

CHAPTER IV

RESULTS

The results of this investigation were presented according to purposes of the study in three parts:

I. COMPARISON OF INITIAL DIMENSIONS OF ELASTOMERIC LIGATURES

1.1. Means and standard deviations of the initial outside diameter, inside diameter, and wall thickness of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures.

1.2. One way analysis of variance of the initial outside diameter, inside diameter, and wall thickness among four groups of elastomeric ligatures.

1.3. Multiple comparisons of the initial outside diameter and wall thickness among four groups of elastomeric ligatures.

II. COMPARISON OF INITIAL FORCE OF ELASTOMERIC LIGATURES

2.1. Means and standard deviations of the force at seven time intervals to 28 days of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures.

2.2. One way analysis of variance and multiple comparisons of the initial force among four groups of elastomeric ligatures.

III. COMPARISON OF PERCENTAGE OF REMAINING FORCE OF ELASTOMERIC LIGATURES

3.1. Means and standard deviations of the percentage of remaining force at seven time intervals to 28 days of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures.

3.2. One way analysis of variance and multiple comparisons of the percentage of remaining force at each time interval among four groups of elastomeric ligatures.

3.3. One way analysis of variance and multiple comparisons of the percentage of remaining force among seven subgroups of four groups of elastomeric ligatures.

มหาวิทยาลัยเชียงใหม่
Chiang Mai University

I. COMPARISON OF INITIAL DIMENSIONS OF ELASTOMERIC LIGATURES

The initial outside diameter (OD), inside diameter (ID), and wall thickness (WT) of all subgroup 1 samples of all groups were measured by the ten-times magnifying glass.

1.1 Means and standard deviations of the initial outside diameter, inside diameter, and wall thickness of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures

Table 4.1 demonstrated means and standard deviations of the initial dimensions (OD, ID, and WT) of four groups of elastomeric ligatures.

Table 4.1 Means (\bar{X}) and standard deviations (SD) of the initial outside diameter (OD), inside diameter (ID), and wall thickness (WT) of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures

Groups	N	OD (mm.)		ID (mm.)		WT (mm.)	
		\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
I	30	3.087	0.043	1.147	0.057	0.970	0.047
II	30	3.093	0.036	1.147	0.057	0.980	0.041
III	30	3.127	0.064	1.147	0.063	1.000	0.045
IV	30	3.153	0.063	1.130	0.059	1.017	0.053

Among samples in four groups of elastomeric ligatures, the initial outside diameter and wall thickness of group IV were larger than those of group III and II, and those of group I were the smallest ($OD_{IV} > OD_{III} > OD_{II} > OD_I$, $WT_{IV} > WT_{III} > WT_{II} > WT_I$). The initial inside diameters of group I, II, and III were the same, but they were larger than that of the group IV ($ID_I = ID_{II} = ID_{III} > ID_{IV}$). There were variations in elastomeric ligature dimension especially of the outside diameter and wall thickness. Outside diameter depended on wall thickness. Inside diameter had more consistency than outside diameter and wall thickness.

1.2 One way analysis of variance of the initial outside diameter, inside diameter, and wall thickness among four groups of elastomeric ligatures

One way analysis of variance (ANOVA) was carried out to differentiate the initial dimensions among four groups of elastomeric ligatures (Table 4.2).

Table 4.2 One way ANOVA of the initial outside diameter (OD), inside diameter (ID), and wall thickness (WT) among four groups of elastomeric ligatures

	Source of variance	Sum of square	df	Mean square	F
OD	Between groups	8.633	3	2.878	10.219***
	Within groups	0.327	116	2.816	
	Total	0.413	119		
ID	Between groups	6.250	3	2.803	0.594
	Within groups	0.407	116	3.509	
	Total	0.413	119		
WT	Between groups	3.900	3	1.300	5.968**
	Within groups	0.253	116	2.178	
	Total	0.292	119		

** p< 0.01, *** p< 0.001

The initial outside diameter and wall thickness among four groups of elastomeric ligatures were significantly different at $p < 0.001$ and $p < 0.01$ respectively, but there was no significant difference in the initial inside diameter among them.

