The Comparison Flow of Four Impression Compounds (Green Stick) with ADA Standard

S. Mir Mohammad Rezaei,[1] A. Monzavi,[1] A. Dehghan Naieri[2]

[1] Assistant Professor, Department of Prosthodontics, Faculty of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
[2] Dentist

Statement of Problem: Low- fusing compound (type 1) is used for border molding and impressions. Flow and reproducibility of surface detail are two important characteristics of these materials. There are no valid data available comparing domestic and imported brands.
Purpose: The Purpose of this study was to evaluate these two properties of four different products including Kerr (Kerr Manufacture MI 98174-2600), Harvard (Hoffman Harvard Dental GMb H Germany); Kymia (Kymia dental company 713 Iran); and Pishro (Pishro 72534 Iran).
Materials and Methods: All procedures were followed according to ADA and BS-Standard. Total number of 48 samples were divided into 8 groups (6 in each group). Twenty disks were fabricated for impression tests. The specimen dimensions were 40 mm (diameter) and 6mm (thickness). Standard test blocks were used to test the specimens.
Results: The Willcoxon test showed significant difference in flow rate between materials tested with the best result for Kerr ($P<0.05$). Kerr flow was 85% and under 5% at 45°C and 37°C, respectively. There were great deviations from standards value at 45°C. For the rest of the samples at 37°C; except Kymia the flow rate for 3 materials (Kerr; Harvard Pishro) were almost acceptable. The impression test results revealed that only Kerr was able to record the details at 45°C.
Conclusion: Kerr flow is exactly what ADA standards specify. But the flow rate for three materials exhibit a great distance from these standards. In impression test only Kerr was able to record the details

Key words: Impression compound flow; Viscosity; Plasticity

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Dental compound is a thermoplastic material. It softens under heat and solidifies when it is cooled. It contains resins, waxes, fillers, and plasticizers. These compounds have certain properties such as high viscosity, suitable flow, and plasticity.(1) There are two specifications for flow test, ADA and BS standard.(2, 3)
Based on temperature, dental compound may be divided into 3 groups.(4)
1-Low fusing: (softens at low temperatures) such as green stick, which is used for border molding and impression with copper bands.
2-Medium fusing: (softens at medium temperatures) used for primary impressions for edentulous patients.
3-High fusing: (softens at high temperatures) used for making special trays, which are used

for the final impression.[4]

Minimum flow is needed at mouth temperature but at 8 degrees higher than mouth temperature, compound should have proper flow. Therefore at 45ºC it is plastic and is able to record the impression.[5] Viscosity or flow of a compound depends on its components and the temperature. Slight change in temperature will affect the flow property. In figure 1 the flow changes versus temperature of a certain type of compound is shown. In the temperature range of 37ºC-45ºC, it has major flow changes (Fig. 1).[6]

Plasticity is another aspect that ADA has specified and it is only pertains to type I. The substance should be able to record small grooves (with the width of 0.2-0.4 mm) of the test block at 45ºC.

The most important factors in the flow test procedure appear to be: (1) the age of the specimen at the time of testing; (2) slight temperature variations at the critical 40ºC (104.0ºF) flow temperature; and (3) the chilling of the top of the specimen by the metal platen of the apparatus.[7]

Bevan (1963) in a research about properties of impression compound selected 20 representative materials available from British. Tests were carried out according to ADA standard. The compound should be melted under infrared lamp and kneaded in water using a mixing hydrocoloid syring.

