



Correlation among cap design, gripping technique and age in the opening of squeeze-and-turn packages: A biomechanical study



Gabriel H.C. Bonfim^{a,*}, Fausto O. Medola^b, Luis C. Paschoarelli^b

^a Graduate Programme in Design, UNESP – Univ. Estadual Paulista, Bauru, SP, Brazil

^b Graduate Programme in Design, Department of Design, UNESP – Univ. Estadual Paulista, Bauru, SP, Brazil

ARTICLE INFO

Article history:

Received 30 March 2015

Received in revised form

3 June 2016

Accepted 12 June 2016

Available online 29 June 2016

Keywords:

Packaging operability

Ergonomics

Biomechanics

ABSTRACT

Child-Resistant Packagings (CRPs) are important because they prevent children accessing potentially harmful products. However, the locking mechanism located on the caps still presents usability problems, especially for elderly users. The aim of this study was to evaluate the effects of packaging design, gripping technique and age in the transmission of torque when opening packages with squeeze-and-turn closures. Three different packages of mouthwashes (squeeze-and-turn type) were analyzed and two gripping techniques were used: tridigital and bidigital. The sample comprised one hundred subjects across five age groups equal in size (3–5 years; 8–12 years; 13–17 years; 30–59 years; over 60 years). For maximum torque measurement, the packages were adapted to receive a torquimeter internally installed and connected to the cap. The results show that packaging design, gripping technique and age are factors that influence the transmission of torque when opening squeeze-and-turn packages. In terms of the packaging design, the cap with the largest diameter allowed the application of higher torques. The opening process using the tridigital gripping presented higher values than the bidigital. In terms of the relative strength of grip across the age groups, children from 3 to 5 years presented the lowest torque values. However, the torque transmission with tridigital grip for children under 5 years old was higher when compared to the bidigital grip for all groups and packagings. The current findings provide biomechanical data on opening squeeze-and-turn packages, contributing to the design of packages that best balance safety and usability.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Every year, about 35,000 children from 0 to 14 years old die as a consequence of unintentional intoxication (Gordon et al., 2004). In an effort to limit children's access to toxic substances, special packaging opening systems – Child-Resistant Packaging (CRP) – have been used in a number of products. Despite the importance of CRPs in the reduction of accidental intoxication among children, many users (mainly the elderly) experience problems in accessing the package content. Therefore, ergonomic studies on the biomechanics of opening CRPs are needed to clarify the underlying aspects that lead to the success or failure in CRP safety.

The efficacy of CRPs in restricting a child's access to it must be at least 85% without previous instruction or demonstration, and not less than 80% after it. The international standard “ISO 8317:2004 CR packaging – Requirements and testing procedures for reclosable packages” (ISO, 2003) establishes test methods to limit the access of children and ensure accessibility for adults between 50 and 70 years old.

The packaging opening process has been addressed by many studies. Many of these show that older adults experience difficulties and limitations in the packaging interaction (Berns, 1981; Voorbij and Steenbekkers, 2002; Fair et al., 2008; Carse et al., 2011). Although the packaging design should be intuitive, suggesting a specific action of opening, the strategy chosen varies from user to user (Rowson and Yoxall, 2011). Other studies have also evaluated the torque transmission by the hands and fingers (Su et al., 2009), as well as the relationship between the materials and the opening process (Andreasson and Jönsson, 2014).

In the case of CRPs, many studies have shown concern about the usability of this kind of packaging, highlighting the danger that

* Corresponding author. Graduate Programme in Design, UNESP – Univ. Estadual Paulista, Av Eng Luiz Edmundo Carrijo Coube, 14-01, Bauru, SP, 17033-360, Brazil.

E-mail addresses: gabrielhcbonfim@gmail.com, gh_cb@hotmail.com (G.H.C. Bonfim), fausto.medola@faac.unesp.br (F.O. Medola), paschoarelli@faac.unesp.br (L.C. Paschoarelli).

children still can access the content of such products (Assargaard and Sjoberg, 1995; Rodgers, 1996; Schmidt et al., 2004). In addition, it is known that the elderly population has great difficulty in opening CRPs (Nayak, 2002; Ward et al., 2010; Bix and de la Fuente, 2012), and this problem may lead to inappropriate actions, such as transferring the content to an easy-to-open recipient, leaving the CRP uncapped, or simply emptying the content into drawers or bags (Winder, 2009).

While there has been considerable research on specific aspects of the opening process of CRPs, to our knowledge, no studies correlate the packaging design, the gripping technique and the age of the subjects. This is important since these variables are factors that greatly influence the opening process. Therefore, this study aimed to assess the influence of the cap design, the prehension technique and the age in the torque transmission when opening squeeze-and-turn packages. This knowledge may benefit designers and manufacturers by providing biomechanical parameters to be used in the design of packaging that best meet users' abilities, needs and expectations, favoring the product ergonomics.

