

STUDIES IN ADHESIVE TAPE IRRITATION*

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INTRODUCTION

Experience in an allergy clinic over a number of years has indicated that many people show a moderate to intense skin irritation to adhesive tape as used in patch tests. These reactions occasionally interfere with the reading of such tests, and obviously raise a question as to the extent of skin reaction to adhesive tape in its more general medical uses.

A survey of the literature has revealed that up to 1922 only occasional comment appeared on the subject of irritation from the use of adhesive tape. Since that time several articles on this subject have been published (1, 2, 3). In the American literature the reports have dealt with small numbers of cases in which various types of adhesive tape were used which made conclusions from any one report of doubtful value. The irregular distribution of cases would make it appear necessary to treat the subject of adhesive tape irritation on a statistical basis. Furthermore, the variables present in any study of this character render the analysis of data extremely difficult even under optimal conditions; therefore, a large amount of data would be necessary to permit the deduction of valid conclusions. Histological studies are not available in the literature upon the type of reaction caused by adhesive tape. For this reason, biopsy in selected cases seemed desirable.

The program of the study herein reported was developed for the purpose of attempting to answer specifically the following questions.

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- (1) What is the incidence of adhesive tape irritation in normal individuals and to what extent is it affected by age and sex?
- (2) Is the incidence of irritation notably different among normal and allergic persons?
- (3) Are all reactions due to specific sensitization, or does primary chemical and mechanical irritation play a role?
- (4) What ingredients of adhesive tape may be specific causes of at least part of its irritating properties?
- (5) Is it necessary, desirable, and possible to prepare a less irritating type of adhesive tape?

A total of 1800 persons were "patch-tested" in this study with adhesive tape and adhesive tape ingredients. While it is recognized that adhesive tape strappings may introduce some different physical factors into the interpretation of results, it is felt nevertheless that observations from patch tests are definitely significant in establishing general relationships. Approximately 10,000 individual patches were applied. Among the group of subjects were non-allergic and allergic persons of both sexes and all ages. When experimental types of tape were developed, 1020 unselected persons were used in testing these experimental tapes against formulae previously used.

TECHNIQUE OF THE TESTS

Patch tests were applied in uniform manner to the skin of the back in a single horizontal row just below the angles of the scapulae. In the first group of individuals tested, two patches (each) of different tapes were applied to each patient. These were applied in duplicate in order to have a better control of reactions. In the first group, two shapes of patches were used, one being a solid piece of tape three-fourths of an inch square, the other a one and one-half inch square, the center of which was prevented from coming in contact with the skin by a piece of white paper one-half inch square. It was expected that this rim-shaped patch would prove helpful in indicating the degree of the reaction in cases of specific irritation, and might permit the determination of the effect of maceration as a possible factor in irritation. It is to be noted, however, that there were no demonstrable differences

in the amount of irritation which could be attributed to differences in shape of the patches.

The patches were left in place for 24 hours, and then were removed without the use of any chemical solvent. Reactions were read first after an interval of one hour following removal of the patch. A second reading was made 24 hours after removal, and, wherever possible, a third was made 72 hours after removal. Reactions were recorded according to Bloch, as follows: 1 plus = erythema, 2 plus = erythema and papule formation, 3 plus = vesicle formation. A new term, "parchment-like" appearance, was introduced to indicate those reactions in which the surface relief of the skin became transformed into a smooth, shiny area which later showed fine parchment wrinkling without erythema or infiltration.

RESULTS OF TESTS

1. What is the incidence of adhesive tape irritation in normal individuals, and to what extent is it affected by age and sex?

Among 411 normal men tested with adhesive formulae A and B, there were 206 reactions to the first reading. Seventy-nine reactions were to A, 127 to B. After 24 hours, second readings were possible on 389 of these men. Among these, there were 240 reactions, 107 to A, and 133 to B. Only 84 observations were possible after 72 hours; at this time there were 39 reactions, 19 to A, and 20 to B. In table I it may be seen that by far the greatest number of reactions at any reading were 1 plus. There were five and four 2 plus reactions present at the second reading; that is, 24 hours after the tape had been removed. Neither of these were present up to the time of the third reading. On the other hand, "parchment-like appearance" was not found before the time of the second reading, and the number of these reactions was considerably increased at the third reading. In fact, there was hardly any other reaction seen at the third reading. A third brand of adhesive tape was used on 273 of these men; slight variations in percentage of positive reactions were observed with this tape, but the reactions rarely exceeded 1 plus (table II).

