

Comparison of 4 Brands of Elastomeric Chains Based On Time Dependent Force Decay

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Abstract:

Objectives: To compare the force decay rate of the four brands of elastomeric chain over time and finally establish a gradation of brands in terms of force degradation characteristics.

Materials and Methods: In this study total of two hundred and forty elastics were used. It had elastics of the same size from four different manufacturers. The experiment was carried out in vivo. For each patient the interbracket distance is measured for all four quadrants. The total distance thus registered is then divided into half and recorded for effective chain length to standardize the amount of stretch for each chain. Four brands of elastomeric chain then attached to the specific attachment in patients mouth using split mouth technique. The patient recalled and the sample collected at 24th hour, after 10 days of following the first sample collection, and 30 days after the second sample collection. One set of sample of specified length was collected at 0 hours at not stretched condition. The procedure is repeated for all the 15 patients. A total of 240 samples thus collected using the following method. An Instron universal testing machine was used to measure the force in newton exerted by the elastics.

Results: The result reveals at 24 hours there is a massive loss of initial exerted force and for all the brands the loss of force ranged from 35-40%. At this specific time the brand that retains maximum amount of initial force is Plastic chain(AO) at the level of 63.48% while maximum degradation of force was found in ALASTIK(3M UNITEK) which retained only 59.92%. At 10 days maximum force retained by ALASTIK(3M UNITEK) at 51.83% while maximum degradation was found in Plastic chain(AO) with only 46.23%. At the end of 30 days the effective loss of initially expressed force appears to be almost at the same level of all the commercially available brands. However the study reveals the leading brand in maximum force retention was DYNA-LINK(G&H) which retained 40.8% while Plastic chain(AO) was found to have lost the maximum force and retained only 39.63%.

Conclusions: The conclusion suggests Plastic chain(AO) retains the highest amount of its initial force in percentage at the end of 24 hours but Between the time period of 24 hours and 10 days ALASTIK(3M UNITEK) loses the minimum amount of force in percentage among all brands. However it is DYNA-LINK(G&H) which showed the highest amount of retained average force compared to its initial force in percentage and exhibited a degradation performance which is more stable than the other brands.

Keywords: Elastomeric chain in orthodontics, Force degradation, ALASTIK(3M UNITEK), DYNA-LINK(G&H), Elastomeric chain(Orthoclastic), Plastic chain(AO).

I. Introduction

Orthodontics is the branch of dentistry which deals with the smile of a patient and reinstates the lost smile and function of an individual. In achieving the desired results, the cuspid retractions, closing diastemas, rotational correction, replacement of ligature ties, and general space closures are the various treatment procedures. Synthetic elastic polymers gained popularity in recent years in orthodontics and are used for the same.¹

“Elastomer” is the general term given to synthetic polymer materials. Natural rubber is also an elastomer but not all elastomers can be called rubber. The elastic properties of such materials depend on irregular twisted arrangements of very long molecular chains linked together at certain points by covalent bonds between different atoms such as sulphur with carbon atoms.²

The major useful property of natural latex rubber is its resiliency. The characteristic property of reversible extensibility result from randomly coiled structure of long folded chains. Upon extension these randomly coiled structure becomes orderly linear extension. The tendency to revert back to the original disorderly state accounts for the elastic behaviour.³

Synthetic elastomeric chains have been used by orthodontist since the 1960s. These polyurethane materials have largely replaced latex elastics for the intra arch tooth movements. The force decay in these materials is significant and has been a clinical problem.⁴

Traditionally latex elastics have been used for interarch mechanics and other intraoral elastic purposes. But during the past several years, there has been an increasing awareness of the health risks of some latex rubber products. Reactions to latex materials have become more prevalent and better recognized since the 1988 adoption of universal precautions.

One of the major shortcomings of the original elastomeric auxiliaries was their inability to maintain the delivered force for a significant duration. Clinical observations found that the early elastomeric modules, when removed from a force system, were permanently elongated and underwent plastic deformation. This deformation was related to the amounts of both time and stretch to which the materials were subjected. In comparing various elastomeric auxiliaries, there were some significant differences among various manufacturers.⁵

Since the references from the literature it's evident that the force decay is present in elastomeric chains, which may vary in different time period and with different manufacturers, this study was planned and designed to compare four brands of elastomeric chain available in the Indian market on the basis of force decay rate in different time periods.

II. Materials And Methods

The study was done in MGM Medical College, Kishanganj, Bihar. Four brands of elastomeric chain with all the uniform parameters were selected. The brands are:

1. ALASTIK(3M UNITEK)
2. Plastic chain(American Orthodontics).
3. Elastomeric chain(Orthoclassic)
4. DYNA-LINK(G & H)

15 patients were selected using the inclusion and exclusion criterion.

Inclusion criteria:

1. patient should be in retraction phase of fixed orthodontic therapy.
2. retraction should be carried out using frictional method.
3. both the upper and lower arch should have patent extraction space.