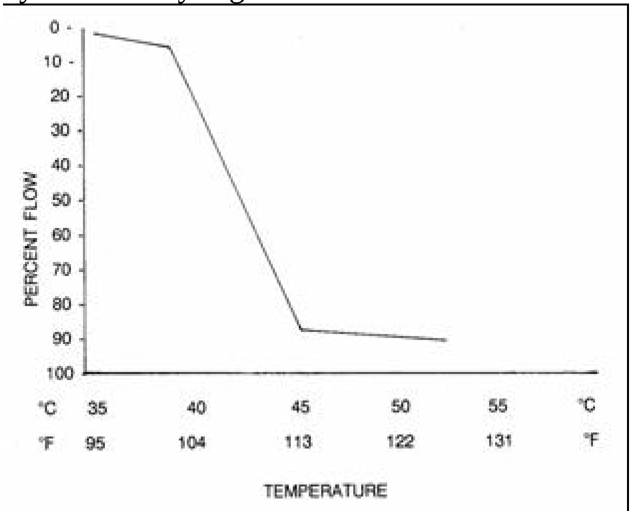


Fig 1- Flow change of compound with temperature

It was observed that a remarkable difference in flow exists between the various products at 37ºC ranging from 1.3 to 81% percent. According to standard, maximum flow is 6% and 2% for type I and II respectively.[8]

At 40ºC a considerable variation in flow still exists but at 45ºC this variation becomes much smaller (81.4% to 92.6%). Only two type I compounds fail to satisfy the standard requirement of a minimum of 85% flow at 45ºC. The small increase in flow which occur in heating from 45ºC to 50ºC does not adequately show the change in flow characteristic which occur for some of the compounds. The results of impression test showed that only two impression compounds fail to reproduce adequately the detail of the test block.[6]

Impression compounds have near Newtonian viscosity characteristics at shear stresses between 104 and 107 dyne/cm^2.

The ADA flow tests for impression compound can be expressed in terms of minimum coefficients of viscosity (for example, 2.8×106 poise at 45ºC).[9] Micheul investigated in reology of impression compound. His report was shown with the viscosity- temperature property.

Bevan (1963) had stated that sectioning of these flow test specimens revealed that some unusually high values were due to large voids containing water or air. Sectioning of the original compound samples also revealed that some products contained air voids, which would not be easily removed by simple kneading.[8]

It has been shown that increased plasticity is dependent on the amount and technique of kneading and thus on the operator concerned. The response of the compounds tested to these factors illustrates that small differences in clinical technique may produce pronounced variation in the results obtained with particular compounds by different individuals. The wet kneading of an inferior compound whilst improving detail registration, will undoubtedly introduce greater likelihood of distortion of the impression on removal from the month.[8]

In spite of the fact that there was considerable variation between the different compounds, all the materials examined could be said to satisfy the clinical requirements of producing a smooth glossy surface on flaming and trimming without chipping at room temperature. However, for the effect of the sharpness of the carving knife, and the technique of flaming, no comparative data are presented.[8]

When accuracy is required, for example, as in a copper band impression, a low flow is essential. The flow may be minimized by softening the material without kneading and there is no distortion thorough chilling before removal.[8]

The purpose of this research was to compare the flow and impression test of two-imported product (Kerr and Harvard), and two Iranian products (Pishro and Kimiya). Our research was performed at two temperatures, 45ºC (modeling temperature) and 37ºC (mouth temperature). The results were compared with ADA and BS standards.[2,3]

Materials and Methods

Four products were chosen for testing. Kerr (Kerr manufacture MI 98174-26001) Harvard (Hoffman Harvard Denta GMbh Germany), Pishro (Pishro 72534 Iran) and Kymia (Kymia dental company Iran).

All the equipments were made according to ADA specification. An equipment was used for flow test which calibrated to the 0.01mm accuracy. (Fig 2a)

The total weight, in air, of its three components was 19.6 N (2000g). The weight, A, was separated a minimum distance of 75 mm from the brass platen by the no conducting shaft. This shaft should be of hard rubber or a similarly thermal insulator. The diameter of the brass platen was not less than 50 mm, and its thickness wasn't exceeding 6.5 mm.

Also, a mold was needed (Fig 2b). It consisted of one plate made of stainless steel with the width of 6mm. The plate had four holes with the diameter of 10mm. The holes' axis was perpendicular to the plate. The inner surface should be smooth and glossy.

