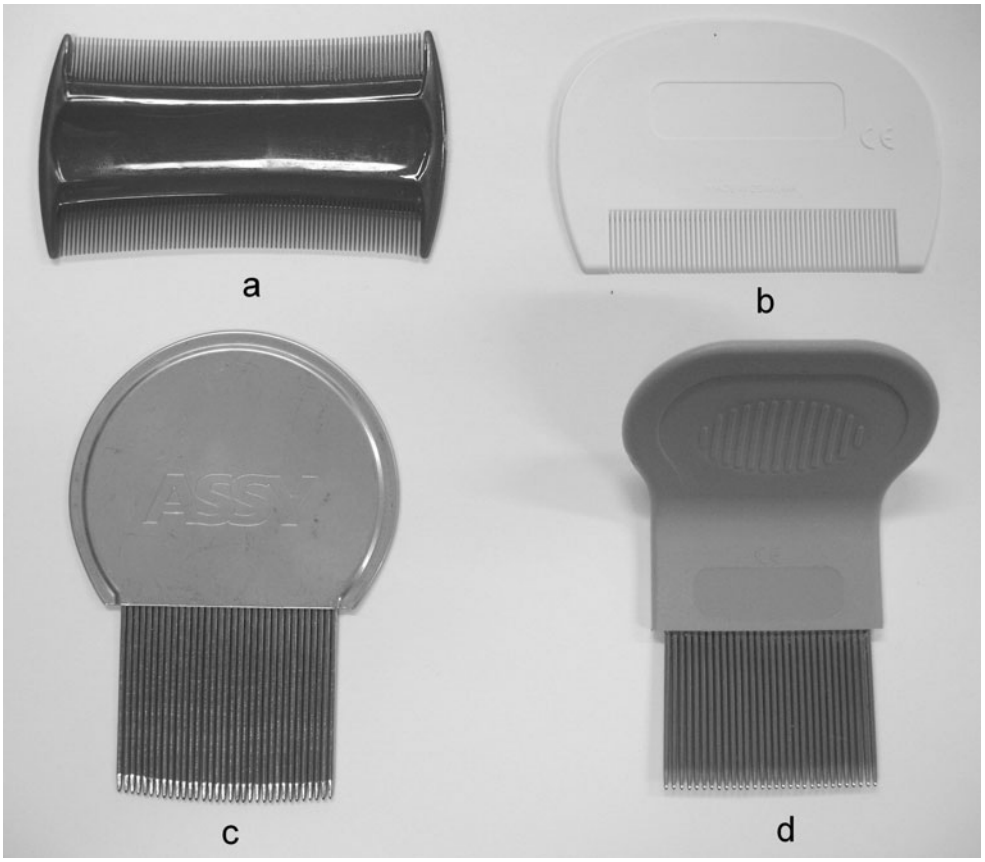

Fig. 1 Fine combs evaluated: **a** NOPUCID® plastic comb, **b** KSL® plastic comb, **c** ASSY® metal comb, **d** KSL® metal comb

teeth and 10.7 mm large. KSL® metal showed 0.15 mm between teeth and 31 mm, and a plastic grip. Finally, ASSY® metal showed 0.09 mm between teeth and 37 mm, and a metal grip (Fig. 1). The assays were performed comparing the combs in pairs, KSL® vs. NOPUCID® plastic combs, KSL® vs. ASSY® metal combs, and KSL® plastic comb vs. ASSY® metal comb.

The study was conducted in elementary schools from Buenos Aires City, Argentina, where the participation of children was authorized by their parents. A total of 1,243 children (6–12 years old) were studied, and children infested with more than ten head lice (n=50), according to the description detailed below, were included in the study. The hair was divided in bilateral halves, and each half was randomly assigned to each fine comb of the pair to be evaluated. For each one, we combed ten times: four from the forehead to the neck, three in reverse, and three from the region behind the ears toward the centre of the head. This examination covered the entire head. In each pair comparative test, the combings were conducted by the same person. The design assumes homogeneous distribution of lice on each half of the same head; thus, the starting number of insects available was the same on each half.