Exclusion criteria:

1. periodontally compromised patient
2. nonextraction or single arch extraction cases

For each patient the interbracket distance is measured using an slide caliper for all four quadrants. The total distance registered is then divided into half and recorded for effective chain length to standardize the amount of stretch for each chain. Four brands of elastomeric chain then attached to the specific attachment in patients mouth using split mouth technique. The brand and the quadrant sequence is as follows:

- a. ALASTIK(3M UNITEK)-----1st quadrant
- b. Plastic chain(American Orthodontics)-----2nd quadrant
- c. Elastomeric chain(Orthoclassic)-----3rd quadrant
- d. DYNA-LINK(G & H)-----4th quadrant

The patient recalled and the sample collected at 24th hour. Second set of sample collected after 10 days of following the first sample collection, and third sample collected 30 days after the second sample collection. Each time the sample collected, the chains are replaced by new elastomeric chain of the same brand and of the same predetermined length. One set of sample of specified length was collected at 0 hours at not stretched condition. All the samples were washed thoroughly with water and stored immediately in the labeled airtight container (figure 1) and transferred to the testing laboratory on the day of sample collection. The procedure performed for all the 15 patients and a total of 240 samples collected using the above explained method.

An Instron universal testing machine (model No.4467) with 10 Kg load cell and cross head speed of 20mm per minute was used to measure the force in newton exerted by the elastics. Brass hooks were used to engage the elastics, on the fixed and moving arms of the Instron machine (figure 9).

Results of all the 240 samples obtained. The data was analyzed statistically using ANOVA , Individual t-test and Tukey's HSD and results were tabulated and graphical representations were made. Statistical package for social science (SPSS) WINDOWS Version II was used for the analysis.

III. Results

The present study has been planned to evaluate and compare the force degradation of 4 different orthodontic elastomeric chains at different time intervals.

Elastics were tested for the force decay; readings were noted as Initial, force decay after 24 hours and the force decay after 10 and 30 days. The same procedure was carried out for all companies and all patients.

The table no 1. Shows the force levels of the elastomeric chains from 4 different commercial brands ALASTIK(3M UNITEK),Plastic chain(AO),Elastomeric chain(Orthoclassic) DYNA-LINK(G&H) in 15 different patients at 4 time periods,0 hours,24 hours,10 days and 30 days. The force expressed in SI unit Newton.

Table 2 shows the force remaining in percentage in elastomeric chains for all the 4 commercial brands. The calculations has been made considering the initial force as 100% and the mean of each group was considered as the obtained value for calculation.The values for each group expressed as percentage of the total initial force.The result reveals at 24 hours there is a massive loss of initial exerted force and for all the brands the loss of force ranged from 35-40%.At this specific time the brand that retains maximum amount of initial force is Plastic chain(AO) at the level of 63.48% while maximum degradation of force was found in ALASTIK(3M UNITEK) which retained only 59.92%.At 10 days maximum force retained by ALASTIK(3M UNITEK) at 51.83% while maximum degradation was found in Plastic chain(AO) with only 46.23%.At the end of 30 days the effective loss of initially expressed force appears to be almost at the same level of all the commercially available brands.However the study reveals the leading brand in maximum force retention was DYNA-LINK(G&H) which retained 40.8% while Plastic chain(AO) was found to have lost the maximum force and retained only 39.63%.

Table 3 was formed for standard statistical calculations. The table contains the basic statistical units,the mean, standard deviation, standard error, upper and lower bound and minimum and maximum in each of the groups at 0,24 hours and 10,30 days. Brand 1,2,3,4 as referred in the table are ALASTIK(3M UNITEK), Plastic chain(AO),Elastomeric chain (Orthoclassic) and DYNA-LINK(G&H) respectively. The table shows the mean of each group at each time period.For the brand ALASTIK(3M UNITEK) the mean at 0,24 hours and 10,30 days time are 5.4439N,3.26545N,2.82853N, and 2.16660N respectively. The brand Plastic chain(AO) at all 4 time periods have mean values of 5.4574N,3.4696N,2.82853N,and 2.16209N respectively. The brand Elastomeric chain (Orthoclassic) has mean values at 4 time periods as 5.2087N, 3.2606N, 2.58886N, 2.10020N Respectively. For DYNA-LINK(G&H) at the given time periods mean values are 5.2287N, 3.20213N, 2.62073N and 2.1300N. The forces in each of the groups for each of the brands varied as the experiment was performed in vivo and the factors degenerating forces varied among different due to different food materials intake,intra oral temperature and pH.

Table 4 shows the result of performing Anova and repeat anova and it has been found that at 24 hours and 10 days highly statistically significant difference in force level exist as the significance is .000 for the time periods while at 30 days it becomes insignificant showing .383 considering the mean difference at .05 level.

Table 5 shows the mean value of force expressed in newton for each of the groups. The result reveals at 0 hours ALASTIK(3M UNITEK) exerts the maximum amount of force at 5.44N whereas Elastomeric chain (Orthoclassic) exerts the minimum at 5.2N when all the elastomeric chains are stretched 200% of its length. At the 24th hour it has been found that the force values drastically reduced and at this point of time Plastic chain(AO) exerts the maximum amount of force at 3.46N and the minimum force produced by DYNA-LINK(G&H) 3.2N.At the end of 10 days from the initial attachment of the elastomeric chains the force decreased further but at a much slower pace. Force exerted by ALASTIK(3M UNITEK) was found maximum with 2.82N and Plastic chain(AO) produced the lowest force among all with a value of 2.52N.Calculations made at the end of 30 days depicted the force degradation reached almost at a plateau stage and the force retained by each of the elastomeric chains are near to constant and much below the clinically significant level as stated by Rock W P.The author prescribed a force value of 3N as the standard and optimum orthodontic force for effective tooth movement.This study has found that at the end of 30 days Plastic chain(AO) and ALASTIK(3M UNITEK) shared the joint leading position with 2.16N force generation and Elastomeric chain (Orthoclassic)produced the minimum force value of 2.1N.