Among these 411 men, there were 82 between 14 and 40 years

TABLE I
Results of patch tests with two types of adhesive tape in adults

FORMULA	READING	TOTAL NUMBER OF SUBJECTS		NEGATIVE		1 PLUS		NUMBER OF REACTIONS				PARCHMENT		TOTAL NUMBER POSITIVE	
		M.	F.	M.	F.	M.	F.	2 plus		3 plus		M.	F.	M.	F.
								M.	F.	M.	F.				
A B	First	411	114	332	89	76	24	2	1	1	0	0	0	79	25
				284	81	124	31	2	2	1	0	0	0	127	33
A B	Second	389	95	282	63	87	27	5	0	0	0	15	5	207	32
				256	55	105	33	4	1	0	0	24	6	133	40
A B	Third	84	64	65	41	1	2	0	0	0	0	18	21	19	23
				64	41	0	1	0	0	0	0	20	22	20	23

TABLE I-A
Percentage distribution as to sex and age of reactions to two types of adhesive tape

READING	AGE GROUP	TOTAL NUMBER OF SUBJECTS		FORMULA	NEGATIVE		PERCENTAGE OF REACTIONS						PARCHMENT	
		M.	F.		M.	F.	1 plus		2 plus		3 plus		M.	F.
							M.	F.	M.	F.	M.	F.		
First	14-40	82	37	A	74.4	81.1	24.4	18.9	0.0	0.0	1.2	0.0	0.0	0.0
				B	65.9	78.4	32.9	21.6	0.0	0.0	1.2	0.0	0.0	0.0
	41-60	188	62	A	80.0	77.4	19.5	21.0	0.5	1.6	0.0	0.0	0.0	0.0
				B	69.2	69.4	30.3	27.4	0.5	3.2	0.0	0.0	0.0	0.0
	Over 60	141	15	A	84.4	73.3	14.9	26.6	0.7	0.0	0.0	0.0	0.0	0.0
				B	70.9	60.0	28.4	40.0	0.7	0.0	0.0	0.0	0.0	0.0
Second	14-40	76	31	A	61.8	54.8	34.2	42.0	1.3	0.0	0.0	0.0	2.6	3.2
				B	53.9	51.6	40.8	42.0	1.3	3.2	0.0	0.0	3.9	3.2
	41-60	179	53	A	71.0	73.6	24.0	26.4	1.1	0.0	0.0	0.0	3.9	0.0
				B	65.9	64.2	25.7	34.0	0.6	0.0	0.0	0.0	7.8	1.8
	Over 60	134	11	A	80.2	63.6	14.2	27.3	1.3	0.0	0.0	0.0	4.3	9.1
				B	72.4	54.5	20.9	36.4	1.5	0.0	0.0	0.0	5.2	9.1
Third	14-40	40	22	A	65.0	59.1	2.5	4.5	0.0	0.0	0.0	0.0	32.5	36.4
				B	67.5	68.2	0.0	0.0	0.0	0.0	0.0	0.0	32.5	31.8
	41-60	28	36	A	89.3	66.7	0.0	2.8	0.0	0.0	0.0	0.0	10.7	30.6
				B	85.7	63.9	0.0	0.0	0.0	0.0	0.0	0.0	14.3	36.1
	Over 60	16	6	A	87.5	66.7	0.0	0.0	0.0	0.0	0.0	0.0	12.5	33.3
				B	81.3	50.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7	50.0

of age, 188 between 41 and 60 years, and 141 were older than 60 years. The percentage of positive tests among adult men did not increase with advancing age; on the contrary, there was even a slight decrease (table I-A).

Similar tests were made, also, with adhesive tapes A and B, on 114 adult women. The first reading showed 58 reactions; 25 to A, and 33 to B. The second reading, made 24 hours later, showed 72 reactions, 32 to A, and 40 to B. At the third reading, most of the 23 reactions seen for each tape among the 62 women who reported for observation, were of the parchment-like type. In general, the results in this group were similar to those in men.

TABLE II
Comparison of patch tests with tape formulae, A, B, and C

FORMULA	READING	TOTAL NUMBER OF SUBJECTS	NEGATIVE	RESULTS			
				1 plus	2 plus	3 plus	Parchment
A	First	273	215	56	2	0	0
B			179	92	2	0	0
C			188	81	4	0	0
A	Second	265	197	51	4	0	13
B			178	64	4	0	19
C			189	52	5	0	19

There was an increased number of reactions at the time of the second reading, and there were more reactions to formula B than to A. Very few reactions exceeded a 1 plus intensity. Distribution of the women into age groups permits the statement, although each group was small, that the percentage of positive reactions was in the same range as it was in men. Likewise, there was no increase in reactions with advancing age.