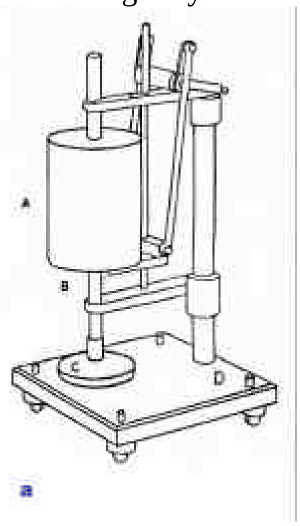


Fig 2a- Testing instruments consist of a metal weight A, a shaft with low thermal conductivity B, a brass plate C, a base D, and b impression

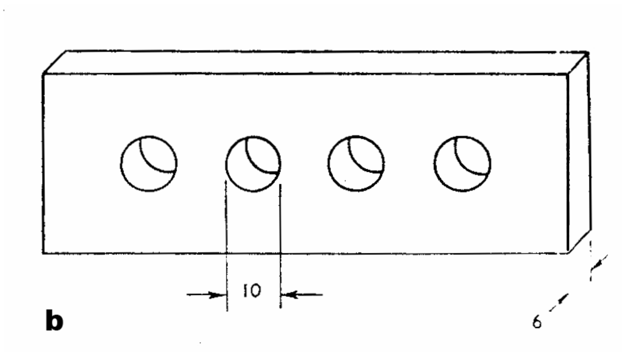


Fig 2b- Plate with four holes

Preparation of specimens (for flow test)

A quantity of compound were broken into pieces and placed in a metal pouring pan. The pan was placed on a surface, which was 130 mm below a 250W infrared lamp. The compound while being stirred was allowed to reach a temperature of 75±5ºC and was maintained at this temperature until the sample was melted throughout. A thermometer was used to measure the temperature.

The mold was preheated to a temperature of 55±5ºC and placed on a smooth glass slab approximately 152 mm long, 76 mm wide, and 20 mm thick preheated to the same temperature.

As the compound cooled and voids appeared, melted compound was added. When the compound had lost its shiny surface, a smooth, flat tinfoil or aluminum foil preheated to 55±5ºC and was placed on top of the mold. Loads of 88 N (9000 g) were applied to the top of the foil covered glass plate for 10 minutes. The weight and the glass plate were removed and the excess compound trimmed away. The mold was removed from the glass slab by gently tapping the side of the mold. The specimens of compound were removed from the mold by chilling in water at 10ºC and was stored at 23±2ºC for 24 hours before testing.

The initial length of the specimen was determined at 23.0±2ºC, using a metric micrometer caliper. Four measurements were made around the circumference and one measurement was made in the center of the specimen. The measurements were recorded to the nearest 0.005 mm. The specimen and flow-testing instrument were placed in a water bath and held at the testing temperature for 20 minutes prior to testing. The temperature of the bath was controlled to within+0.1ºC of the required temperature. Agitation was provided in the water bath by means of a mechanical stirrer. A thin sheet of polyethylene or cellophane was placed between the instrument and each end of the specimen. The bottom of the specimen was 51 mm below the surface of the water in the bath. A constant axial load of 19.6 N (2000g) was applied to the specimen for ten minutes, after which the specimen was removed and cooled in the air to 23.0±2ºC. The polyethylene or cellophane was stripped off and the final length determined in the same manner as the original length.

The flow was reported as a percentage of the change of initial length. The value for flow at any temperature shall be the average value for two specimens and was reported to the nearest 0.1%. (In this experiment, there were 6 specimens instead of two.).

The equipment for impression test has shown in figure 2c. The test block has a base 50 mm in diameter and weighing 1000 ±5 gr.