Table 6 shows the result of Tukeys test and shows the comparison of each one of the brand with all the other brands at different specific time period and the difference between each one of them has been recorded.Except at the time period of 30 days most of the other result showed statistically significant difference in force levels.At 0 hours when the brand ALASTIK(3M UNITEK) compared with other 3 brands statistically significant result found for Elastomeric chain(Orthoclassic) and DYNA-LINK(G&H).Plastic chain(AO) in comparison with other brands also shown statistically significant difference with DYNA-LINK(G&H) and Elastomeric chain(Orthoclassic).At 0 hours both the brands Elastomeric chain (Orthoclassic) and DYNA-LINK(G&H) in comparison with other brands showed statistically significant result with ALASTIK(3M UNITEK) and Plastic chain(AO) but didn't show any significant result when compared with each other.At 24 hour ALASTIK(3M UNITEK) showed statistically significant result only with Plastic chain(AO) while Plastic chain(AO) showed significant difference with all the other brands.Both the brands Elastomeric

chain(Orthoclastic) and DYNA-LINK(G&H) showed statistically significant result only with Plastic chain(AO). Calculations made at the end of 10 days shows ALASTIK(3M UNITEK) shows significantly different force levels with all the other brands while Plastic chain(AO), Elastomeric chain(Orthoclastic) and DYNA-LINK(G&H) showed Statistically significant result only with ALASTIK(3M UNITEK) and not among themselves. At the end of 30 days none of the interbrand results showed any statistical significance.

The graph-1 shows comparative force levels of all the four commercial brands at different time interval. It is evident from the bar diagram that while ALASTIK(3M UNITEK) and Plastic chain(AO) shows almost equal force the other 2 brands Elastomeric chain(Orthoclastic) and DYNA-LINK(G&H) showed a lesser value. The marking within the bars shows the mean +/- standard deviation. At the end of 24 hours it was Plastic chain(AO) which showed maximum force generation while at the end of 10 days the position has been claimed by ALASTIK(3M UNITEK). At the end of 30 days all the brand shows nearly a similar force generation.

The graph-2 shows the decline in force levels when plotted against time for all the brands. The brands have been represented as coloured line diagrams. The diagram portrays a sharp contrast among the various brands in question. ALASTIK(3M UNITEK) at the end of 24 hours have a maximum drop in force level followed by DYNA-LINK(G&H) Elastomeric chain(Orthoclastic) and Plastic chain(AO) showed the least drop in force value. But as time progress from 24th hour to 10 days ALASTIK(3M UNITEK) surpasses other brands and shows the least drop in force value within this time period while Plastic chain(AO) from its depicted value at 24th hour, experience a sharp decline in force value and end in the lowest position among all the brands at the end of 10 days. However during the time period from 10 days to 30 days force degradation for all brands found to be at a minimum level and shows a plateau like pattern.

IV. Discussion

Resiliency of elastic products has been exploited to form force delivery systems in orthodontics. However, as with all objects living and non living, elastics do succumb to the laws of nature. The force levels decrease with respect to the initial forces exerted. This property is termed as the force decay.

There are various factors identified by number of authors that influence the force degradation characteristic of the elastomeric chain. The factors are: colour, fluoride, ir, ozone, disinfection and sterilization, temperature, ph, mastication, staining, oral cavity, water. Although there have been a number of studies concerning dental elastomers and the degradation of strength with time, varying results have been reported. This inconsistency is the result of many different kinds of materials and experimental methods, making it difficult to compare the products. Therefore in this experiment, products of same size were used and their physical properties were examined with standardized environments. The brands are divided in the same patient using split mouth technique so that they experience the degenerative factors which become standardised for all commercial brands in question. A study was conducted to determine the action of oral fluids on the effectiveness of elastics showed that oral fluids could decrease the effectiveness of the elastics by 20% after 24 hours of constant use.⁶ Another study by Ash J L suggested greater force decay was observed in wet condition than in dry condition for the same temperature. In a study by storey and Smith they have found chains stored in liquid has less force decay than in vivo condition.¹⁰ Thus the present study was planned in vivo which standardises the clinical conditions for all the commercial brands. A study by De Genova suggested the short module chains produce higher initial force and show lesser force decay when compared with long modules.⁴ So the study design standardised and included short chain of the available brands. Bales T R suggested, stretching elastics to twice their lumen size would produce a force, which better represents the manufacturer's expected value.⁷ The present study designed such that all the chains are stretched 200% which is twice its lumen size.

