Original Article

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Randomized comparative trial of efficacy of paracetamol, ibuprofen and paracetamol-ibuprofen combination for treatment of febrile children

Abstract

Objective: Paracetamol and ibuprofen are widely used for fever in children as monotherapy and as combined therapy. None of the treatments is proven clearly superior to others. Hence, the study was planned to compare the efficacy of paracetamol, ibuprofen and paracetamol-ibuprofen combination for treatment of febrile children. **Materials and Methods:** This was an investigator blind, randomized, comparative, parallel clinical trial conducted in 99 febrile children, 6 months to 12 years of age, allocated to three groups. First group received paracetamol 15 mg/kg, second group received ibuprofen 10 mg/kg and third group received both paracetamol and ibuprofen, all as a single dose by the oral route. Patients were followed-up at intervals of 1, 2, 3 and 4 h post dose by tympanic thermometry. **Results:** Mean tympanic temperature after 4 h of drug administration was significantly lower in the combination group compared with paracetamol group ($P < 0.05$); however, the difference was not clinically significant (<1°C). The rate of fall of temperature was highest in the combination group. Number of afebrile children any time post dose until 4 h was highest in the combination group. Difference between combination and paracetamol was significant for the 1st h ($P = 0.04$). Highest fall of temperature was noted in the 1st h of drug administration in all the groups. No serious adverse events were observed in any of the groups. **Conclusion:** Paracetamol and ibuprofen combination caused quicker temperature reduction than either paracetamol or ibuprofen alone. If quicker reduction of body temperature is the desired goal of therapy, the use of combination of paracetamol + ibuprofen may be advocated.

Key words: Children, combination therapy, fever, ibuprofen, paracetamol

INTRODUCTION

Fever also known as pyrexia or controlled hyperthermia[1] is a common medical sign characterized by an elevation of temperature above the normal range of 36.5-37.5°C due to an increase in the body temperature regulatory set-point.[2] Fever is common in children and can cause distress, parental anxiety and in some parents "fever phobia." Rationales for treating childhood fever include relieving distress and lowering temperature, often to reduce the risk of febrile convulsions.[3,4] Options for treating fever in children include taking cool fluids, dressing lightly, tepid sponging and antipyretics drugs like paracetamol and ibuprofen.

Both paracetamol and ibuprofen have shown greater efficacy in comparison to placebo[5,6] and ibuprofen

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superior to paracetamol in the treatment of fever.[7,8] Both antipyretics have been found to be equally safe in children.[9] However, literature reviews often conclude that paracetamol should be used preferentially due to a lower risk of adverse effects.[6,10] Ibuprofen has the advantage of less frequent dosing (every 6-8 h vs. every 4 h for paracetamol) and its longer duration of action makes it a suitable alternative to paracetamol.[11]

Paracetamol and ibuprofen exert their effects at differing points in the pyrogenic pathways, so synergistic action is plausible. Parents and health-care professionals treat fever in children by using ibuprofen and paracetamol.[12,13] The practice of giving both medicines concurrently as fixed dose combination or separately is widespread, but there is lack of conclusive evidence of superiority of combination over individual drugs.[14-18] Currently, the Cochrane systematic review for summarizing the available literature on the efficacy of paracetamol compared to that of ibuprofen and the combination of these two drugs is going on.[19] Hence, this study was planned with the aim of comparing the efficacy of a single dose of paracetamol, ibuprofen and their combination in the treatment of fever in children.

METHODS

Study design

This was investigator blind, randomized, parallel group, multiple arm comparative, single dose trial carried out at Pediatrics department of a tertiary care teaching hospital. Prior approval of the Institutional Ethics Committee was obtained and written informed consent was obtained from the parent or legal guardian before screening of patients.

Inclusion criteria

Children between 6 months and 12 years of age, of either sex and with a tympanic temperature of 38°C or above were included in the study.

Exclusion criteria

Patients were excluded if they had received any anti-pyretic drug in the previous 6 h, any history of hypersensitivity to study medication, severe or life-threatening infections, meningitis, severely ill-patients suffering from circulatory collapse, blood dyscrasias, cellulites or other spreading skin infection, suspected chicken pox, patient known to be immunosuppressed, acute jaundice, symptoms of active gastrointestinal bleeding, known coagulopathy, chronic renal, liver or cardiac failure, dehydration, medicated with warfarin, heparin or any anti-hypertensive drug, asthma defined as a need for regular preventive medication and body weight below 7 kg. Any medication that could interfere with the study was not permitted during the study.

