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Pain and fear in connection to orthodontic extractions of deciduous canines

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Background. Interceptive extractions of deciduous canines are, from a patient perspective, poorly investigated.

Aims. To describe pain, discomfort, and dental fear in connection to extractions of the deciduous canines, indicated as an orthodontic treatment procedure.

Design. Thirty-two Swedish children aged 7–9 years had all four deciduous canines extracted over three occasions. The children rated procedural and postoperative pain on visual analogue scales. Acceptance of injections and extractions was assessed by the treating dentists. Analgesic consumption and recovery time for drinking and eating was reported by parents. Dental fear was assessed using the Children's Fear Survey Schedule questionnaire.

Results. Procedural pain showed low median levels, although some individuals reported high values. Boys reported significantly more pain at appointments when two (as opposed to one) canines were extracted. Postoperative pain levels were low and use of analgesics sparse. Dental fear paralleled norm values and did not increase from pre- to post-extraction.

Conclusions. Pain management routines during extractions of this kind should be revised. Single tooth extractions seem to be preferable to extractions of two canines at the same appointment. Extraction of four deciduous canines should not cause major postoperative inconvenience; these extractions neither triggered nor increased dental fear.

Introduction

Dental crowding is found in at least one-third of the child and adolescent populations[1]. So-called 'serial extraction'[2] is a well established but controversial[3] interceptive treatment procedure, with the aim of creating space and thereby facilitating spontaneous correction of mal-positioned permanent incisors[2]. The first step is the removal of the deciduous canines in the early mixed dentition, and additional extractions of primary molars and permanent premolars are frequently needed[2]. Thus, a substantial number of invasive treatment procedures may be performed on children with presumably limited dental experience. Such a demanding, and perhaps painful, early or even first encounter with dental treatment might constitute a risk of inducing dental fear[4].

Most studies concerning pain in connection to extractions of deciduous teeth relate to postoperative pain[5,6], whereas procedural pain is more commonly presented in relation to other types of invasive treatment procedures[7]. Therefore, our knowledge regarding procedural pain connected to early interceptive extractions is mainly based on anecdotal information from clinicians.

Pain has been defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage[8]. In addition to physiological responses, its complex aetiology includes past experiences, learned responses, and expectations[9]. Negative effects on pain perception during subsequent

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treatment sessions[10] and later in life[11] have been reported in connection to painful early invasive dental treatment.

Pain sensitivity has traditionally been reported to be greater among women than among men because of a combination of biological and sociological differences[12]; however, studies on postoperative pain among adolescents and young adults have presented inconsistent results on gender differences[4,5,13].

Discomfort experienced in connection to tooth extraction is most certainly influenced by pain[4] and dental fear/anxiety[14–16]. It is also associated with the sensation of anaesthesia and unfamiliar or unpleasant tastes[17] Disturbances in everyday routines, such as recovery time for drinking and eating could probably also create a certain amount of discomfort.

Furthermore, a review by Tate and Acs[9] revealed insufficient use of medical pain alleviation (analgesics, local anaesthesia, and sedatives) in dental treatment of children. About one-third of children undergoing extractions of deciduous teeth reported postoperative pain, according to two studies on North American children (aged 6–9 years and 2–10 years, respectively)[5,6]. Analgesics were given to less than or half of those reporting postoperative pain, and to 13–18% of all children. During recent years, studies on Danish[18] and Swedish[19] dentists' attitudes towards procedural pain and pain management have shown that a substantial portion of the dentists believe that young children report pain with uncertainty. Less than 90% of the Danish dentists reported that they 'always or often' used local analgesia for restorative work. The Swedish dentists were reported to 'underuse' local analgesia, analgesics, and sedatives during dental treatment of children and adolescents[18,19].

Efforts to minimize experiences of pain in the early years are important not only to avoid discomfort at the time, but also to prevent the risk of triggering dental fear[4] and the risk of future avoidance of dental treatment[20].

Dental fear has been associated with tooth extraction in studies on children in Finland[14]and in the Netherlands[15,16]. A significant but weak relationship between the number of extractions and the level of fear was found in the study by Ten Berge *et al.*[16]. Klassen *et al.* found that little of the variance in fearfulness could be explained by the extractions, although the fearful children had more experience of extractions[15].