A comparative study by Howard R.S. done on the relaxation of orthodontic elastic threads with Polymeric threads conducted, in vivo and in vitro environments showed that, force decay was subsequently greater in, in vivo⁸. Another study by Kuster R. also confirmed this and stated that more rapid and extensive force degradation seen under intra oral use than in laboratory tests.⁹ which further inspired us to conduct the present study in vivo. In another study Williams and von Fraunhofer looked at the force decay properties of short filament gray and clear chains from three companies. The clear chains generally provided a higher initial force level and retained a larger percentage of this force while extended at a constant length¹⁰. In the present study design all the commercial brand's elastomeric chains included were clear in nature. Many other studies has been recorded which includes the effects of temperature ,ph, subject's oral temperature, fluorides, and alkaline phosphates concludes that each one of these acts as a factor in force degradation in elastomeric chains. A study was performed by Ana Christina Soares which included 4 commercial brands of elastomeric chains. In her study she has compared the interbrand force decay rate. Though the overall results obtained is in agreement with the above study, parameters used by A.C. Soares, is in variance with the study as the present study has been performed in vivo using split mouth technique.

The result of the present study shows a gradual decrease in force in all the available elastomeric chains although it confirms that each one of the available brands differ in the pattern of decay significantly.

The result reveals at 24 hours there is a massive loss of initial exerted force and for all the brands the loss of force ranged from 35-40%. At this specific time the brand that retains maximum amount of initial force is Plastic chain(AO) at the level of 63.48% while maximum degradation of force was found in ALASTIK(3M UNITEK) which retained only 59.92%. At 10 days maximum force retained by ALASTIK(3M UNITEK) at 51.83% while maximum degradation was found in Plastic chain(AO) with only 46.23%. At the end of 30 days the effective loss of initially expressed force appears to be almost at the same level of all the commercially available brands. However the study reveals the leading brand in maximum force retention was DYNA-LINK(G&H) which retained 40.8% while Plastic chain(AO) was found to have lost the maximum force and retained only 39.63%.

V. Conclusion

This study concludes that;

- ALASTIK(3M UNITEK) loses maximum amount of its initial force in percentage among all brands within the first 24 hours followed by DYNA-LINK(G&H), Elastomeric chain(Orthoclassic) and Plastic chain(AO).
- Plastic chain(AO) loses the highest amount of force in percentage among all brands followed by Elastomeric chain(Orthoclassic), DYNA-LINK(G&H) and ALASTIK(3M UNITEK) between the time period of 24 hours and 10 days.
- DYNA-LINK(G&H) showed the highest amount of retained average force compared to its initial force in percentage and exhibited a degradation performance which is more stable than the other brands.

Tables

Table 1: Master chart depicting the force values in Newton for 4 different brands

Patient	brand	0 HOURS	24 HOURS	10 DAYS	30 DAYS
Patient 1	ALASTIK (3M UNITEK)	5.43	3.211	2.819	2.152
	AMERICAN ORTHODONTICS	5.804	3.422	2.562	2.112
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.109	3.011	2.56	2.096
	DYNA-LINK(G&H)	5.021	3.012	2.49	2.056
Patient 2	ALASTIK(3M UNITEK)	5.4	3.196	2.85	2.012
	AMERICAN ORTHODONTICS	5.71	3.322	2.491	2.096
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.1	3.211	2.565	2.011
	DYNA-LINK(G&H)	5.129	3.122	2.516	2.122
Patient 3	ALASTIK(3M UNITEK)	5.45	3.204	2.916	2.011
	AMERICAN ORTHODONTICS	5.696	3.604	2.519	2.209
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.096	3.102	2.602	2.011
	DYNA-LINK(G&H)	5.119	3.316	2.612	2.102
Patient 4	ALASTIK(3M UNITEK)	5.521	3.316	2.814	2.012
	AMERICAN ORTHODONTICS	5.5	3.519	2.6	2.314
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.193	3.096	2.602	2.012
	DYNA-LINK(G&H)	5.13	3.173	2.712	2.102
Patient 5	ALASTIK(3M UNITEK)	5.429	3.29	2.912	2.16
	AMERICAN ORTHODONTICS	5.412	3.496	2.51	2.219
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.219	3.121	2.611	2.119
	DYNA-LINK(G&H)	5.161	3.201	2.714	2.152
Patient 6	ALASTIK(3M UNITEK)	5.416	3.219	2.796	2.219
	AMERICAN ORTHODONTICS	5.312	3.473	2.654	2.199
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.316	3.319	2.512	2.156
	DYNA-LINK(G&H)	5.121	3.316	2.691	2.156
Patient 7	ALASTIK(3M UNITEK)	5.452	3.356	2.812	2.319
	AMERICAN ORTHODONTICS	5.366	3.48	2.521	2.219
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.011	3.33	2.672	2.32
	DYNA-LINK(G&H)	5.219	3.219	2.761	2.26
Patient 8	ALASTIK(3M UNITEK)	5.437	3.411	2.919	2.151
	AMERICAN ORTHODONTICS	5.346	3.512	2.496	2.319
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.419	3.519	2.6	2.296
	DYNA-LINK(G&H)	5.316	3.321	2.546	2.051
Patient 9	ALASTIK(3M UNITEK)	5.396	3.219	2.86	2.213
	AMERICAN ORTHODONTICS	5.319	3.419	2.513	2.3
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.316	3.5	2.612	2.212
	DYNA-LINK(G&H)	5.516	3.296	2.916	2.191