2. Materials and methods

This study was carried out in the Ergonomics and Interfaces Laboratory at Univ. Estadual Paulista – UNESP, Bauru, Sao Paulo, Brazil.

2.1. Participants

A total of 100 subjects voluntarily participated in this study. The sample was equally divided into five groups of different age intervals: 3–5 years (avg = 4.68; s.d. = 0.47); 8–12 years (avg = 10.30; s.d. = 1.03); 13–17 years (avg = 15.60; s.d. = 1.17); 30–59 years (avg = 45.90; s.d. = 6.81); above 60 years (avg = 74.67; s.d. = 9.08). Each group comprised 20 subjects (10 male; 10 female). The younger subjects (groups 3–5, 8–12, 13–17) were recruited in municipal schools from Bauru, Sao Paulo, Brazil. The subjects in the 30–59 years and over 60 years groups were individually invited to participate in the study.

2.2. Materials

Three different squeeze-and-turn packages of mouthwashes were evaluated in this study (Fig. 1). These packages were selected because they are popular brands, easy to find and they have different designs of cap. The containers are made of Polyethylene Terephthalate (PET) while the caps are made of Polypropylene (PP). The caps are flexible enough on the bases to allow a degree of deformation that is necessary for the opening. To open this type of package it is necessary to squeeze the side tabs of the cap, so that the lugs on the cap are deformed away from the container. While squeezing the cap it is also necessary to turn it, this way the cap's lugs override those on the container, enabling the opening (Fig. 2).

In order to measure maximum torque applied to the caps, a torquimeter (Static Torque Screwdriver - STS - Mecmesin Ltd., UK) was internally installed in the packaging and connected to an extension attached to the cap (Fig. 3).

2.3. Methods

Torque measurements were taken for each subject with the three packages using two gripping techniques: bidigital and tridigital (Fig. 4). Subjects were instructed to hold the packaging at the height of the abdomen and turn the cap with their maximum strength. The sequence of packages and gripping techniques were randomized with online software (www.random.org). A single

torque measurement was taken for each packaging and gripping technique; therefore each subject performed a total of six trials, with one minute rest interval between the trials.

Prior to data collection, volunteers read and signed an informed consent form that had been approved by the Ethics Committee of Faculty of Science (Process n. 254.413/2013). In the case of the children, the Consent was obtained from their parents or guardians.

2.4. Data analysis

The average (and standard deviation) torque was obtained for each group of subjects in each of the six situations (two gripping techniques and three packagings). The condition of normality (Shapiro Wilk's W test) and homogeneity (Levene's test) of data were verified. In order to compare the average torque among the groups, ANOVA test was applied to normal and homogeneous data to compare both devices. Non-parametric tests were applied (Friedman, Kruskal-Wallis, Mann-Whitney or Wilcoxon) to the data sets that did not meet these conditions. All results were considered significant at a P value of 0.05 or less.

3. Results

The results for the average maximum torque for the three packages and two gripping techniques among all groups are summarized in Fig. 5. Grip technique was shown to be a key factor influencing torque transmission when opening CRPs. For all the subjects groups, maximum torque was significantly greater with tridigital prehension than bidigital for all the packages.

Overall, the transmitted torques of children (3–5 years) were lower than all other groups when opening the three packagings, taking each prehension technique separately. Furthermore, the maximum torque measurements of the elderly group were lower when compared to adults (30–59 years), with significant difference found only for the packaging with cylindrical cap.

Considering the cap design, the greater maximum torques were found in the packaging with inverted conical cap for all groups and both gripping techniques, with significant differences when compared to the packaging with conical cap. When it comes to gripping technique, the tridigital torque measurements for the packaging with conical cap were the lowest values for all groups.

Possibly the main finding of this study is that the torque transmission with tridigital grip for children under 5 years old (the risk group for accidental poisoning) was higher when compared to the bidigital grip for all groups and packages.

4. Discussion

Research on the ergonomics of packages has been of increasing interest as it influences both product usability and marketing. Although the importance of ensuring the safety of the CRPs in order to prevent children having access to potentially harmful content is recognized, the mechanism of locking-opening the cap has affected product usability among adults and the elderly. Therefore, the investigation into the factors influencing torque transmission in opening CRPs may provide objective parameters that may be of great interest for designers and manufacturers in developing packages that can be both protective and usable. To our knowledge, this is the first study that addresses the biomechanics of opening squeeze-and-turn packages that correlates packaging design, gripping technique and user age.

In general, the most immediate biomechanical strategy for opening a screw-cap packaging is through the use of tridigital grip. When opening CRPs, users usually do not search for informative instructions in the package about the correct opening technique

Download English Version:

<https://daneshyari.com/en/article/1095796>

Download Persian Version:

<https://daneshyari.com/article/1095796>

[Daneshyari.com](https://daneshyari.com)