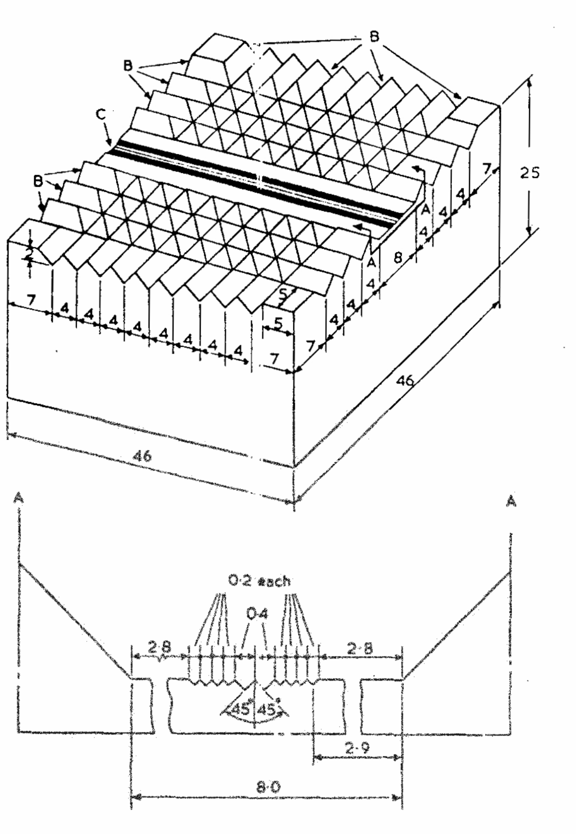


Fig 2c- Test block

Preparation of impression specimen

The impression specimen was a disk 40 mm in diameter and between 4-7mm in thickness.

A water bath was adjusted to 45± 0.1ºC. A flat plate was support the specimen while it was coming to the required temperature. The water level in the bath was 30±5 mm above the top surface of the test block. The impression specimen was placed in the water bath on the flat plate. Twenty minutes later, the specimen was centered on the test block, a sheet of waterproof cellophane was placed over the specimen, and the weight was placed over the cellophane. Ten minutes later, the weight was removed, the test block and specimen were taken from the bath and chilled at a temperature of 10ºC and the specimen was removed from the test block.[2]

The impression was examined to determine if the ridges corresponding to the large cross grooves of the test block were sharp, and the ridges corresponding to the fine grooves were complete and visible to the unaided eye for at least 30 mm of their length.

During both tests (flow and impression test) all equipment and specimens should be on an insulator plate in the water. A stirrer should agitate the water to keep the temperature at a constant level.

Data were statistically analyzed by Wilcoxon test.

Results

The results of the compound flow have are shown in table I and graphs 1 and 2. Also, the descriptive table of relative changes of the four products at 37ºC and 45ºC is shown in tables II and III, and in graphs 1. At 45ºC Kerr had flow in the standard range, above 85%. At this temperature, Kymia had flow between 69 and 74%, Pishro about 60% to 64 %, and Harvard less than 60%.

At 37ºC, Kymia was the only product that had 6% more than the standard flow. As shown in graphs 2, the flow of Kymia and Kerr are 10 14 and 2% respectively. But, Harvard and Pishro's flow is less than 1%.

According to the data analysis at 37ºC and 45ºC, at a 5% level; the four products had a substantial difference with what ADA has specified (P=0.03). At 45ºC, Kerr's flow difference was positive, and the flow rate was in the ADA standard range. For the other products, this difference was negative. Their flow rate was under the standard range.

Table I- The result of flow test for four groups (six samples each group) at 45º and 37ºC; F=$\frac{\Delta L}{L_1}\times 100$