These findings indicate the importance of performing interceptive orthodontic extractions in a manner that minimizes the risk of inducing or increasing dental fear.

The primary aim of this study was to describe procedural and postoperative pain and discomfort among child dental patients undergoing orthodontic extractions of four deciduous canines. A secondary aim was to explore changes in dental fear from pre- to post-treatment.

Material and methods

Subjects

The study participants were recruited from children attending 250 orthodontic consultation appointments in Örebro County, Sweden from November 2005 to June 2007. To meet the inclusion criteria, children had to be in the early mixed dentition stage and exhibit moderate to severe anterior crowding.

Exclusion criteria were diseases affecting somatic growth, neuro-psychiatric disabilities, and/or learning disabilities. Children diagnosed with agenesis and/or having undergone extraction of a primary or permanent tooth and/or earlier or ongoing orthodontic treatment were excluded. Children or parents in need of an interpreter during the treatment dialogue were also excluded.

One hundred and ten children and their accompanying parents were invited to participate in a randomized controlled study of the effect of serial extraction on incisor alignment. Sixteen children/parents declined participation without giving a specific reason, 11 requested either extraction or nonextraction treatment and were also excluded. Eighty-three children were randomized stratified for gender into one extraction and one control group. Of the 40 children randomized to the extraction group, 4 girls and 2 boys were excluded after being randomized because of

notations of increased mobility of the deciduous canines. One girl/parent changed their mind about participating and 1 girl was referred to paediatric specialist care for extractions of the first molars together with the deciduous canines. Thus, the study group in this report consisted of those agreeing to participate and randomized to the intervention group (i.e., four extractions to be performed); 14 boys and 18 girls with a mean age (SD) of 8.6 (0.7) and 8.3 (0.5) years, respectively.

Dental records were retrieved for all children regarding earlier treatment experiences, and the variables were recorded as present or not at any time from the age of four to the time of randomization. Of the 32 children included, 10 had previous experience of invasive treatment with ($n = 8$) or without ($n = 2$) injection of local anaesthesia. For two children, invasive dental treatment had been performed at emergency care.

All participants, children and parents, received oral and written information about the study, and signed informed consent was provided by an adult with parental responsibilities and rights. The study was approved by the research ethics committee Regionala Etikprövningsnämnden, Stockholm, Sweden.

Procedures

All interventions took place at public dental clinics, and the child's usual dentist performed the extractions following clinical routine procedures. Pre-extraction parental ratings of dental fear were solicited before randomization. The deciduous canines were removed in a specific order over three occasions. At the first appointment the left lower canine (73) was extracted, at the next visit the two canines on the right side (53 and 83) were removed, and at the last visit the upper left canine (63) was extracted. Post-extraction dental fear was rated after the extractions had been performed.

A diary was used for registration of procedural pain and discomfort, postoperative pain, analgesic consumption, and postoperative recovery time for drinking and eating. One diary lacked registrations for pain and discomfort, and was excluded from these analyses.

Measures

Procedural pain and discomfort were reported by the child, guided by a parent, on two 100 mm visual analogue scales (VAS) with 'no pain' and 'worst imaginable pain' and 'no discomfort' and 'worst imaginable discomfort' as the respective endpoints. Postoperative pain was reported at bedtime over 7 days using a similar scale. We used 30 mm on the VAS as the cut-off point for considerable pain, based on standards for offering pain alleviation at Karolinska University Hospital in Huddinge/Solna, Sweden[21].

As a complement to the self-ratings of procedural pain and discomfort, the treating dentist rated the child's acceptance for injections and extractions separately at each occasion. Ratings on a four-point scale (from 0 to 3)[22] were categorized in the analysis as follows: nonacceptance = ratings of 0–1, reluctant acceptance = rating of 2, and full acceptance = rating of 3. One girl was sedated during all three occasions and, therefore, categorized under nonacceptance although the dentist scored her as 3.

Postoperative discomfort was evaluated from parental diary reports of pain medication (type, quantity, and concentration) over 7 days and median recovery time for drinking and eating (for the first time after the extraction, and 'as usual').

