تعیین فراهمی زیستی نسبی نمونه‌های متفاوت کبسول سفالسین

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چکیده:

سفالسین یکی از سفالسپورین‌های نسل اول یا کاربرد بالینی فراوانی می‌یابد که بصورت‌های مختلف تجویز می‌گردد. در تجویز خروکاکی، این دارو بسرعت جذب شده و به میزان وسیعی در اکثر بافت‌ها و سابعه‌ها بسته و توسعه می‌شود. به‌طوری‌که ۹۰٪ سفالسین به صورت داروی تغییر نیافته از طریق کلیه‌ها دفع می‌گردد. با توجه به تنوع در فرمولاسیون فرم خروکاکی سفالسین در ایران و تنوع در منابع خرید مواد اولیه آن، بررسی فراهمی زیستی نسبی این فرمولاسیون‌ها و مقایسه آنها با یک نمونه خارجی ضروری به نظر می‌رسد.

در این مطالعه از هشت داواتب مرد سالم و چهره‌نمونه متفاوت کبسول سفرادین ساخت سپاهان داخل کشور (نمونه‌های (I.I,II,III,IV,II)) که در لیبل ساخت کارخانه‌ای (Lilly انگلستان) تهیه و تهیه‌کننده آنها تجاری (Refex) متقابل استفاده گردید. قطعات سفالسین در زیر که از نمونه‌های خویی و اداری داوطلبان پس از هر تجویز به روش سنجش میکرویک آنتی‌بیوتیک‌ها و با استفاده از مت انتشار در دیسک تعیین گردید.

با استفاده از منحنی‌های پلاسما و ادراری رسم شده برای سفالسین پارامترهای مختلف فارماکوکینیتی و فراهمی زیستی نسبی آن محاسبه گردید. نتایج ادراری با استفاده از نرم‌افزار کنده تی‌جوت خویی بود. بررسی‌های انجام شده نشان داد که نتایج بدست آمده تأیید کننده نتایج خویی بود. بررسی‌های انجام شده نشان داد که نتایج بدست آمده در توافق کامل با نتایج گزارش شده در مقالات مختلف بود. کلیه پارامترهای فارماکوپکینیتی و هزاره‌زیتی نسبی محاسبه شده از داده‌های خویی و ادراری با استفاده از آزمون آماری مورد ارزیابی قرار گرفتند. مشخص شد که این پارامترها برای نمونه‌های داخلی با نمونه‌های خارجی مشابه می‌باشند. بنابراین بررسی‌های مشخص کننده‌های از لحاظ میزان و مداوم بودن (از نظر گزارش داده‌ها) نمونه‌های متفاوت کبسول سفالسین ساخت داخل کشور با نمونه‌های خارجی مورد بررسی می‌باشد و این نمونه‌ها هیچ‌گونه تفاوت معنی‌داری با یکدیگر ندارند.

کلید واژه‌ها: ۱- سفالسین
۲- فراهمی زیستی
۳- ادرار
۴- پلاسما

دانشکده داروسازی، دانشگاه علوم پزشکی مشهد

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مجیل دانشگاه علوم پزشکی ایران
RELATIVE BIOAVAILABILITY OF CEPHALEXIN DIFFERENT BRANDS OF CAPSULES

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ABSTRACT

In a cross over study eight normal human volunteers were employed. The bioavailability of different commercial brands of cephalixin capsules were examined. The relative bioavailability of four brand (I, II, I, II) manufactured by two different domestic companies were compared with one brand (Keflex) which was manufactured by Lilly pharmaceutical company, England. The plasma and urine cephalixin concentration were determined by microbiological assay (disk diffusion) using Sarcina Lutea ATCC 9341 as test organism. Plasma and urine data were used to evaluate various pharmacokinetic parameters cephalixin including $K, t_{1/2}, C_1/F, Vd/F, T_{max}, C_{max}, AUC$ and $F$ (relative).

Results obtained from urinary data were supported the plasma data. The analysis of variance, to compare relative bioavailability and other pharmacokinetic parameters between tested samples were performed. These information indicates that there are no significant differences between the five different tested brands and they are bioequivalent. Therefore it can be suggested that brands (I, II, I, II, II) which formulated by domestic manufactures are bioequivalent and comparable to each other and to the one formulated by Lilly pharmaceutical company.

Key Words: 1) Cephalixin  
2) Bioavailability  
3) Plasma  
4) urine

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INTRODUCTION
Cephalexin, (7R)-3-Methyl-7- (α-D-PHENYLglycylamin o) -3-Cephem-4-
Carboxylic Acid Monohydrate, is a semisynthetic derivative of cephalosporine
C. Cephalexin is bactericidal and has a broad spectrum of antimicrobial activity. It has
weak bondability to blood protein, has no metabolites, has low toxicity, and is rapidly
absorbed following oral administration to give a high serum level and urine
concentration. Cephalexin is excreted unaltered by the kidneys, almost all of the
dose being recovered within six hours (11).