Tests with the same formulae of tape were conducted on 109 children ranging in age from 8 months to 13 years. At the first reading, there were 97 reactions, 40 to A, and 57 to B. At the second reading, 98 children showed 48 reactions, 25 of them to A, 23 to B. At the third reading, 72 children had 38 reactions, of which 15 were to A, and 18 to B. All reactions at the third read-

ing were of the parchment-like type; no reaction at any reading exceeded grade 1 plus. Thus, while the incidence of initial reactions was uniformly higher in children than it was in adults, there was no increase in the intensity of the reactions. No explanation is offered for the fact that the girls showed a lower incidence of reactions than did the boys. In this connection it should be emphasized that the total number in the groups was probably too small to make this difference of great significance (table III).

Results of these tests indicated that some degree of reaction to adhesive tape occurs in appreciable number of patients. Sex

TABLE III
Results of patch tests with two formulae of adhesive tape in children

FOR- MULA	READING	TOTAL NUMBER OF SUBJECTS		NEGATIVE		RESULTS								
		M.	F.	M.	F.	1 plus		2 plus		3 plus		Parch- ment		
						M.	F.	M.	F.	M.	F.	M.	F.	
A B	First	58	51	34	35	24	16	0	0	0	0	0	0	0
A B	Second	49	49	34	39	14	9	0	0	0	0	1	1	
A B	Third	36	36	26	31	0	0	0	0	0	0	10	5	
				23	31	0	0	0	0	0	0	13	5	

seemed to be of relatively little importance in this investigation, as there was a similarity in the number of reactions throughout the age groups of adult men and women. In children, the incidence of reactions was definitely higher than among adults, yet the reaction tended to be of a uniformly mild degree.

2. Is the incidence of irritation notably different among normal and among allergic persons?

The series of 109 children tested were, as far as could be ascertained, all non-allergic. It seemed justifiable, in view of the higher incidence of reactions in this age group than among adults, to use non-allergic children as controls for the series of individuals known to be allergic.

Of 110 allergic persons tested, only a small number could be checked a second and third time. At the first reading, there were 55 positive reactions, 24 of them to formula A, 31 to B (table IV). One subject gave 2 plus reactions with both types of tape. It must be mentioned that the allergic group was an unselected continuous series of cases in the allergy clinic. Thus, each person presenting himself at the allergy clinic for investigation was tested for reactions to adhesive tape. The group consisted of 42 patients with asthma, 28 patients with hay fever, 17 with migraine, 10 with urticaria, 10 with atopic eczema, and 3 cases of contact

TABLE IV
Results of patch tests in allergic persons

READING	TOTAL NUMBER OF SUBJECTS		FOR-MULA	NEGATIVE		RESULTS							
	M.	F.		M.	F.	1 plus		2 plus		3 plus		Parch-ment	
						M.	F.	M.	F.	M.	F.	M.	F.
First	45	65	A	38	48	7	16	0	1	0	0	0	0
			B	36	43	9	21	0	1	0	0	0	0
Second	7	10	A	5	5	2	5	0	0	0	0	0	0
			B	4	5	3	5	0	0	0	0	0	0
Third	4	2	A	3	1	0	0	0	0	0	0	1	1
			B	3	1	0	0	0	0	0	0	1	1

dermatitis. One person with contact dermatitis due to dyes gave a 2 plus reaction to adhesive tape.

The results in this study show little if any difference in irritative response between known allergic and presumably non-allergic persons. The incidence of reactions to adhesive tape, as indicated by our results, may well be of the same magnitude in normal persons as in allergic individuals.

3. Are all reactions due to specific sensitization, or does mechanical or primary irritation play a part?

In order to answer this question particularly in view of the lack of histological data on such reactions, it was decided to perform a series of biopsies of skin areas which showed reactions

after adhesive tape had been applied for a period of 48 hours. Because such information had not been previously available, the findings are reported in some detail.

The photomicrographs represent cross-sections of the skin which have been fixed and stained to show the various structures and the pathological changes which resulted from the applications of adhesive tape. These sections were fixed in 70 per cent alcohol and stained with hematoxylin and eosin. The plates reproduced represent:

Plate Series I—A specific reaction
Plate Series II—A non-specific reaction
Plate Series III—A normal response

Plate Series I. These are photomicrographs of tissue taken at biopsy one-half hour after removal of an adhesive patch. This is considered a specific reaction, inasmuch as this individual showed, on subsequent test, reactions to some of the ingredients of the tape.