Dental fear was assessed using the Swedish version of the Dental Subscale of the Children's Fear Survey Schedule (CFSS-DS) questionnaire for parental ratings. The pre-extraction questionnaire (pre-ex) was sent out to the participants in the study before randomization to the extraction or control group. The post-extraction questionnaire (post-ex) was returned within 3 weeks after the extraction had been carried out. The cut-off point for dental fear was set at a CFSS-DS score of ≥38, in accordance with earlier studies[23–26], with a borderline range from score 32[26].

Statistical methods

Descriptive statistics (mean, SD, median, interquartile range, min., max.) were used to report data. Differences between groups were

analyzed using the Mann–Whitney *U*-test, and changes over time were analyzed with the Wilcoxon signed-rank test. McNemar's test and Fischer's exact test were used for analysis of categorical data in small groups. Spearman's rank correlation coefficient (*r*) was used for presenting correlation between variables. A *P*-value less than 0.05 was considered statistically significant. Statistical analyses were performed using version 15.0 of the SPSS software package (SPSS Inc., Chicago, IL, USA).

Results

Procedural pain and discomfort

Procedural pain showed low median levels on all three extraction occasions (6/100, 8/100, and 2/100, respectively). Some individuals reported high values; the total ranges were 0–59, 0–83, and 0–99 (Fig. 1). Among the boys, a significantly higher pain level was reported when two teeth were extracted when compared with the occasions when one tooth was extracted (23.5 *vs* 6 and 3; $P = 0.02$ and $P = 0.03$, respectively; Fig. 1). Girls reported low median levels on all three occasions (Fig. 1). Seven children (six boys, one girl) had pain scores exceeding 30/100 on the VAS at least once (i.e., at least at occasion 2) during the three appointments.

Discomfort was scored at median levels 7, 8, and 10, with ranges 0–89, 0–95, and 0–95 (Fig. 1). Differences between boys and girls were nonsignificant (Fig. 1).

Fifteen children (five boys, ten girls) were categorized under full acceptance for both injection and extraction at all three treatment occasions, whereas 11 children (6 boys, 5 girls) showed reluctant acceptance and 6 children (3 boys, 3 girls) were nonacceptant at any of the three occasions (Table 1). Although statistically nonsignificant, there were fewer children showing full acceptance during the second appointment when compared with occasions 1 and 3 for both injection (17 *vs* 26 and 21) and extraction (21 *vs* 27 and 26; Table 1).

Postoperative pain and discomfort

Median VAS ratings for postoperative pain at bedtime after each of the three occasions ranged from 0 to 3.5, and did not differ between boys and girls (Fig. 2). Individual maximum scores for pain reported at bedtime were 59 on the first evening, 33 on the second, and 21 on the third, and decreased thereafter. Two boys and two girls reported pain exceeding the clinically accepted cut-off (>30 on the VAS) during the first two evenings after the extractions at occasion 2.

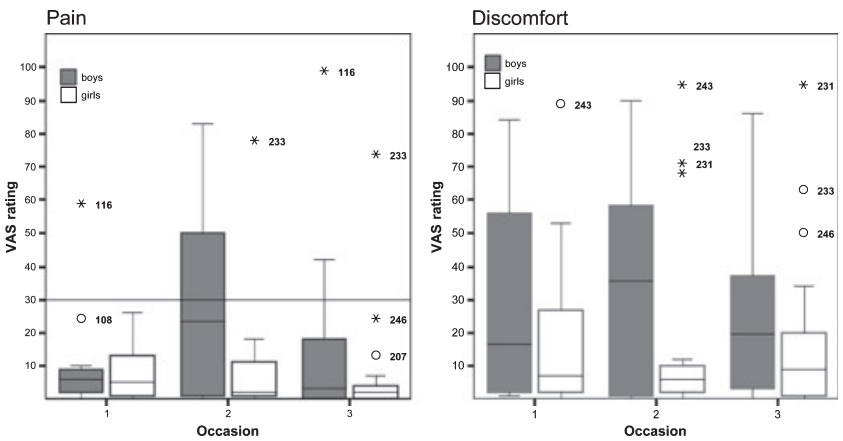

Fig. 1. Ratings of procedural pain (left) and discomfort (right) at extraction occasions 1, 2, and 3. Box plots showing median, interquartile range, and min. and max. values for boys and girls. Whiskers less than 1.5 box lengths from either end of the box show min. and max. values. Outliers (o) are defined as cases with values that are 1.5 to 3 box lengths from either end of the box, and extreme values (*) are defined as cases with values more than 3 box lengths from either end of the box. The vertical axis represents the 100 mm visual analogue scale, with 'no pain/discomfort' and 'worst imaginable pain/discomfort' as endpoints. Case numbers from 100 represent boys and numbers from 200 represent girls.