In clinical chemotherapy the bioavailability of drugs is a very important subject. It is
obvious that all commercially available products do not show bioequivallency.
Therefore, the evaluation of the bioavailability of various solid dosage forms
especially where the only generic products are available is necessary.

In the present study the relative bioavailability of four generic cephalexin capsules were
examined. A known marketed cephalexin capsule (Keflex, Lilly, England) was used to
compare the result of the study.

EXPERIMENTAL
Reagent and Materials: Cephalexin monohydrate used as standard material and
a marketed cephalexin capsule (Keflex) which also used for comparison to other
generic capsules were gifted from Jaber
Ibn-Hayyan and Loghman pharmaceutical companies (Tehran, Iran). All the reagent
used were Merk analytical grade.

Subjects and Treatments: Eight normal healthy male volunteers, 22-28 years old,
weighing between 61-74 Kg participated in this study. The subjects had no past histories
to allergic reaction to penicillin and showed normal renal function. All the subject had no
concurrent drug treatment for several days before and during the study. Informed
written consent was obtained from each subject. The overnight fasting subjects
recieved a single permitted to eat until 3h after dosing. Five different dosage forms (JI,
JII, LI, LII and Keflex) of cephradine on five separate occasions were tested. A Known
commercial cephalexin capsule (Keflex, Lilly, Pharmaceutical Company, England),
was used as standard to be compared with four local generic dosage forms, brand JI
and JII, (Jaber Ibn - Hayyan Pharmaceutical Company, Tehran-Iran) and brand LI and
LII,(Loghman Pharmaceutical and Hygenic Company, Tehran-Iran). At least one week
separated all experiments. The study was
designed as a randomized double - blinded complete crossover investigation.

Sampling: Venous blood samples were collected into heparinized glass tubes
immediately prior to dosing, and at 0.5, 1, 1.5, 2, 3, 4, 5, 6 and 8 hours after drug
administration. Total urine voids were collected for the following time period after drug administration: 0-1, 1-2, 2-3, 3-4, 4-6, and 6-8 hours. Plasma separated from all blood samples immediately after collection and frozen until the time of analysis. Urine volume was measured and an aliquot was frozen for analysis.

**Assay:** Plasma and urine sample concentrations were measured by disc diffusion microbiological assays using Sarcina Lutea ATCC 9341 as the test organism. Standard curves for each biological fluid sample were freshly prepared on each day of analysis, using human plasma or a phosphate buffer as the diluent. The lower limit of sensitivity for the cephalixin assay was 0.25 mcg/ml.

**Pharmacokinetic Analysis:** Plasma and urine data were analysed for appropriate pharmacokinetic parameters using a one compartment open model with first-order absorption (4,8). Area under the cephalixin plasma concentration versus time curves (AUC) were calculated for all subjects using trapezoidal method. Other pharmacokinetic parameters such as the peak concentration, time of peak concentration, clearance elimination half-life and urinary recovery were calculated and compared for the various dosage forms. The relative bioavailability of various dosage forms were compared using urine and plasma data.

**RESULTS AND DISCUSSION**

**Plasma data:** Figure 1 shows the plasma concentration of cephalixin (average of

![Figure 1. Comparison of Mean Cumul. Urinary Excre. of cephalixin after Oral Administration of 500 mg of Each Brands in 8 Subjects](image-url)
eight subjects) for five different dosage forms (Keflex, J.I, J.II, L.I, L.II). These results indicate that these profiles are very similar. Pharmacokinetic parameters which have been utilized as a function of the rate of drug absorption are the peak plasma concentration and time of peak plasma concentration (12). The mean time of peak plasma concentration (Tmax) for all brands and subjects was 1.12 ± 0.11 h (table 1).

Table 1: Mean Pharmacokinetic Parameters of Cephalexine after Oral Administration of Various Cephalexine Capsules to Eight Subjects

<table>
<thead>
<tr>
<th>BRAND</th>
<th>K (l/h)</th>
<th>T1/2 (h)</th>
<th>CL/F (L/h)</th>
<th>V/F (L)</th>
<th>Tmax (h)</th>
<th>Cmax (μ g/mL)</th>
<th>AUC(0 - ∞) (μ g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keflex</td>
<td>0.64</td>
<td>1.1</td>
<td>18.3</td>
<td>28.6</td>
<td>1.1</td>
<td>16.2</td>
<td>28.3</td>
</tr>
<tr>
<td>J.I</td>
<td>0.63</td>
<td>1.1</td>
<td>21.4</td>
<td>33.6</td>
<td>1.1</td>
<td>14.3</td>
<td>24.4</td>
</tr>
<tr>
<td>J.II</td>
<td>0.66</td>
<td>1.1</td>
<td>18.4</td>
<td>28.1</td>
<td>1.1</td>
<td>15.0</td>
<td>28.6</td>
</tr>
<tr>
<td>L.I</td>
<td>0.60</td>
<td>1.2</td>
<td>16.2</td>
<td>27.2</td>
<td>1.1</td>
<td>18.1</td>
<td>32.0</td>
</tr>
<tr>
<td>L.II</td>
<td>0.67</td>
<td>1.0</td>
<td>18.3</td>
<td>27.3</td>
<td>1.3</td>
<td>13.3</td>
<td>28.5</td>
</tr>
<tr>
<td>Mean±S.D</td>
<td>0.64±0.03</td>
<td>1.1±0.1</td>
<td>18.5±1.8</td>
<td>29.0±2.7</td>
<td>1.1±0.1</td>
<td>15.4±1.8</td>
<td>28.4±2.7</td>
</tr>
</tbody>
</table>