Before using the fine comb, the hair of each child was combed with an ordinary comb in order to untangle the hair

Table 1 Comparative efficacy of KSL® and NOPUCID® plastic combs in removing head lice

Stage	Lice removed (n=16)[b]				T value	p value
	KSL® comb		NOPUCID® comb			
	Mean±SD (n)[b]	Total	Mean±SD (n)[a]	Total		
Nymph I	1.50±1(4)	6	0.25±0.4 (4)	1	0.00	0.068
Nymph II	2±1.1 (4)	8	1.50±1.1 (4)	6	3.50	0.583
Nymph III	2.10±1 (9)	19	0.55±0.7 (9)	5	0.00	0.007
Adult	3.25±3.7 (16)	52	3±2.1 (16)	48	57.50	0.88
Total eggs	1.33±0.5 (6)	8	0.50±0.7 (6)	3	2.00	0.138
Hatched eggs (nits)	1.33±0.5 (6)	8	0.50±0.7 (6)	3	2.00	0.138

[a]Number of studied infested heads

[b]Number of heads from which instars were collected

Table 2 Comparative efficacy of KSL® and ASSY® metal combs in removing head lice

Stage	Lice removed (n=13)[b]				T value	p value
	KSL® comb		ASSY® comb			
	Mean±SD (n)[b]	Total	Mean±SD (n)[a]	Total		
Nymph I	1.33±2.3 (9)	12	3.44±2.5 (9)	31	3.50	0.075
Nymph II	1.37±1.0 (8)	11	4.37±2.77 (8)	35	2.50	0.029
Nymph III	1.88±2.1 (9)	17	2.22±1.92 (9)	20	13.50	0.520
Adult	6.30±5.29 (13)	82	4.61±3.5 (13)	60	22.50	0.195
Total eggs	6.07±6.69 (13)	84	61.92±70.5 (13)	867	0.00	0.0009
Hatched eggs (nits)	2.35±3.57 (13)	32	23.42±22.31 (13)	328	0.00	0.001

[a]Number of studied infested heads

[b]Number of heads from which instars were collected

to allow the optimum slippage of the fine combs. That combing, interpreted as a control carried out with a normal comb, did not remove any lice (eggs, nymphs or adults) in any case. The Wilcoxon matched pairs test was used to compare the efficacy of the two combs evaluated in each comparison using InfoStat software (Di Rienzo et al. 2011). The test evaluates the difference between pairs of observations as variable, and the null hypothesis is that the median difference between pairs of observations is zero. The comparison was significantly different when $p<0.05$. The means are reported as a descriptive value.

Results

The two plastic combs removed more adults than nymphs or eggs. KSL® removed a higher number of individuals of all stages; however, significant differences were only found for nymphs III ($p=0.007$). All the eggs removed by the two plastic combs were hatched eggs (Table 1).

The two metal combs showed higher efficacy in removing eggs than in removing mobile stages. ASSY® removed more insects of all stages (except adults), showing significant differences for nymph II and eggs (Table 2).

The comparative test between KSL® plastic and ASSY® metal showed that ASSY® removed more individuals of all stages, showing significant differences for nymph I, and eggs (Table 3).

The percentages in Fig. 2 indicate the number of lice (all mobile stages) that were removed by one comb with respect to the number of lice removed by the two combs of the evaluated pair. The results showed that KSL® was the most effective plastic comb ($p<0.05$), ASSY® was the most effective metal comb ($p>0.05$), and ASSY® metal removed significantly more lice than KSL® plastic comb ($p<0.05$).

Discussion

This study consisted of a pair comparison of the effectiveness of four fine-toothed combs in removing head lice. Firstly, comparative tests of the same material combs (plastic or metal) were made, and then the two most effective combs were compared between them. In general, the higher differences were assessed between ASSY® metal and KSL® plastic in removing eggs.