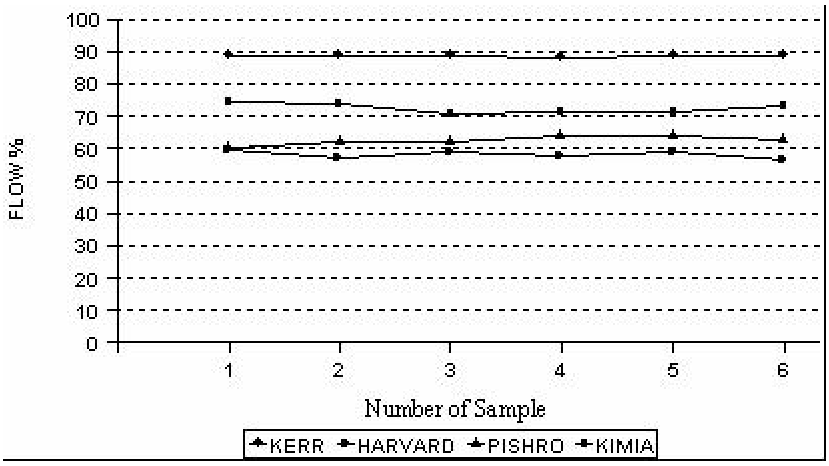
	Kerr				Harvard				Pishro				Kymia		
	L_1 mm	L_2 mm	F%	T=45°C	L_1 mm	L_2 mm	F%	T=45°C	L_1 mm	L_2 mm	F%	T=45°C	L_1 mm	L_2 mm	F%
	5.89	0.66	88.79		5.87	2.38	59.45		53.79	2.30	60.27		5.83	1.49	74.44
T=45°C	5.88	0.66	88.70		5.87	2.50	57.41		5.89	2.23	62.14		5.86	1.54	73.72
	5.85	0.66	88.72		5.88	2.40	59.18		5.86	2.22	62.12		5.91	1.74	70.55
	5.87	0.70	88.07		5.83	2.46	57.80		5.87	2.12	63.88		5.87	1.68	71.37
	5.87	0.66	88.75		5.86	2.39	59.21		5.87	2.12	63.88		5.86	1.67	71.50
	5.83	0.66	88.79		5.89	2.55	56.70		5.89	2.20	62.64		5.86	1.57	73.20
	L_1 mm	L_2 mm	F%	T=37°C	L_1 mm	L_2 mm	F%	T=37°C	L_1 mm	L_2 mm	F%	T=37°C	L_1 mm	L_2 mm	F%
	5.86	5.73	2.22		5.87	5.86	0.17		5.88	5.84	0.68		5.87	5.28	10.05
	5.83	5.69	2.40		5.87	5.85	0.34		5.87	5.84	0.51		5.87	5.26	10.39
T=37°C	5.84	5.68	2.74		5.89	5.87	0.27		5.88	5.84	0.68		5.86	5.09	13.14
	5.84	5.68	2.74		5.85	5.82	0.51		5.87	5.83	0.68		5.84	5.08	13.01
	5.83	5.72	1.88		5.88	5.85	0.51		5.83	5.79	0.68		5.84	5.03	13.86
	5.84	5.73	1.88		5.83	5.79	0.68		5.86	5.83	0.51		5.83	5.01	14.06

Table II- The descriptive data of relative changes for four products at 45ºC

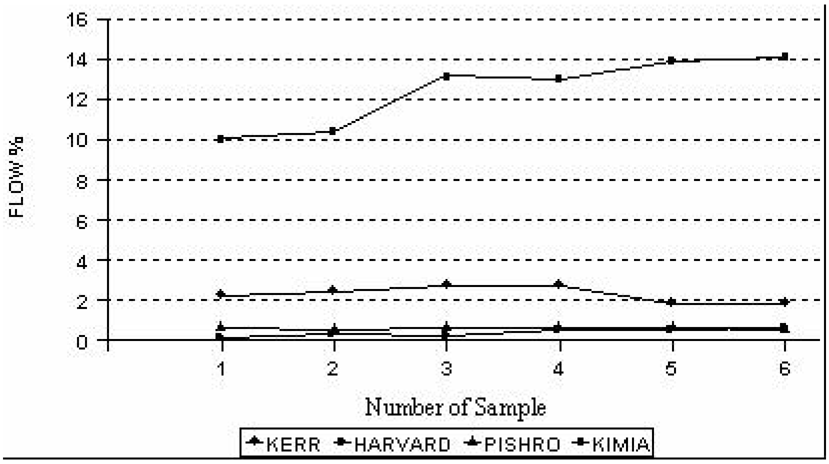
Material	Mean ± SD	CV
Harvard	58.3±1.14	3.38
Kerr	88.63±0.28	0.72
Kimia	72.46±1.53	3.89
Pishro	62.49±1.34	3.61