1.3 Multiple comparisons of the initial outside diameter and wall thickness among four groups of elastomeric ligatures

As one way ANOVA showed significant differences in the initial outside diameter and wall thickness among four groups of elastomeric ligatures, the Scheffe's multiple comparisons were carried out (Tables 4.3 and 4.4).

Table 4.3 Scheffe's multiple comparisons of the initial outside diameter (OD) among four groups of elastomeric ligatures

Groups		I	II	III	IV
	\bar{X} (mm.)	3.087	3.093	3.127	3.153
I	3.087				
II	3.093	0.006			
III	3.127	0.040*	0.033		
IV	3.153	0.066***	0.060***	0.026	

* $p < 0.05$, *** $p < 0.001$

Table 4.3 showed that the outside diameter of group IV was greater than that of group I and II with highly significant differences ($p < 0.001$). The outer diameter of group III was also significantly greater than that of group I at $p < 0.05$, but there was no significant difference between group III-II, III-IV and I-II.

Table 4.4 Scheffe's multiple comparisons of the initial wall thickness (WT) among four groups of elastomeric ligatures

Groups		I	II	III	IV
	\bar{X} (mm.)	0.970	0.980	1.000	1.017
I	0.970				
II	0.980	0.010			
III	1.000	0.030	0.020		
IV	1.017	0.047**	0.037*	0.017	

* $p < 0.05$, ** $p < 0.01$

Table 4.4 showed that the wall thickness of group IV was significantly greater than that of group I and II at $p < 0.01$ and $p < 0.05$ respectively. There was no significant difference among the wall thickness of group I, II and III.

II. COMPARISON OF INITIAL FORCE OF ELASTOMERIC LIGATURES

After dimension measuring, all subgroup 1 samples of all groups were tested for the initial force (F_0) at displacement of 5.5 millimeters by the universal testing machine. All samples in four groups of subgroup 2, 3, 4, 5, 6 and 7 were tested for the generated force following the same procedure on the 1st, 2nd, 7th, 14th, 21st and 28th days respectively ($F_1, F_2, F_7, F_{14}, F_{21}$ and F_{28}).

2.1 Means and standard deviations of the force at seven time intervals to 28 days of 1, 2, 3-time treated and untreated elastomeric ligatures

The means and standard deviations of the force at seven time intervals of four groups of elastomeric ligatures were shown in the Table 4.5.

Table 4.5 Means (\bar{X}) and standard deviations (SD) of the force (gm.) at seven time intervals of four groups of elastomeric ligatures

Time intervals	Force (gm.)							
	Group I		Group II		Group III		Group IV	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Initial	635.47	17.13	631.63	15.90	601.40	10.06	595.73	10.69
1 st day	176.43	14.40	170.67	11.46	169.73	11.83	168.07	15.35
2 nd day	164.87	8.74	152.07	10.69	151.07	9.83	153.50	10.76
7 th day	102.30	7.36	99.77	7.69	96.33	9.66	95.63	11.45
14 th day	65.57	5.49	64.37	7.13	64.63	5.92	60.10	4.84
21 st day	37.10	4.31	35.80	6.43	34.43	5.83	35.20	5.22
28 th day	28.20	4.08	26.80	3.13	30.27	3.35	28.15	3.79

Table 4.5 showed that the generated force at each time interval among four groups were quite different. In each group, the force among seven time intervals was different. The force of all groups of elastomeric ligatures decreased continuously with time ($F_0 > F_1 > F_2 > F_7 > F_{14} > F_{21} > F_{28}$).

The generated force at seven time intervals of four groups were presented in curves as in Figure 4.1.