Fig. 1. There is a distinct difference between the left half and the right half of the photograph. The epidermis of the left half appears darker, and the nuclei in this part are darker. Furthermore, the nuclei seem closer together, making a very compact strip. In the right part, the nuclei look paler and the epidermis shows areas of edema in spots. There is also parakeratosis in both parts. The cutis shows infiltration.

Fig. 2. In Photograph B, the epidermis shows intracellular edema combined with a beginning extracellular edema on the right side. The left half appears to be almost normal in this respect. There is extensive parakeratosis and a distinct engorgement of the capillaries of the cutis.

Plate Series II. This biopsy was also made one-half hour after removal of the patch from a reddened area after patch-testing with ordinary adhesive tape. It was classed as a non-specific reaction, because when tests were made with individual ingredients, there was no reaction to any of the test materials. This classification, however, may be incorrect, since it is entirely possible that a sensitivity might occur only from a certain combination of ingredients.

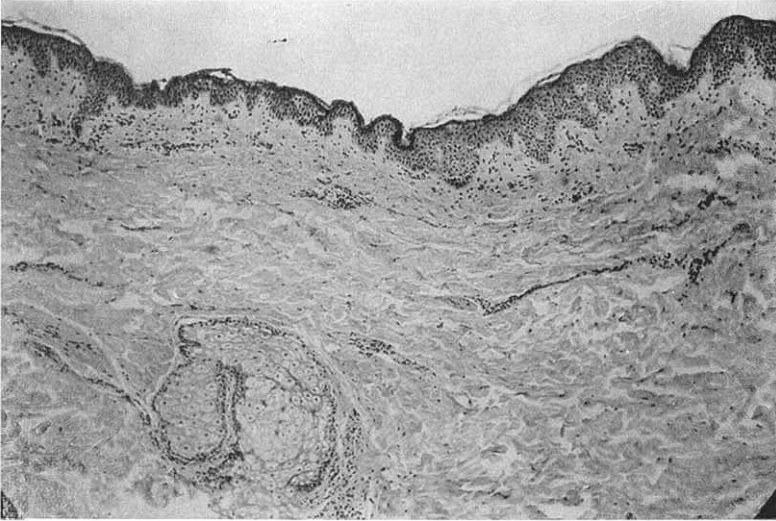


FIG. 1. Plate Series I A. Skin section from the infrascapular region showing parakeratosis and spotty edema of the epidermis; infiltration of the cutis. Fix. 70% alcoh. 5 microns serial sect. hematox.-eosin stain. $\times 90$.

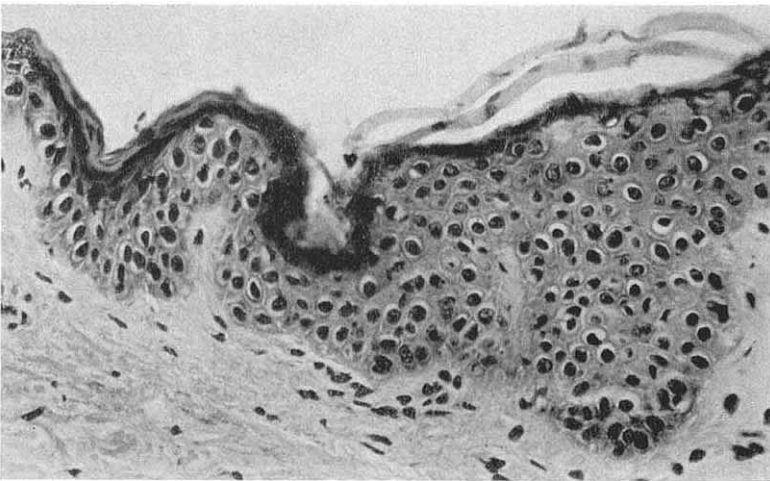


FIG. 2. Plate Series I B. Same as above. Intra- and beginning extracellular edema of the epidermis. $\times 500$.

Fig. 3. Photograph A shows distinct localized areas of intracellular edema with some extracellular edema. There is no apparent parakeratosis and the horny layer appears to be very thin in this case. Considerable infiltration is present in the cutis.

Fig. 4. Photograph B shows areas of intra and extracellular edema of the epidermis. There is slight disruption of the uppermost surface, and the remains of adhesive tape can also be seen.

The results obtained in this biopsy indicate the difficulties encountered in separating the non-specific and the specific types of reactions, for it appears that mechanical trauma, which was apparently present here, brought about almost the same type of reaction that was found in the allergic or chemical irritation. It had been hoped that a definite difference would be shown in these biopsies which would make a differentiation easily possible.