Table 1. Rated acceptance categorized into nonacceptance, reluctant acceptance, and full acceptance. Total number, boys, and girls categorized by acceptance of both injection and extraction at all three occasions and acceptance at sessions 1, 2, and 3.

	All three occasions			Injection			Extraction		
				Occasion			Occasion		
	Total	Boys	Girls	1	2	3	1	2	3
Nonacceptance	6	3	3	1	5	2	2	2	2
Reluctant acceptance	11	6	5	5	10	9	3	9	4
Full acceptance	15	5	10	26	17	21	27	21	26

Use of analgesics was reported for seven children (four boys, three girls), as a single dose for all but one. One child used analgesics at all three occasions, and was the only one to use analgesics at occasion 3. Recovery time ranged from 0.5 to 6 h (first drinking) and 1 to 18 h (first eating) after the three occasions (Table 2). Median time for eating as usual after the three appointments was 3.5, 3.8, and 2.8 h with a total range from 1 to 24 h (Table 2). There was significantly longer recovery time at occasion 2 for first eating when compared with occasion 1 ($P = 0.02$) and for eating as usual when compared with occasion 3 ($P < 0.01$).

Dental fear changes

Baseline ratings (median 22.0; range 15–40) of child dental fear paralleled population norm values[27] for both boys and girls (Fig. 3). CFSS-DS median scores decreased from pre- to post-extraction for boys (23.5–21.5; $P = 0.02$) and, although nonsignificant, for girls (20.0–18.0; NS; Fig. 3). Cronbach's alphas were 0.085 and 0.087 for the pre- and post-extraction measurements. Two girls showed post-extraction ratings in the borderline range 32 or above, but none exceeded the cut-off point for dental fear (≥38; Fig. 3).

Analysis of bivariate relationships and subgroups

There was a strong relationship found ($r = 0.70$–0.78) between the pain and discomfort reports at the three occasions. Further, the pain and discomfort reports both showed a moderate relationship with the post-extraction CFSS-DS ratings ($r = 0.47$ and 0.54, respectively). Children rating procedural pain >30 on the VAS scale had no significantly different pre- or post-extraction median CFSS-DS rating compare with the others (23.0 and 23.0 *vs* 22.0 and 19.0). Children categorized as fully acceptant, when compared with those who were reluctant or nonacceptant, rated discomfort lower at the second occasion (median 4.5 *vs* 22.0; $P = 0.049$), whereas no significant differences were seen for procedural pain at any of the three occasions.

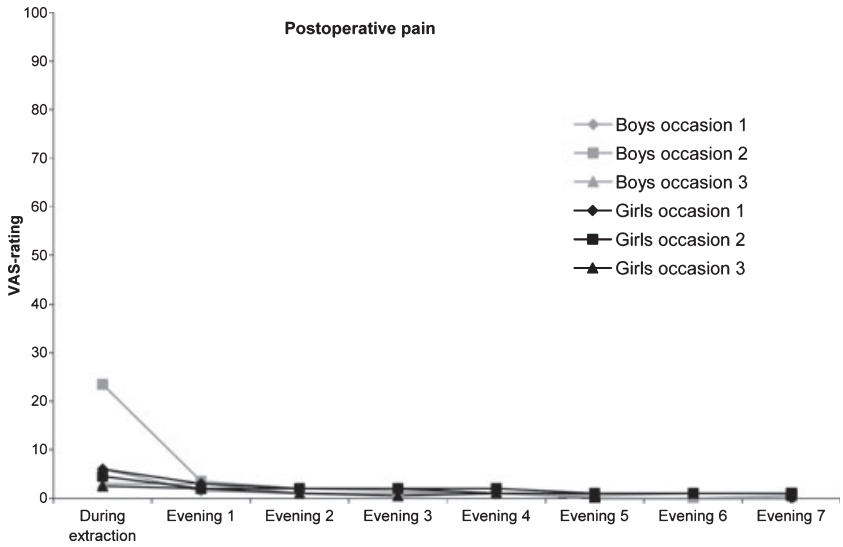

Fig. 2. Procedural and postoperative pain ratings by boys and girls at bedtime the same day as the extraction and the following six evenings. The lines show median pain scores reported on the 100-mm visual analogue scale during the three occasions.