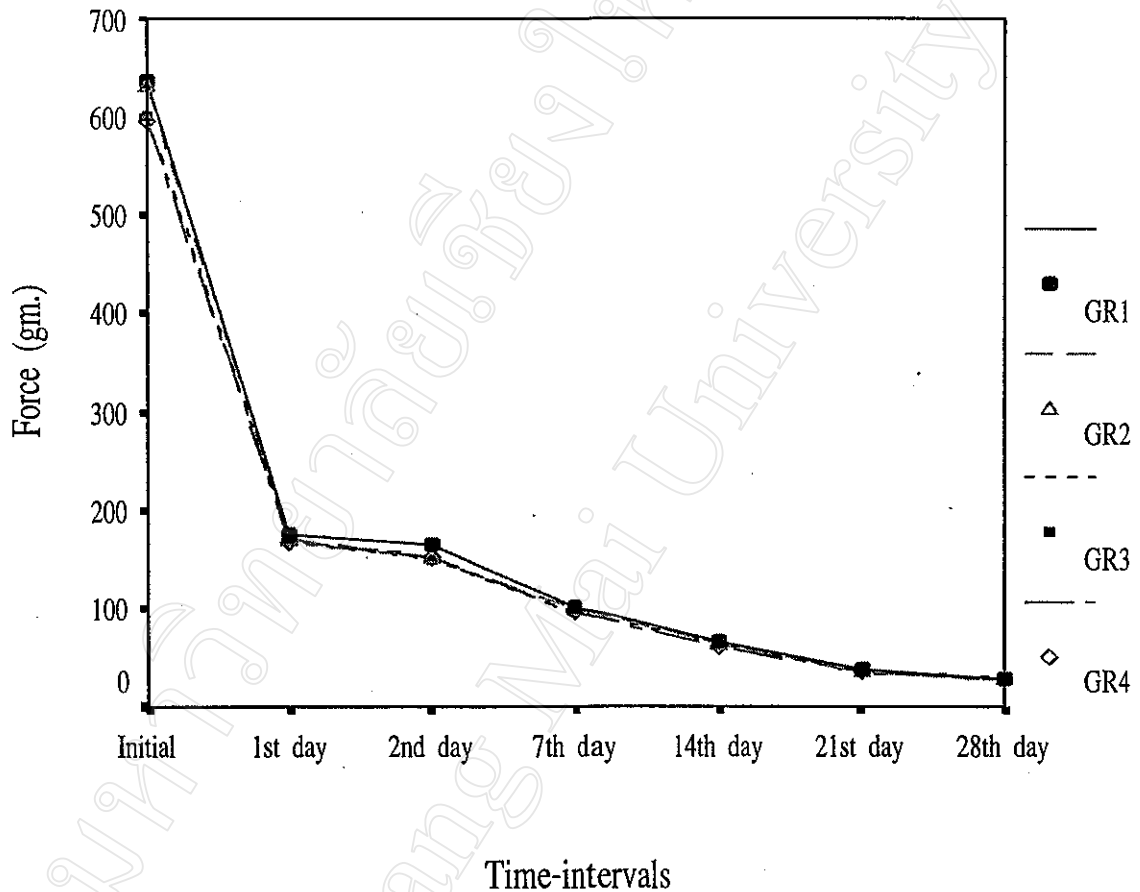


Figure 4.1 The generated force at seven time intervals to 28 days of all groups of elastomeric ligatures.

Figure 4.1 showed that the force degradation patterns of all four groups of elastomeric ligatures were almost similar. The greatest force loss occurred on the first day and then they continuous gradually decreased throughout 28 day-period.

2.2 One way analysis of variance and multiple comparisons of the initial force among four groups of elastomeric ligatures.

Table 4.6 One way ANOVA of initial force among four groups of elastomeric ligatures.

Source of variance	Sum of square	df	Mean square	F
Between groups	37417.092	3	12472.364	65.503***
Within groups	22087.500	116	190.409	
Total	59504.592	119		

*** $p < 0.001$

Table 4.6 presented that there was highly significant difference ($p < 0.001$) among the initial forces of four groups.

Table 4.7 Scheffe's multiple comparisons of initial force among four groups of elastomeric ligatures.

Groups	X (gm.)	I	II	III	IV
		635.47	631.63	601.40	595.73
I	635.47				
II	631.63	3.83			
III	601.40	34.07***	30.23***		
IV	595.73	39.73***	35.90***	5.67	

*** $p < 0.001$

Therefore, the Scheffe's multiple comparisons were carried out (Table 4.7). The initial force of group I and II was significantly higher than that of group III and IV ($p < 0.001$), but there was no significant difference between the initial force (F_0) of group I-II, and group III-IV.