Withdrawal criteria

Any clinical adverse event, serious illness or other medical condition in view of investigator/treating doctor, in which continued participation was not in the best interest of the subject, voluntary decision of legal guardian/patient to withdraw from the study, if the subject found to have entered the study in violation of this protocol or if the patient was uncooperative during the study, any patient who required the use of an unacceptable concomitant medication or intervention that interfered with the study and if febrile seizure/convulsions occurred to the child during the study.

Sample size

The planned sample size was 30 patients in each treatment group with 90% power and assuming variability of 1.18°C based on previous study of McIntyre and Hull. [20] The clinically relevant difference for the change from baseline in temperature over a 4 h period was considered as 1°C. We considered the attrition rate as 10% for the clinical trial based on Lassagna's law[21] and hence the final sample size was fixed at 33 patients per group (Total 99).

Study procedures

Age, sex, weight, primary diagnosis, treatment received and detailed history were recorded in Case Record Form for children attending pediatric out-patient department and presenting with fever as one of the presenting symptoms. The participants, who fulfilled the inclusion/exclusion criteria, were admitted to the pediatric ward. The participants were allocated by the un-blinded investigator to one of the three treatment arms as per randomization charts. Randomization sequence was concealed by the un-blinded investigators and drug administration was carried out in the absence of the blinded investigator, who was responsible for the conduct of the study except randomization and drug administration. Based on computer generated randomization, block randomization was used to assign three sequences to 33 subjects in each group in the ratio of 1:1:1.

Interventions

Paracip® Syrup, (Cipla Pharmaceuticals Ltd.) - 60 ml bottle contains 100 mg/5 ml of paracetamol and Ibugesic® Syrup (Cipla Pharmaceutical Ltd.) 60 ml bottle contains 125 mg/5 ml of ibuprofen. Study drugs were administered as single oral dose after calculating the dose in milliliter - for ibuprofen 10 mg/kg or paracetamol 15 mg/kg or both ibuprofen and paracetamol, with the help of calibrated measuring cylinder with 60 ml of water. The dose of the study drug was repeated if the child vomited within 1 h

of administration of the drug. The bottles of the drug were kept at room temperature. Only the un-blinded investigators had access to study drugs.

The tympanic thermometer is more sensitive in measuring the core body temperature, compared to conventional thermometer and also convenient for the patient due to shorter time required for measurement of temperature.[22] Hence, the tympanic temperature was measured with the help of a pediatric tympanic thermometer (Swan-DX 6603®). The tympanic temperature was recorded before drug administration and then on an hourly basis till 4 h post dose. We chose 4 h as efficacy end point based on past studies.[9,16] Some children would require repetition of antipyretics at 4 h. Moreover, our primary study objective was the reduction in the tympanic temperature from the baseline temperature at the end of 4 h after drug administration. No rescue medication was used in the trial. Baseline temperature was recorded thrice to ensure precision of the thermometer.

Assessment of outcomes

Primary end point for efficacy was the reduction in the tympanic temperature from the baseline temperature at the end of 4 h after drug administration.

Secondary end points were – Percent reduction of temperature from baseline to 4 h post dose, proportion of afebrile children at 1, 2, 3 and 4 h post dose, any adverse drug events occurring during the 4 h period as recorded by the investigators and causality assessed with the help of Naranjo's algorithm.[23]

Statistical analysis

Data was analyzed using an analysis of variance for demographic variables and analysis of the primary outcome based on per protocol analysis on valid case set, i.e., set of patients that participated in the study as intended. Time for the temperature to fall to 37.5°C was compared using the log rank test. The number of patients experiencing adverse events and the number of patients whose temperature fell by 1°C or more at 4 h were each compared using the χ^2 test. All statistical tests performed were two tailed with significance determined by reference to the 5% level.

RESULTS

A total of 99 children were randomized between July 2009 and November 2010. The flow chart for the study participants is depicted in Figure 1. Out of 99 patients enrolled, 93 completed the study.

Baseline demographic variables

Baseline variables of three groups such as age, gender, weight and height and baseline temperature were comparable [Table 1]. Table 2 shows the distribution of clinical diagnosis in three groups, common being upper respiratory infections and malaria. Table 3 depicts the