Table 2. Recovery time (hours) after extractions of single and two deciduous canines.

	First drinking, median (range)			First eating, median (range)			Eating as usual, median (range)		
	Occasion			Occasion			*Occasion*		
	1	2	3	1	2	3	1	2	3
Boys	2.0 (1.0–4.0)	2.0 (0.5–5.5)	2.0 (0.5–5.0)	2.0 (1.2–4.0)	2.0 (1.0–5.5)	2.0 (1.0–5.0)	3.0 (2.0–19.0)	3.0 (1.5–24.0)	2.0 (1.0–13.0)
Girls	2.5 (0.5–5.0)	2.2 (1.0–5.5)	2.8 (2.0–6.0)	2.8 (2.0–5.0)	3.5 (1.0–18.0)	3.0 (2.0–6.0)	3.5 (2.0–10.0)	4.0 (1.5–24.0)	3.3 (2.0–10.0)
Tot	2.0 (0.5–5.0)	2.0 (0.5–5.5)	2.0 (0.5–6.0)	2.0 (1.2–5.0)	2.8 (1.0–18.0)	2.5 (1.0–6.0)	3.5 (2.0–19.0)	3.8 (1.5–24.0)	2.8 (1.0–13.0)

The fully acceptant group showed a lower (median 17.5 *vs* 24.0; $P < 0.01$) post-extraction dental fear score compared with a group of reluctant and nonacceptant children.

Discussion

This descriptive study of 32 Swedish children aged 7–9 years revealed low median levels of procedural and postoperative pain in connection to extraction of the deciduous canines. Parental pre- and post-extraction ratings did not show signs of triggered or increased dental fear.

Despite this, one of five children reported scores indicating a need for additional pain alleviation. These results give further support to the conclusions by Tate and Acs[9] and Wondimu and Dahllöf[19] calling for complementary routines of preparatory use of analgesics.

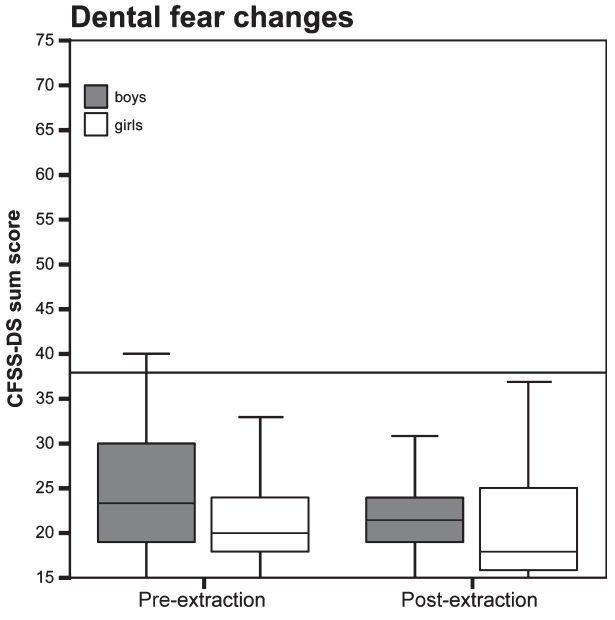

Fig. 3. Parental ratings of pre- and post-extraction dental fear scores for boys and girls. Box plots showing median, interquartile range, and min. and max. values. The vertical axis represents the CFSS-DS sum scores with a minimum of 15 and maximum of 75. The horizontal line at a CFSS-DS sum score of 38 indicates the cut-off point for dental fear.