III. COMPARISON OF PERCENTAGE OF REMAINING FORCE OF ELASTOMERIC LIGATURES

The generated force at the 1st, 2nd, 7th, 14th, 21st and 28th days ($F_1, F_2, F_7, F_{14}, F_{21}$ and F_{28}) of all groups of elastomeric ligatures was calculated to the percentage of remaining force (PRF) as $PRF_0, PRF_1, PRF_2, PRF_7, PRF_{14}, PRF_{21}$ and PRF_{28} respectively.

3.1. Means and standard deviations of the percentage of remaining force at seven time intervals to 28 days of 1, 2, 3-time glutaraldehyde treated and untreated elastomeric ligatures.

The means and standard deviations of the PRF at seven time intervals of four groups of elastomeric ligatures were shown in the Table 4.8.

Table 4.8 Means (\bar{X}) and standard deviations (SD) of the percentage of remaining force (%) at seven time intervals of four groups of elastomeric ligatures

Time intervals	Percentage of remaining force (%)							
	Group I		Group II		Group III		Group IV	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Initial	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
1 st day	27.77	2.16	27.02	1.69	28.23	2.01	28.22	2.62
2 nd day	25.96	1.46	24.08	1.67	25.12	1.65	25.76	1.67
7 th day	16.12	1.40	15.81	1.36	16.03	1.71	16.07	2.08
14 th day	10.32	0.88	10.20	1.19	10.74	0.97	10.09	0.86
21 st day	5.84	0.71	5.67	1.02	5.73	0.99	5.91	0.89
28 th day	4.45	0.71	4.25	0.52	5.03	0.56	4.58	0.67

Table 4.8 showed that the PRF at each time interval among four groups was slightly different. In each group the PRF among seven time intervals was different. The PRF of all groups of elastomeric ligatures decreased continuously with time ($PRF_0 > PRF_1 > PRF_2 > PRF_7 > PRF_{14} > PRF_{21} > PRF_{28}$). The PRF_1 of all four groups was 27.02% –

28.23% of its initial force. It subsequently gradually decreased throughout 28 days to 4.25% - 5.03% of its initial force.

The PRF at seven time intervals of the four groups was presented in curves as in Figures 4.2.