which is in agreement with other reports (1,7,9,13). Mean peak plasma concentration (Cmax) for all tested brands and subjects were 15.40 ± 1.85 mcg/ml (table 1). This value agrees with other reports (3,7,9,10,13). Statistical analysis of the Cmax and Tmax data indicated no significant differences (p=0.05) between different brands and subjects. Other pharmacokinetic parameters of cephalexin were calculated using individual data after administration of various dosage forms (table 1). All the pharmacokinetic parameter values are in agreement with the data reported in the literature (7,9,13). Statistical analysis of these data showed no significant differences (p=0.05) between the pharmacokinetic parameters of five different tested dosage forms. The extent of absorption of various dosage forms evaluated using area under the plasma concentration-time curve (AUC), (table 1). The relative bioavailability (Keflex, used as standard, 100% availability assumed) of all tested brands is shown in table 2. No statistically significant differences (p=0.05) between the different brands of cephalexin capsules were observed. However significant inter subject variation was
observed table 2.

**Table 2: Relative Bioavailability of Five Different Cephalexine Capsules**

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Keflex</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100 (......)</td>
</tr>
<tr>
<td>J.I</td>
<td>131</td>
<td>109</td>
<td>60</td>
<td>59</td>
<td>75</td>
<td>82</td>
<td>103</td>
<td>95</td>
<td>89.2 (±25.0)</td>
</tr>
<tr>
<td>J.II</td>
<td>105</td>
<td>99</td>
<td>108</td>
<td>111</td>
<td>91</td>
<td>96</td>
<td>112</td>
<td>84</td>
<td>100.8 (±10.0)</td>
</tr>
<tr>
<td>L.I</td>
<td>109</td>
<td>125</td>
<td>116</td>
<td>110</td>
<td>116</td>
<td>101</td>
<td>112</td>
<td>116</td>
<td>113.1 (±7.0)</td>
</tr>
<tr>
<td>L.II</td>
<td>87</td>
<td>104</td>
<td>102</td>
<td>90</td>
<td>127</td>
<td>100</td>
<td>99</td>
<td>99</td>
<td>101.0 (±12.02)</td>
</tr>
</tbody>
</table>

**Urinary excretion of cephalaxin:** Since cephalaxin is eliminated unchanged in the urine, the percentage of the total dose excreted can be used as indication of bioavailability (4,8). Since the concentration of cephalaxin in the urine sample collected at 8 hours showed negligible value, therefore the cumulative amount excreted after 6 hours would be a proper indication of the extent of cephalaxin absorption. Figure 2 shows the mean cumulative cephalaxin excreted after administration of five different brands. The mean value for percentage of administered dose excreted over the period

![Graph showing comparison of mean plasma cephalaxin concentration over time for different brands.](image-url)

**Figure 2. Comparison of Mean Plasma Cephalaxin Concentration after Oral Administration of 500 mg of Each Brands in 8 subjects**
of 6 hours to eight subjects is 80.94 ± 2.44 (range from 78.76 to 84.84 %dose), which is similar to the other previously reported values (2,6,7). No significant statistical differences (p= 0.05) between the different brands were observed. The relative bioavailability of various dosage forms were estimated using cumulative amount of unchanged cephalexin excreted. Analysis of variance of these data showed no significant statistical differences (p= 0.05) between the relative bioavailability of all tested brands. These results support the information obtained from plasma Data.

Comparison of plasma and urinary Data: The mean plasma half-life values of cephalexin in eight subjects after oral administration of five different brands of cephalexin capsules were calculated from urine data (0.81 ±0.01 hours) and from plasma data (1.1±0.05) which are fairly in good agreement. Comparison of relative bioavailability the area under the plasma time curve (AUC), total urinary recovery of drug (%dose), Ae ∞ and other pharmacokinetic parameters clearly shows the results obtained from urinary data clearly support the information obtained from plasma data.

REFERENCES

CONCLUSION
The plasma and urine data of this study demonstrate that the bioavailability and other pharmacokinetic parameters of cephalexin after single oral administration of five different dosage forms of cephalexin capsules. No significant statistical differences (p=0.05) can be demonstrated in any of the pharmacokinetic parameter measured at any of dosage forms used in this investigation when comparing the four different generic agents, (JI, JIII, LI, LIII) to a known marketed cephalexin capsule (Keflex). The urinary data was supported the plasma data in all cases.

The results of this study indicates that the behavior of different tested brands of cephalexin capsules are compatible and bioequivalent.

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