A few individuals showed very high ratings of pain and discomfort at several occasions, further emphasizing the importance of individual care with regard to this kind of dental treatment. Because of the complex aetiology of pain and the often limited experience of invasive treatment among children in this age group, prediction of individual pain experiences during extraction of deciduous canines must be regarded as highly unreliable. Individual pain management protocols for analgesics are therefore difficult to achieve. Routine use of preoperative and postoperative medication could thus be a preferable way to reduce the risk of inadequate pain control. With appropriate analgesics, administered in recommended doses and taking the child's medical history into account, this kind of medication should not constitute a toxic risk for paediatric patients[28].

The higher ratings seen for discomfort compared with pain should also be considered, as they represent factors besides pain that are probably important to the child's perception of good empathic care.

As a complement to the children's own ratings of pain and discomfort, the treating dentist rated acceptance of injections and extractions. The frequency of nonacceptance (19%) was higher in this study than in population-based Swedish studies by Holst and Crossner (8%)[22] and Klingberg (10%)[29]; however, the acceptance behaviour in this study was reported exclusively for injections and extractions. Postoperative pain and discomfort ratings indicate that most of the children experienced only a limited amount of

inconvenience. The type of treatment *per se* is probably one explanation for this, as the extracted primary canines in this study could be assumed to be free from inflammation and infection and presumably had uncomplicated root anatomy with some degree of resorption. In addition, the pain ratings might also have been biased by positive expectations regarding reduced orthodontic treatment time. A few children reported pain during the first evenings after the extractions, and there appeared to be no consistent strategy for the use of analgesics. A plain recommendation to parents including both pre- and post-extraction medication with analgesics therefore seems reasonable.

Although the boys reported a pronouncedly higher pain level at appointment 2, the low numbers in this study did not allow for detection of any clear gender difference. Single tooth extraction may be preferable to extractions of two teeth at the same appointment, given the boys' procedural pain ratings and the distribution of postoperative pain ratings exceeding the cut-off for offering pain alleviation. Having repeated injections and/or a more spread out analgesic sensation may also be experienced as more unpleasant than the actual removal of two deciduous canines, and thus contribute to a negative dental experience.

Dental fear can be triggered or increased by painful dental experiences; our working hypothesis was that CFSS-DS scores would increase from pre- to post-extraction. But dental fear scores remained at population mean values, and median values even decreased from pre- to post-extraction in both boys and girls. Although a few individual CFSS-DS scores increased, we conclude that extraction of the four deciduous canines neither induced nor increased dental fear in this group of 7- to 9-year-old children.

This descriptive study has focused on magnitude and duration of pain and discomfort self-reported by a limited number of children. As pain and discomfort is a highly subjective sensation, the self-reporting stands out as a clear strength of this study when compared with earlier studies[5,6], based on parental reports, and thus not easily comparable.

A common trait can although be seen in that no consistent strategy for pain alleviation was performed despite the substantial number of the pain reports in the earlier studies and some high ratings in this study. No common characteristics could be found for the group in need of additional pain alleviation such as negative earlier dental experience or different dental fear levels. This could although be due to the limited number of subjects in the study. The order of extraction might have influenced the ratings of pain and discomfort, but no trend or significant increase of ratings over time could be seen between occasion 1 and 3.

Orthodontic inclusion criteria were used in this study, and pre-extraction dental fear scores paralleled population mean values; however, ratings of dental fear may have been biased because of fearful children not wanting to participate. Parental ratings of children's dental fear and age and gender-differentiated cut-off scores on the CFSS-DS scale are also considered insufficiently validated[27,30], which, together with the small number of study subjects, calls for caution in the interpretation of the results.

In conclusion, this study has revealed the necessity of updating clinical routines for pain management. Extraction of four deciduous canines should not cause major postoperative inconvenience, and was not shown to trigger or increase dental fear.

New prospective studies performed in general dentistry with larger samples are needed for further analysis of children's experiences in connection to invasive treatment procedures of this kind.

What this paper adds

- This paper provides new information on magnitude and duration of pain rated by 7- to 9-year-old children having single and two deciduous canine extractions performed at the same appointment.
- The paper also describes discomfort and parent rated dental fear related to these extraction procedures.

Why this paper is important to paediatric dentists

- This paper shows large individual differences in reported pain and discomfort in connection with deciduous canine extractions as a part of an interceptive orthodontic treatment procedure, and thus calls for treatment and pain management routines adapted to minimize the risk of inducing pain.

Acknowledgements

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