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Patient 10	ALASTIK(3M UNITEK)	5.411	3.209	2.8	2.002
	AMERICAN ORTHODONTICS	5.121	3.322	2.491	2.016
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.321	3.211	2.535	2.011
	DYNA-LINK(G&H)	5.056	3.126	2.516	2.112
Patient 11	ALASTIK(3M UNITEK)	5.499	3.3568	2.521	2.012
	AMERICAN ORTHODONTICS	5.511	3.419	2.129	2.009
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.126	3.216	2.609	2.131
	DYNA-LINK(G&H)	5.129	3.219	2.602	2.096
Patient 12	ALASTIK(3M UNITEK)	5.451	3.316	2.874	2.2
	AMERICAN ORTHODONTICS	5.319	3.519	2.654	2.109
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.316	3.201	2.612	2.012
	DYNA-LINK(G&H)	5.399	3.173	2.419	2.261
Patient 13	ALASTIK(3M UNITEK)	5.419	3.219	2.8	2.512
	AMERICAN ORTHODONTICS	5.714	3.512	2.491	2.096
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.176	3.207	2.565	2.011
	DYNA-LINK(G&H)	5.208	3.211	2.516	2.112
Patient 14	ALASTIK(3M UNITEK)	5.496	3.219	2.819	2.512
	AMERICAN ORTHODONTICS	5.412	3.422	2.562	2.116
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.316	3.013	2.561	2.094
	DYNA-LINK(G&H)	5.591	3.011	2.491	2.055
Patient 15	ALASTIK(3M UNITEK)	5.452	3.24	2.916	2.012
	AMERICAN ORTHODONTICS	5.319	3.604	2.707	2.098
	ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.096	3.102	2.611	2.011
	DYNA-LINK(G&H)	5.316	3.316	2.809	2.122

TABLE:2 brands force remaining in elastomeric chains expressed in percentage for 4

BRAND	0 HOUR	24 HOUR	10 DAYS	30 DAYS
ALASTIK(3M UNITEK)	100	59.92	51.83	39.7
AMERICAN ORTHODONTICS	100	63.48	46.23	39.63
ELASTOMERIC CHAIN(ORTHOCLASSIC)	100	61.73	49.61	40.38
DYNA-LINK(G&H)	100	61.3	50.19	40.8

Table 3: The standard table for statistical analysis
Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
0 HOUR	BRAND1	15	5.4439	.03692	.00953	5.4235	5.4644	5.40	5.52
	BRAND2	15	5.4574	.19421	.05015	5.3498	5.5650	5.12	5.80
	BRAND3	15	5.2087	.11874	.03066	5.1429	5.2744	5.01	5.42
	BRAND4	15	5.2287	.16677	.04306	5.1364	5.3211	5.02	5.59
	Total	60	5.3347	.18158	.02344	5.2878	5.3816	5.01	5.80
24 HOURS	BRAND1	15	3.26545	.069422	.017925	3.22701	3.30390	3.196	3.411
	BRAND2	15	3.46967	.083940	.021673	3.42318	3.51615	3.322	3.604
	BRAND3	15	3.21060	.153213	.039559	3.12575	3.29545	3.011	3.519
	BRAND4	15	3.20213	.103193	.026644	3.14499	3.25928	3.011	3.321
	Total	60	3.28696	.151092	.019506	3.24793	3.32599	3.011	3.604
10 DAYS	BRAND1	15	2.82853	.097064	.025062	2.77478	2.88229	2.521	2.919
	BRAND2	15	2.52667	.129910	.033543	2.45472	2.59861	2.129	2.707
	BRAND3	15	2.58860	.039091	.010093	2.56695	2.61025	2.512	2.672
	BRAND4	15	2.62073	.140866	.036371	2.54272	2.69874	2.419	2.916
	Total	60	2.64113	.156136	.020157	2.60080	2.68147	2.129	2.919
30 DAYS	BRAND1	15	2.16660	.172223	.044468	2.07123	2.26197	2.002	2.512
	BRAND2	15	2.16207	.100652	.025988	2.10633	2.21781	2.009	2.319
	BRAND3	15	2.10020	.106557	.027513	2.04119	2.15921	2.011	2.320
	BRAND4	15	2.13000	.065347	.016873	2.09381	2.16619	2.051	2.261
	Total	60	2.13972	.117819	.015210	2.10928	2.17015	2.002	2.512

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[Brand 1,2,3,4 are ALASTIK (3M UNITEK),Plastic chain(AO), Elastomeric chain (Orthoclassic) and DYNA-LINK(G&H) respectively]

The * indicates the result bears a statistical significance

Table 4: Anova showing comparison within and between groups
ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
0 HOUR	Between Groups	.812	3	.271	13.359	.000
	Within Groups	1.134	56	.020		
	Total	1.945	59			
24 HOURS	Between Groups	.703	3	.234	20.384	.000
	Within Groups	.644	56	.011		
	Total	1.347	59			
10 DAYS	Between Groups	.771	3	.257	21.564	.000
	Within Groups	.667	56	.012		
	Total	1.438	59			
30 DAYS	Between Groups	.043	3	.014	1.039	.383
	Within Groups	.776	56	.014		
	Total	.819	59			