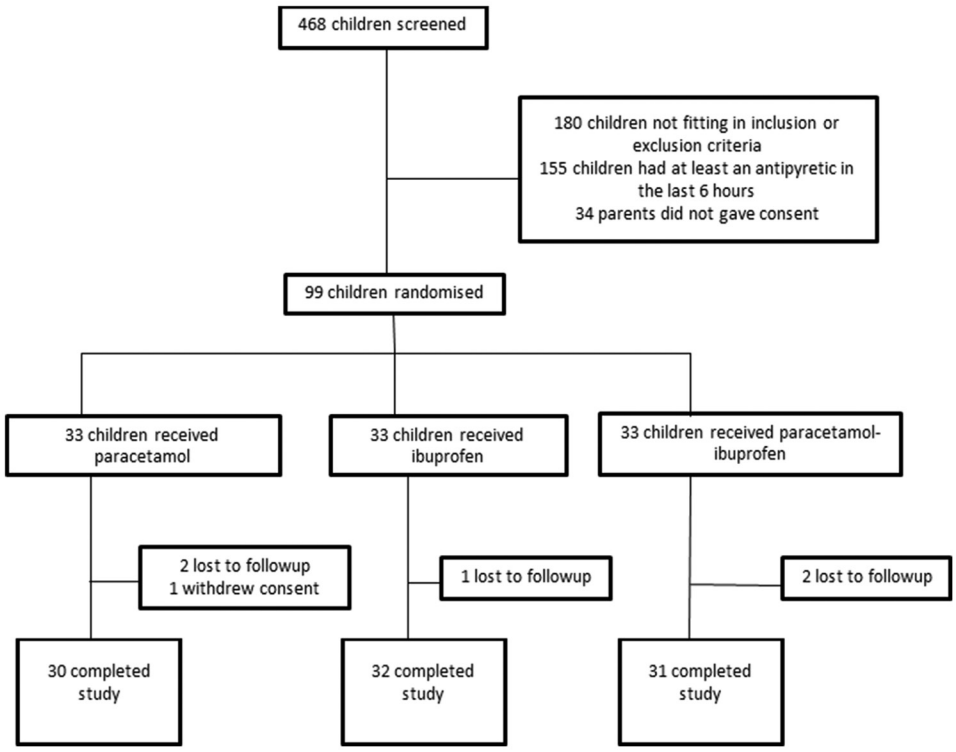

Figure 1: Flow chart of subject enrolment in the study

Table 1: Baseline demographic and clinical characteristics of study groups

Characteristics	Mean±SD (min-max)			*P* value*
	Paracetamol	Ibuprofen	Combination	
Age (in months)	66.70±32.84 (9-120)	74.72±39.58 (11-140)	71.68±34.44 (12-138)	0.68
Gender				
Male:Female	17:13	16:16	19:12	0.67
Weight (in kg)	16.45±5.00 (9-26)	17.45±6.61 (9-34)	15.97±4.92 (10-30)	0.56
Height (in cm)	104.00±16.82 (70-130)	106.78±19.89 (70-140)	103.65±15.55 (74-134)	0.74
Baseline temperature (in °C)	38.72±0.48 (38.00-39.70)	38.80±0.36 (38.20-39.50)	38.78±0.41 (38.00-39.50)	0.72

*P<0.05, Based on ANOVA and Chi-square test. SD=Standard deviation, ANOVA=Analysis of variance

Table 2: Provisional diagnosis at admission (*n*=93)

Disease	Paracetamol *n*=30 (%)	Ibuprofen *n*=32 (%)	Combination of both *n*=31 (%)	Total (%)
Upper respiratory infection	11 (36.67)	8 (25)	9 (29.03)	28 (28.28)
Malaria	8 (26.67)	6 (18.75)	7 (22.58)	21 (21.21)
Enteric fever	5 (16.67)	8 (25)	6 (19.35)	19 (19.19)
Febrile convulsion	4 (13.33)	4 (12.5)	7 (22.58)	15 (15.15)
Lower respiratory infection	4 (13.33)	3 (9.38)	3 (9.68)	10 (10.10)
Viral illness	1 (3.33)	3 (9.38)	-	4 (4.04)
Urinary tract infections	-	1 (3.13)	-	1 (1.01)
Bronchiolitis	-	-	1 (3.23)	1 (1.01)

Table 3: Mean reduction in temperature at 4 h post dose

Drug group	Mean±SD in °C (minimum-maximum)
Paracetamol-15 mg/kg	1.48±0.94 (−0.60-3.20)
Ibuprofen-10 mg/kg	1.87±0.99 (−0.20-3.40)
Paracetamol+ibuprofen 15 mg/kg+10 mg/kg	2.19±0.83 (0.40-3.70)

By using ANOVA F=4.548, Sum of squares=84.732, df=92, Mean squares=3.888 and 0.8555, P=0.013. SD=Standard deviation, ANOVA=Analysis of variance