The comparison of same material combs suggested that the space between comb teeth is an important feature in removing lice. The most effective plastic comb has smaller distance between their teeth (0.23 vs. 0.3 mm). Similarly, the most effective metal comb was that with the smallest distance (0.09 vs. 0.15 mm).

Table 3 Comparative efficacy of the best-performing plastic (KSL®) and metal (ASSY®) comb in removing head lice

Stage	Lice removed (n=21)[b]				T value	p value
	KSL® comb (plastic)		ASSY® comb (metal)			
	Mean±SD (n)[b]	Total	Mean±SD (n)[a]	Total		
Nymph I	0.83±2.2 (12)	10	3.66±3.54 (12)	44	8.50	0.03
Nymph II	1.0±0.9 (5)	5	2.6±1.2 (5)	13	0.00	0.108
Nymph III	1.0±1.7 (12)	12	2±1.47 (12)	24	12.00	0.114
Adult	4.0±5.9 (18)	72	4.83±5.34 (18)	87	61.00	0.717
Total eggs	0.85±2.4 (21)	18	19.52±24.9 (21)	410	5.00	0.0001
Hatched eggs (nits)	0.33±1.1 (21)	7	12.85±15.04 (21)	270	0.00	0.0001

[a]Number of studied infested heads

[b]Number of heads from which instars were collected

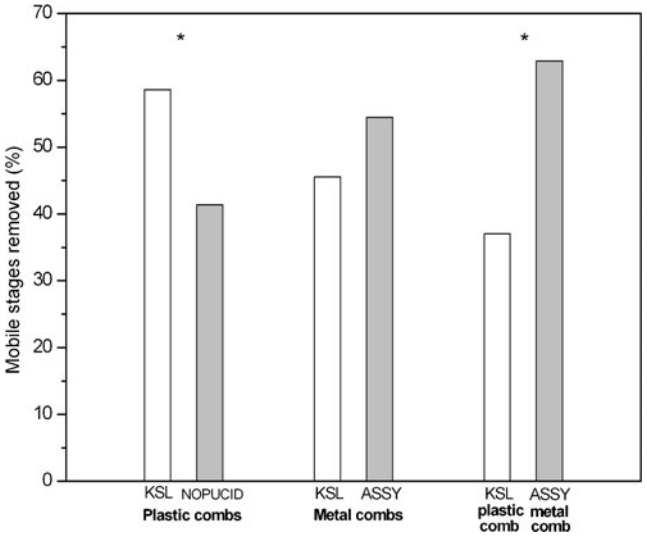

Fig. 2 Mobile stages removed in each treatment group. *Asterisks* indicate significant differences ($p<0.05$)

Despite the importance of fine-tooth combs in the control of head lice, there are no available data on the comparative effectiveness of plastic combs. Kurt et al. (2009) evaluated two metal combs that only differ in the gap between their teeth, and they have not detected statistically significant differences. These results differ from those obtained in the present study, probably because the combs used by Kurt et al. (2009) had smaller difference in space between teeth (0.15 vs. 0.18 mm) than combs used in the present study (0.09 vs. 0.15 mm).

The comparison of different material combs demonstrated that the metal was more effective than plastic in removing mobile stages and eggs. Similar results were reported by Speare et al. (2007) who found that the metal comb was significantly more effective than plastic comb in removing eggs. However, they have not detected significant differences in the removal of mobile stages. Those authors had not concluded if the differences in efficacy were related to the shape of the teeth or the construction material (Speare et al. 2007). In our study, important differences were found between combs which differ in the material, space between teeth and length of teeth. However, further studies are needed to assess the features of the combs related to the effectiveness in removing head lice and eggs. This study demonstrated that same material combs are not necessarily equally effective in removing lice and eggs and that the evaluated metal comb was more effective than the evaluated plastic comb.

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