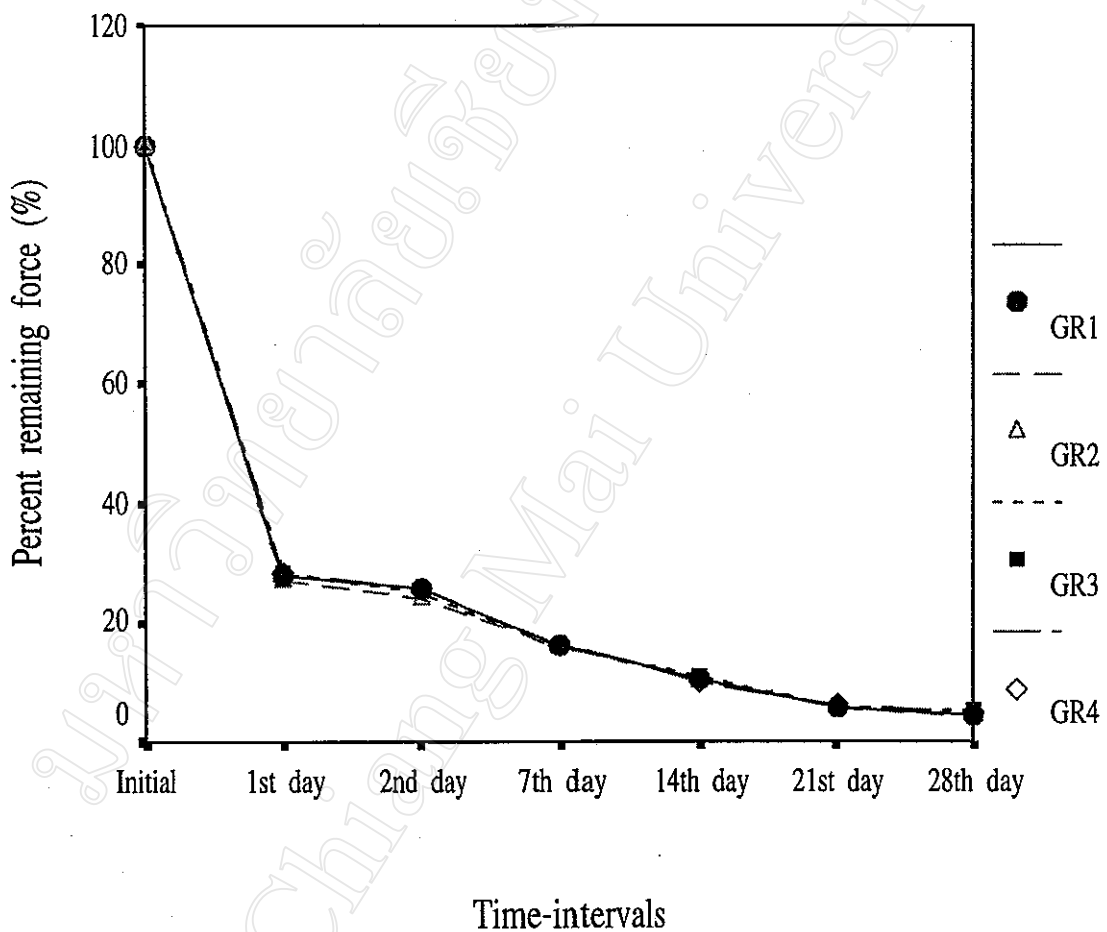


Figure 4.2 The percentage of remaining force at seven time intervals to 28 days of all groups of elastomeric ligatures.

Figure 4.2 presented that the PRF of all groups of elastomeric ligatures decreased continuously with time as did the force of the four groups (Figure 4.1). However, at each time interval, the PRF of four groups was similar whereas the force of the four groups was different (Figure 4.1).

3.2. One way analysis of variance and multiple comparisons of the percentage of remaining force at each time interval among four groups of elastomeric ligatures.

Table 4.9 One way ANOVA and Scheffe's multiple comparisons of the PRF at each time interval among four groups of elastomeric ligatures

Time intervals	F-value	Scheffe's test of PRF					
		\bar{X}_I vs \bar{X}_{II}	\bar{X}_I vs \bar{X}_{III}	\bar{X}_I vs \bar{X}_{IV}	\bar{X}_{II} vs \bar{X}_{III}	\bar{X}_{II} vs \bar{X}_{IV}	\bar{X}_{III} vs \bar{X}_{IV}
1 st day	2.109	0.75	0.46	0.45	1.21	1.20	0.01
2 nd day	8.196***	1.88***	0.84	0.20	1.04	1.68**	0.63
7 th day	0.202	0.31	0.09	0.05	0.22	0.26	0.04
14 th day	2.558	0.12	0.42	0.22	0.55	0.11	0.65
21 st day	0.427	0.17	0.11	0.07	0.06	0.24	0.18
28 th day	9.083***	0.20	0.58**	0.14	0.78***	0.34	0.44*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.9 presented the comparisons of the PRF at each time interval among four groups of elastomeric ligatures. Most of the PRF at each time interval among four groups was insignificantly different (PRF_1 , PRF_7 , PRF_{14} , PRF_{21}). Only the PRF_2 and PRF_{28} showed highly significant differences ($p < 0.001$) among four groups. The PRF_2 of group II was significantly lower than that of group I and IV ($p < 0.001$ and $p < 0.01$ respectively). The PRF_{28} of group III was significantly higher than that of group I, II and IV ($p < 0.01$, $p < 0.001$ and $p < 0.05$ respectively).

3.3 One way analysis of variance and multiple comparisons of the percentage of remaining force among seven subgroups of four groups of elastomeric ligatures

The PRF of four groups of elastomeric ligatures among seven time intervals to 28 days was compared by one way ANOVA as shown in the Table 4.10.