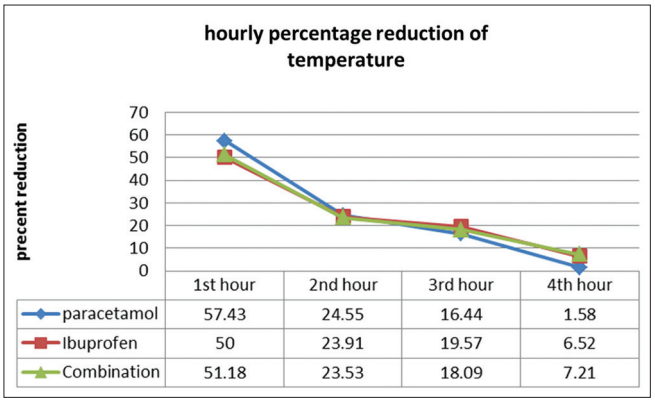

Figure 2: Percentage reduction in tympanic temperature in three groups over 4 h

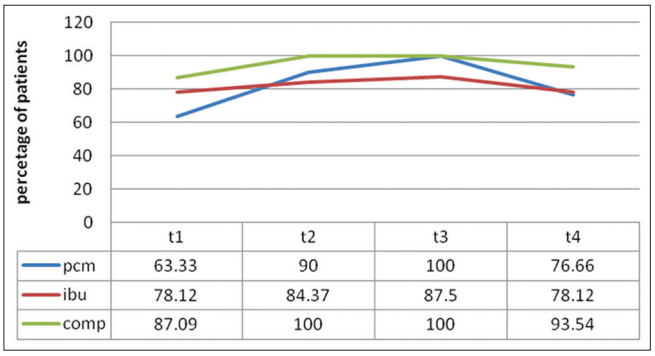

Figure 3: Percentage of afebrile patients at different intervals during trial duration

mean reduction in the tympanic temperature in comparison with the baseline temperature at the end of 4 h post dose for the three groups. There was a significant difference between three groups (P = 0.013), maximum reduction in temperature being observed in paracetamol-ibuprofen combination and minimum in paracetamol group. *Post-hoc* multiple comparison test between the three groups showed a significant difference between paracetamol and the combination group (P = 0.03) and no significant difference between ibuprofen and the combination group (P = 0.167) or between paracetamol and ibuprofen group (P = 0.102). Figure 2 depicts percentage fall in temperature at 1, 2 and 3 h post dose considering the reduction at 4 h post dose as 100% for each drug. 4th h fall with paracetamol was 1.58% of the total reduction, whereas in case of ibuprofen and combination it was 6.52% and 7.21% respectively, though the difference between paracetamol and combination groups being not significant (P = 0.58). Throughout 4 h observation period, the combination group had the highest percentage of afebrile patients and there was statistically significant difference at 1st h (P = 0.04) between the paracetamol and the combination group [Figure 3].

No serious or severe adverse events were noted in any of the groups. In the paracetamol group, two patients out of 30 had experienced the adverse events, one patient had vomiting and the other had abdominal pain, both were mild in severity and doubtful relationship. In the ibuprofen group, three patients out of 32 had experienced the adverse events; one had nausea, one abdominal pain and one had

maculopapular skin rash. All the three adverse events were mild with a possible relationship to treatment. In the combination group, four patients out of 31 had experienced the adverse events. One patient had vomiting, which was mild with doubtful relationship to treatment. Two patients had abdominal pain and one patient had a skin rash, which were mild with a possible relationship to treatment.

DISCUSSION

This randomized trial was planned to evaluate and compare the antipyretic efficacy and safety of a single dose of paracetamol, ibuprofen and paracetamol-ibuprofen combination in febrile children. So far a few trials[15-18,24] compared the combination of paracetamol + ibuprofen with these two drugs administered alone. While some of these showed no clinically significant difference between paracetamol, ibuprofen and combined paracetamol ibuprofen treatment,[15,16,18] a study comparing antipyretic effect of three different treatment regimens in children, using either ibuprofen alone, ibuprofen combined with paracetamol or ibuprofen followed by paracetamol over a single 6 h observation period showed that combined and alternating doses of ibuprofen and paracetamol provided greater antipyresis than ibuprofen alone at 4-6 h.[17] The Cochrane systematic review for summarizing the available literature on the efficacy of paracetamol compared to that of ibuprofen and the combination of these two drugs is still going on to settle this issue.[19] Hence, this study was planned to compare the antipyretic efficacy of paracetamol, ibuprofen and combined paracetamol ibuprofen in Indian children.