Table:5 mean value of Force expressed in newton for 4 brands and at 4 time periods

BRAND	0 HOUR	24 HOURS	10 DAYS	30 DAYS
ALASTIK(3M UNITEK)	5.44	3.26	2.82	2.16
AMERICAN ORTHODONTICS	5.45	3.46	2.52	2.16
ELASTOMERIC CHAIN(ORTHOCLASSIC)	5.2	3.21	2.58	2.1
DYNA-LINK(G&H)	5.22	3.2	2.62	2.13

Table 6: Comparison between brands at 0,24 hours and 10,30 days

Tukey HSD

Multiple Comparisons

Dependent Variable	(I) BRAND	(J) BRAND	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
0 HOUR	BRAND1	BRAND2	-.01347	.05196	.994	-.1510	.1241
		BRAND3	.23527*	.05196	.000	.0977	.3728
		BRAND4	.21520*	.05196	.001	.0776	.3528
	BRAND2	BRAND1	.01347	.05196	.994	-.1241	.1510
		BRAND3	.24873*	.05196	.000	.1112	.3863
		BRAND4	.22867*	.05196	.000	.0911	.3662
	BRAND3	BRAND1	-.23527*	.05196	.000	-.3728	-.0977
		BRAND2	-.24873*	.05196	.000	-.3863	-.1112
		BRAND4	-.02007	.05196	.980	-.1576	.1175
	BRAND4	BRAND1	-.21520*	.05196	.001	-.3528	-.0776
		BRAND2	-.22867*	.05196	.000	-.3662	-.0911
		BRAND3	.02007	.05196	.980	-.1175	.1576
24 HOURS	BRAND1	BRAND2	-.204213*	.039153	.000	-.30789	-.10054
		BRAND3	.054853	.039153	.504	-.04882	.15853
		BRAND4	.063320	.039153	.377	-.04035	.16699
	BRAND2	BRAND1	.204213*	.039153	.000	.10054	.30789
		BRAND3	.259067*	.039153	.000	.15539	.36274
		BRAND4	.267533*	.039153	.000	.16386	.37121
	BRAND3	BRAND1	-.054853	.039153	.504	-.15853	.04882
		BRAND2	-.259067*	.039153	.000	-.36274	-.15539
		BRAND4	.008467	.039153	.996	-.09521	.11214
	BRAND4	BRAND1	-.063320	.039153	.377	-.16699	.04035
		BRAND2	-.267533*	.039153	.000	-.37121	-.16386
		BRAND3	-.008467	.039153	.996	-.11214	.09521

Comparison Of 4 Brands Of Elastomeric Chains Based On Time Dependent Force Decay

10 DAYS	BRAND1	BRAND2	.301867*	.039862	.000	.19632	.40742
		BRAND3	.239933*	.039862	.000	.13438	.34548
		BRAND4	.207800*	.039862	.000	.10225	.31335
	BRAND2	BRAND1	-.301867*	.039862	.000	-.40742	-.19632
		BRAND3	-.061933	.039862	.413	-.16748	.04362
		BRAND4	-.094067	.039862	.097	-.19962	.01148
	BRAND3	BRAND1	-.239933*	.039862	.000	-.34548	-.13438
		BRAND2	.061933	.039862	.413	-.04362	.16748
		BRAND4	-.032133	.039862	.851	-.13768	.07342
	BRAND4	BRAND1	-.207800*	.039862	.000	-.31335	-.10225
		BRAND2	.094067	.039862	.097	-.01148	.19962
		BRAND3	.032133	.039862	.851	-.07342	.13768
30 DAYS	BRAND1	BRAND2	.004533	.042979	1.000	-.10927	.11834
		BRAND3	.066400	.042979	.418	-.04740	.18020
		BRAND4	.036600	.042979	.829	-.07720	.15040
	BRAND2	BRAND1	-.004533	.042979	1.000	-.11834	.10927
		BRAND3	.061867	.042979	.481	-.05194	.17567
		BRAND4	.032067	.042979	.878	-.08174	.14587
	BRAND3	BRAND1	-.066400	.042979	.418	-.18020	.04740
		BRAND2	-.061867	.042979	.481	-.17567	.05194
		BRAND4	-.029800	.042979	.899	-.14360	.08400
	BRAND4	BRAND1	-.036600	.042979	.829	-.15040	.07720
		BRAND2	-.032067	.042979	.878	-.14587	.08174
		BRAND3	.029800	.042979	.899	-.08400	.14360

*. The mean difference is significant at the .05 level.