Table 4.10 One way ANOVA of the percentage of remaining force among seven time intervals of four groups of elastomeric ligatures

	Groups	Sum of square	df	Mean square	F
I	Between groups	200490.411	6	33415.069	22253.215***
	Within groups	304.822	203	1.502	
	Total	200795.233	209		
II	Between groups	201511.203	6	33585.201	22979.733***
	Within groups	296.687	203	1.453	
	Total	201732.036	209		
III	Between groups	199588.026	6	33264.671	19482.091***
	Within groups	346.612	203	1.707	
	Total	199934.638	209		
IV	Between groups	200516.391	6	33419.399	14706.045***
	Within groups	461.316	203	2.272	
	Total	200977.708	209		

*** $p < 0.001$

The PRF of all four groups of elastomeric ligatures showed highly significant differences ($p < 0.001$) among seven time intervals. Consequently, Scheffe's multiple comparisons were carried out (Tables 4.11, 4.12, 4.13 and 4.14).

Table 4.11 Scheffe's multiple comparisons of the percentage of remaining force among seven time intervals of group I elastomeric ligatures

Time intervals	Initial	1 st day	2 nd day	7 th day	14 th day	21 st day	28 th day
\bar{X} (%)	100.00	27.77	25.96	16.12	10.32	5.84	4.45
Initial	100.00						
1 st day	27.77	72.23***					
2 nd day	25.96	74.04***	1.81***				
7 th day	16.12	83.88***	11.65***	9.84***			
14 th day	10.32	89.68***	17.45***	15.64***	5.80***		
21 st day	5.84	94.16***	21.93***	20.12***	10.28***	4.48***	
28 th day	4.45	95.55***	23.32***	21.51***	11.67***	5.87***	1.39**

** $p < 0.01$, *** $p < 0.001$

From Table 4.11, the PRF of group I showed significant differences in all time intervals. Similarly to group I, the PRF of group II showed significant differences in all time intervals (Table 4.12).

Table 4.12 Scheffe's multiple comparisons of the percentage of remaining force among seven time intervals of group II elastomeric ligatures

Time intervals	Initial	1 st day	2 nd day	7 th day	14 th day	21 st day	28 th day
\bar{X} (%)	100.00	27.02	24.08	15.81	10.20	5.67	4.25
Initial	100.00						
1 st day	27.02	72.98***					
2 nd day	24.08	75.92***	2.94***				
7 th day	15.81	84.19***	11.21***	8.27***			
14 th day	10.20	89.80***	16.82***	13.88***	5.61***		
21 st day	5.67	94.33***	21.35***	18.41***	10.14***	4.53***	
28 th day	4.25	95.75***	22.77***	19.83***	11.56***	5.95***	1.42**

** p< 0.01, *** p< 0.001

Table 4.13 Scheffe's multiple comparisons of the percentage of remaining force among seven time intervals of group III elastomeric ligatures

Time intervals	Initial	1 st day	2 nd day	7 th day	14 th day	21 st day	28 th day
\bar{X} (%)	100.00	28.23	25.12	16.03	10.75	5.73	5.03
Initial	100.00						
1 st day	28.23	71.77***					
2 nd day	25.12	74.88***	3.11***				
7 th day	16.03	83.97***	12.20***	9.09***			
14 th day	10.75	89.25***	17.48***	14.37***	5.28***		
21 st day	5.73	94.27***	22.50***	19.39***	10.30***	5.02***	
28 th day	5.03	94.97***	23.20***	20.09***	11.00***	5.72***	.70

*** p< 0.001

Table 4.13 presented that there were highly significant differences ($p < 0.001$) in the PRF of group III in nearly all time intervals, excluding the PRF between the 21st day and the 28th day.

Table 4.14 Scheffe's multiple comparisons of the percentage of remaining force among seven time intervals of group IV elastomeric ligatures

Time intervals		Initial	1 st day	2 nd day	7 th day	14 th day	21 st day	28 th day
	\bar{X} (%)	100.00	28.22	25.76	16.07	10.09	5.91	4.59
Initial	100.00							
1 st day	28.22	71.78***						
2 nd day	25.76	74.24***	2.46***					
7 th day	16.07	83.93***	12.15***	9.69***				
14 th day	10.09	89.91***	18.13***	15.67***	5.98***			
21 st day	5.91	94.09***	22.31***	19.85***	10.16***	4.18***		
28 th day	4.59	95.41***	23.63***	21.17***	11.48***	5.50***	1.32	

*** $p < 0.001$

Table 4.14 showed that there were highly significant differences in the PRF of group IV in nearly all time-intervals, excluding the PRF between the 21st day and the 28th day.