Table III- The descriptive data of relative changes of four products at 37ºC

Material	Mean ± SD	CV
Harvard	0.43±0.18	0.51
Kerr	2.31±0.38	0.86
Kimia	12.42±1.76	4.01
Pishro	0.63±0.09	0.17



Graph 1- Comparison between variations in the four groups at 45ºC



Graph 2- Comparison between relative variations in the four groups at 37ºC

At 37ºC, Kymia's flow difference was outside of the specified range. The results of impression test showed that only Kerr was able to record test block's detail at 45°C. Kymia and Harvard's test results were recorded at 50ºC. Pishro recorded the test block's details at 55ºC.

Discussion

Dental compounds were produced forty or fifty years ago.

The variance rates of flow percentage pertaining to the samples being studied at 45ºC are shown. A low variance around the average, of Kerr, is seen. This low variance is related to the homogenous structure of the compound.

The average flow is shown in table II, III. Whether the product is homogenous or not is clearly visible in the graph. Kymia has the in-homogenous structure of the product as observed in the graph 2.

The variance and the minimum and maximum points around the average (at 37ºC) are shown in table II. Kymia has great distance between the variance rate and the maximum and minimum points.

Kerr's flow is exactly what the ADA standards specify. The Iranian compounds exhibited a great distance from the standard. Kymia and Pishro weren't comparable to Kerr.

Also during this investigation, we came across other practical points. One of them is the products' ability to be trimmed. Kerr had an excellent ability, Harvard good, Pishro fairly good, and Kymia weak. Another point is the products' properties when softening and when becoming rigid. When held over the flame, Kerr would soften homogeneously and would not drip. When hardening, Kerr would not become rigid quickly; therefore the dentist can work with this compound very easily. The other products did weak in different ways.

After the impression test, Kerr compound is very accurate and is able to record the details of the test block. The edges of large grooves are recorded very sharply. The small grooves are completely visible, and have been recorded with great precision. The other products were not able to record the details at 45ºC at all.

In order to study the quality of the other products' ability to record details, we increased the temperature. Harvard at 50^{o}C and Kymia at 55ºC were able to record the test block's details. Kymia is not sharp and accurate. The grooves' edges that were recorded were not sharp or clear at all. The other two products (Harvard and Pishro) had good results.

Taking into consideration that we have cleared the path for the next researchers, we hope that in the near future this topic will be further studied. Various products should be investigated and more importantly the results should be made available to the Iranian producers. They should be guided to produce better dental compounds to be able to compete with the non-Iranian products and offer better services to their fellow countrymen.

Conclusion

As the result of the flow tests, Kerr had an appropriate flow at 37ºC and 45ºC. This means that at 45ºC, Kerr had a suitable flow when taking impressions of the mouth. At 45ºC, Kerr recorded the details correctly. At 37ºC, Kerr allowed the impression to come out of the mouth without any change.

In the other three samples, at 45ºC, their low flow caused them not to be able to take impressions suitably. We noticed this case in Harvard the most. At 37ºC, Kymia had a flow above the standard.

This flow showed itself when taking the impression out of the mouth. When using Kymia, the impression changes once taken out of the mouth. The other two samples, Harvard and Pishro, had a flow of less than 1% at 37ºC, and that is extremely suitable.

The impression test showed that except Kerr all other products were not suitable for recording the detail.

These two tests (flow and impression test) complete and verify each other. When the flow of a compound at 45ºC is high, (in the standard range) the test block's details are better recorded. Although, for a better assessment, there is a need for more physical and even chemical tests.

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