[Brand 1,2,3,4 are ALASTIK(3M UNITEK),Plastic chain (AO), Elastomeric chain (Orthoclassic) and DYNA-LINK (G&H) respectively]
The * indicates the result bears a statistical significance

LEGENDS



Figure-1 Storage of all the 4 brands at 4 time periods



Figure-2 Plastic airtight container storing elastomeric samples



Figure-3 G & H elastomeric chain spool



Figure -4 ALASTIK elastomeric chain spool

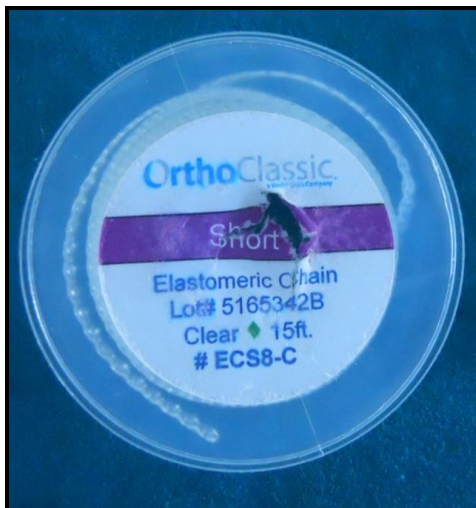


Figure - 5 OrthoClassic elastomeric chain spool



Figure -6 American Orthodontics elastomeric chain spool