The reduction of body temperature at 4 h from baseline was 1.48°C for paracetamol, 1.87°C for ibuprofen and 2.19°C for ibuprofen + paracetamol combination. There was statistically significant difference between paracetamol group and combination group ($P = 0.003$), but not between paracetamol and ibuprofen group ($P = 0.102$) or between ibuprofen and combination group ($P = 0.167$). This finding is in accordance with the previous study of Erlewyn-Lajeunesse *et al.* who reported a significant difference between the combination group and paracetamol alone but not between the combination group and ibuprofen as well as between the ibuprofen and paracetamol groups at 1 h post dose.[15] This finding was also reported by Hay *et al.*[16] However, our study findings differ from the earlier study, which showed a significant difference between combination and ibuprofen group. The difference could be due to longer follow-up after dosing.[17].

A European study[25] showed single dose ibuprofen produced quicker temperature reduction and also had statistically superior efficacy than paracetamol group at 4th h post dose. The same is reported in a systemic review.[26]

In our study, the difference in temperature reduction between two groups although statistically significant, was not clinically significant less than 1°C (0.71°C). A study by McIntyre and Hull also reported no clinically significant difference in reduction of temperature between paracetamol and ibuprofen at 4 h post dose.[20] Moreover, the antipyretic effect of paracetamol started declining earlier compared with ibuprofen or combination of the two. In a recent systemic review by Purssell which analyzed seven randomized controlled trials comparing the efficacy or effectiveness of any dose of a combination of paracetamol and ibuprofen, either together or separately, with either drug alone, concluded that there is little benefit from combining paracetamol and ibuprofen.[18] However, our study was conducted before this review was available at a time when controversy about the superiority of combination therapy was still on.

The highest fall of temperature was noted in the 1st h of drug administration in all the groups; in all three groups more than 50% of the total reduction in temperature occurred in the 1st h after drug administration. This finding is in accordance with the results of Carabaño Aguado *et al.*, 2005 who found that the maximum rate of temperature reduction was achieved during the first 60 min after drug administration and 1 h post dose fall of temperature noted in the ibuprofen group was significantly greater compared to paracetamol group.[24] The highest percentage of afebrile patients at any time was observed in the paracetamol-ibuprofen combination group as compared to ibuprofen and paracetamol alone, but the difference was not statistically significant. Percentage of afebrile patients in the ibuprofen group was higher than paracetamol group which is different from the earlier study, which revealed equal number of afebrile children.[24]

None of the participants suffered from any severe or serious adverse event. All adverse events were mild in severity and having possible or doubtful relation to the treatment and requiring no treatment. There was no statistically significant difference between groups in this respect ($P = 0.71$). This finding is in accordance with the results of previous studies of Perrott *et al.* and Walson *et al.*,[5,9] The safety of paracetamol and ibuprofen combination for multiple dosing may require further studies. Higher percentage of children in the combination group showed improvement in general well-being than paracetamol or ibuprofen groups, but there was no statistically significant difference between the groups.

Wilson *et al.*, in their study reported patients with higher baseline temperature show significantly greater

fall than patients with lower temperature.[27] In our study also, the group having baseline ≥39°C showed greater fall in temperature (2.18 ± 0.92) compared to the group <39°C (1.69 ± 0.94), which was statistically significant ($P = 0.02$).

Out trial was randomized, investigator blinded, a very simple but effective trial design and we had less attrition rate due to scientifically and logistically fair follow-up period. We measured tympanic temperature, which is more sensitive and convenient than axillary temperature. Age for inclusion was kept 6 months-12 years so that wide age groups could be included. The study also evaluated antipyretic efficacy and improvement in general well-being in a way likely to reflect common practice.[3]

We administered the dose on bodyweight basis but this is not a regular clinical practice. As both drugs are available over the counter, community practice is to administer the drug according to age. We have evaluated effects of a single dose given orally, but the effects of multiple dosing can be different both in terms of efficacy and safety. We compared the combination of paracetamol and ibuprofen with each drug individually as it is a common clinical practice of prescribing combination of these two drugs, pharmacokinetically and pharmacodynamically suitable for concurrent use.[28,29]

Double blind design would have been ideal but would have been complicated and not likely to be acceptable by participants hence investigator blind design was considered.

CONCLUSION

To conclude, this randomized comparative study has shown that paracetamol-ibuprofen combination is statistically superior to paracetamol as antipyretic in children, but not compared to ibuprofen. However, the difference of temperature over 4 h between combination and paracetamol group even though statistically significant, cannot be considered clinically significant (<1°C). Combination of paracetamol-ibuprofen may have marginal clinical benefit over ibuprofen or paracetamol alone in routine clinical practice only when quicker reduction in body temperature is the goal of therapy.

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