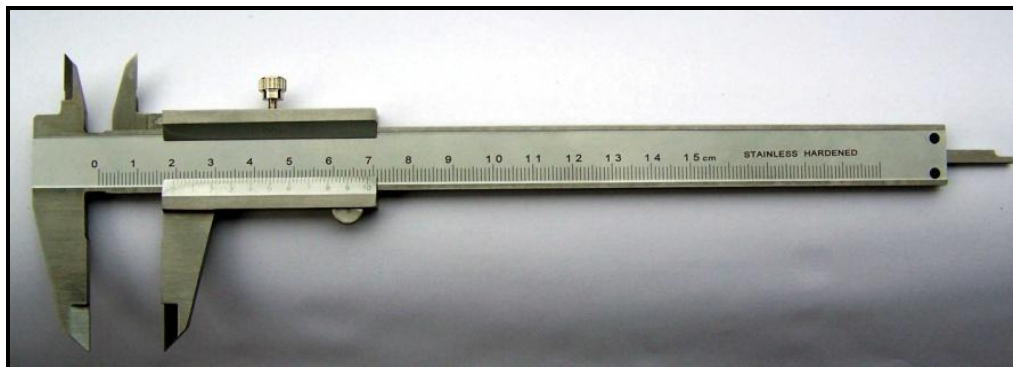


Figure – 7 Slide caliper



Figure – 8 Instron machine

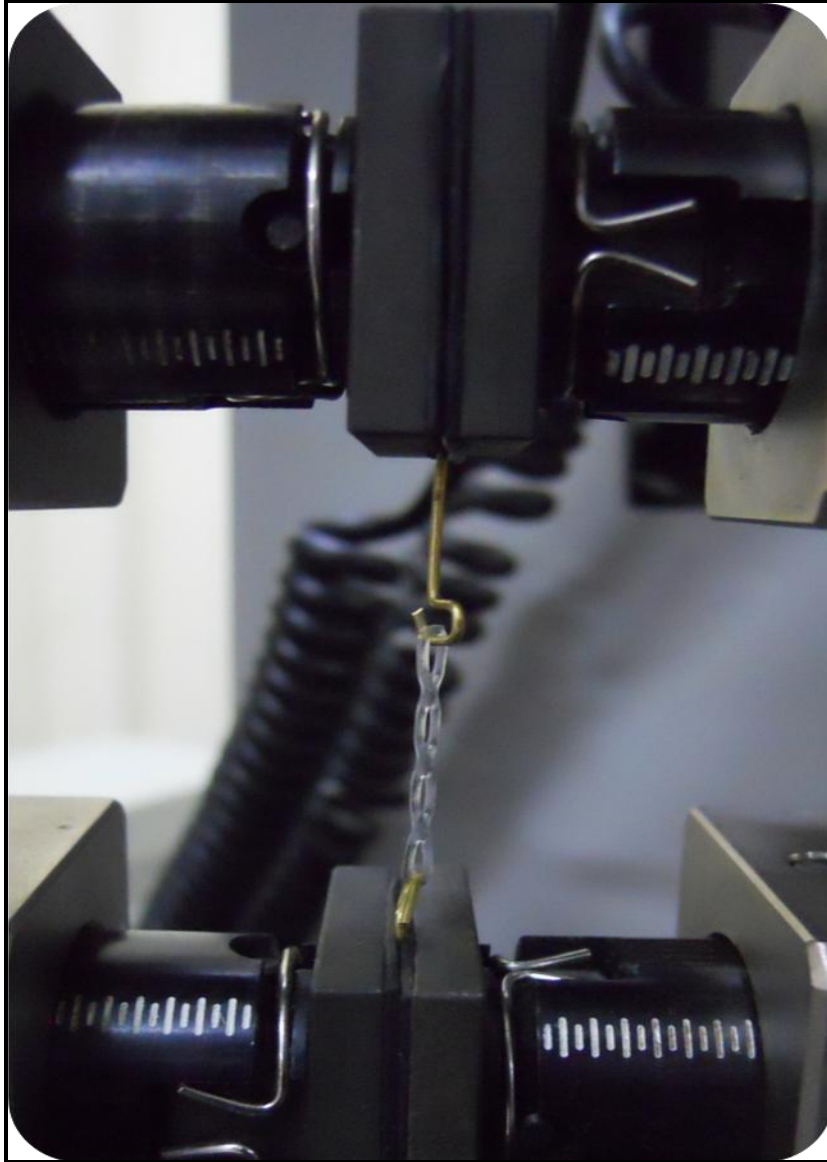
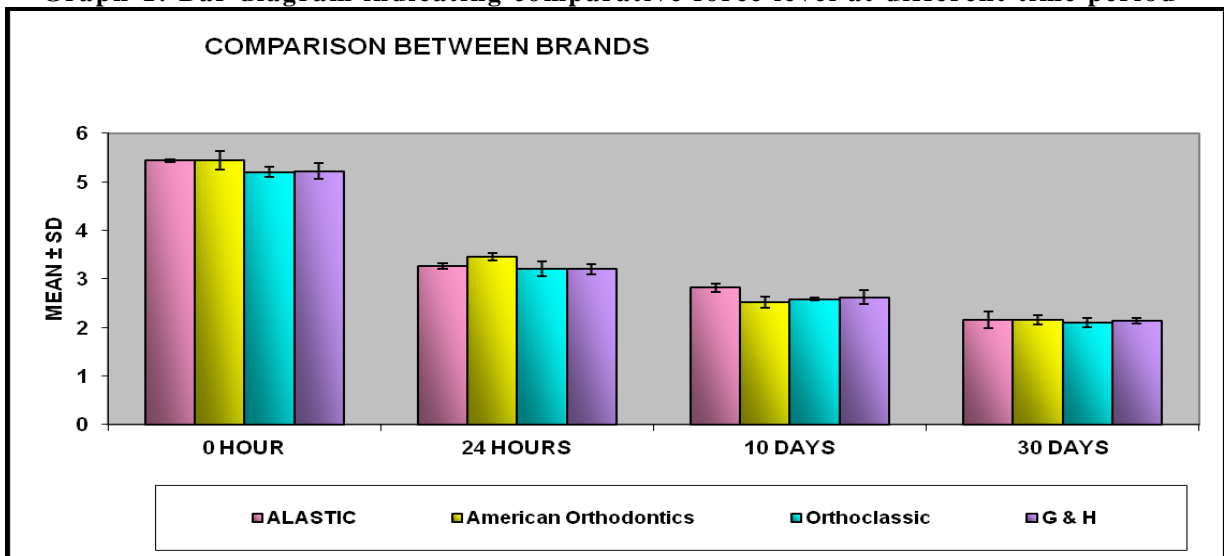
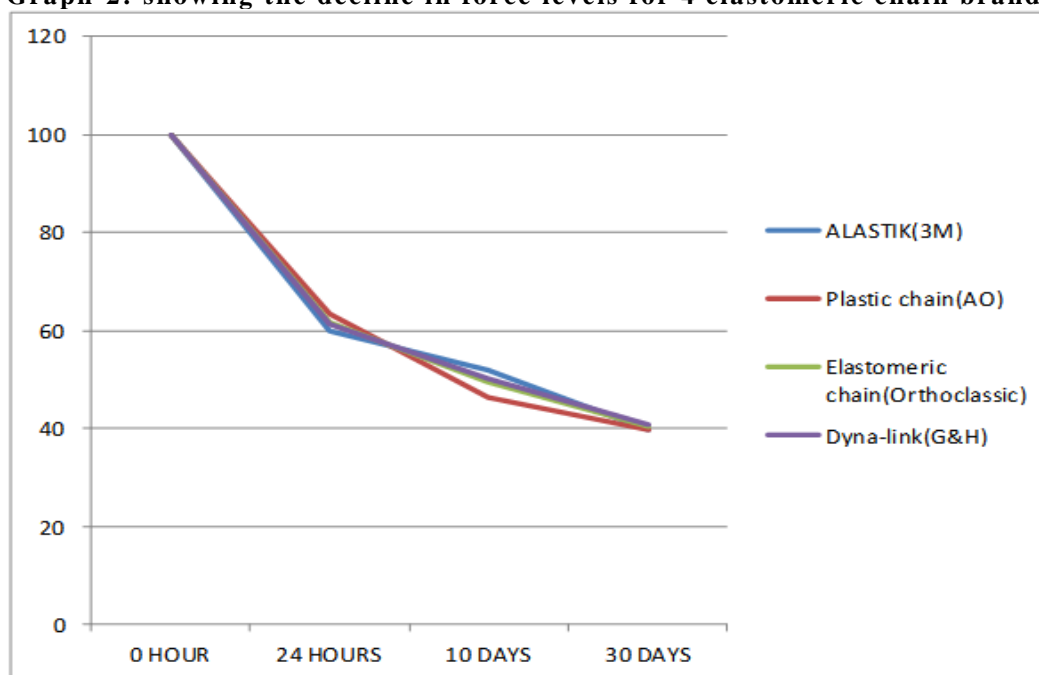


Figure-9 Brass hooks engaged on the fixed and moving arm of instron machine

Graph-1: Bar diagram indicating comparative force level at different time period



Graph-2: showing the decline in force levels for 4 elastomeric chain brands



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