Plate Series III (figs. 5, 6). This biopsy was taken from a skin area which was considered to be completely normal after the removal of formula A adhesive tape. The biopsy was taken one-half hour after removal of the tape. The epidermis and cutis are normal. Photomicrograph A is 90 magnifications and B 500. It will be noticed that there is no evidence of nuclei in the horny layer, and only a few can be seen in the kerato-hyaline layer. There has been considerable disruption of the horny layer, but apparently not much has been stripped away during the act of removing the tape.

The results of the biopsies may be summarized as follows. Response to adhesive tape varied widely among different individuals. Furthermore, different responses were often found in adjacent skin areas in the same biopsy specimen. Histological examination of the biopsy material did not permit a differentiation between mechanical trauma and chemical irritation. This interpretation is based on the fact that some of the individuals having negative patch tests to adhesive tape ingredients gave a similar microscopic appearance to adhesive tape as did individuals demonstrating specific reactions to certain ingredients.

The reactions encountered may be divided into two types: First, those which involved only the epidermis, manifest by intra and extracellular edema, vesicle formation, and parakeratosis;

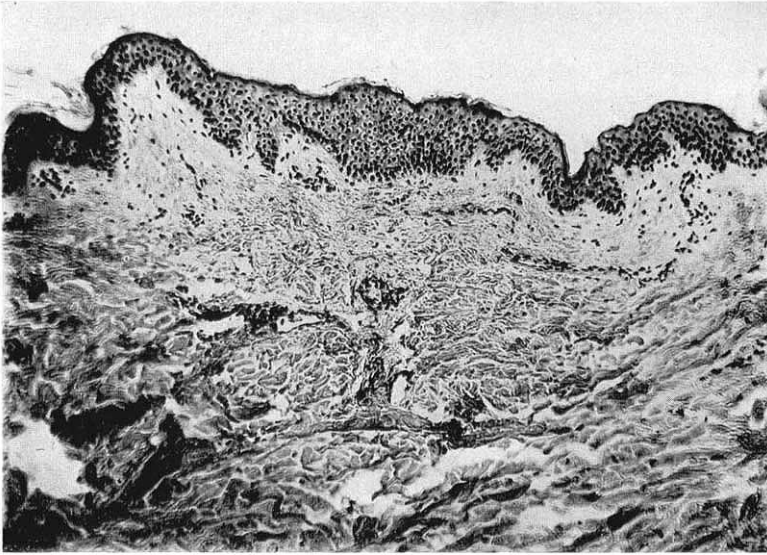


FIG. 3. Plate Series II A. Skin section from the infrascapular region showing spotty edema of the epidermis; no parakeratosis. The capillaries of the cutis are engorged. Fix. 70% alcoh. 5 microns serial sect. hematox.-eosin stain. $\times 90$.

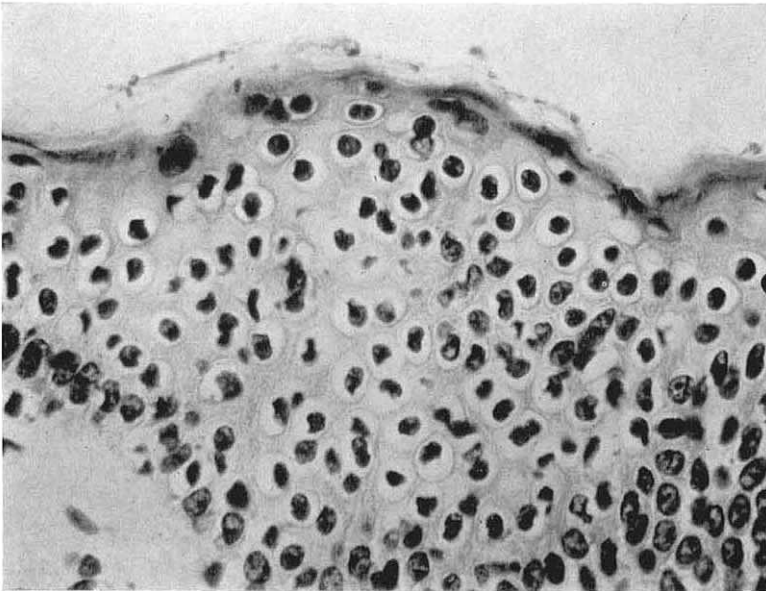


FIG. 4. Plate Series II B. Same as above. Intra- and extracellular edema of the epidermis. $\times 500$.



FIG. 5. Plate Series III A. Skin section from the infrascapular region showing normal epidermis and cutis. Fix 70% alcohol. 5 microns serial sect. hematox.-eosin stain. $\times 90$.

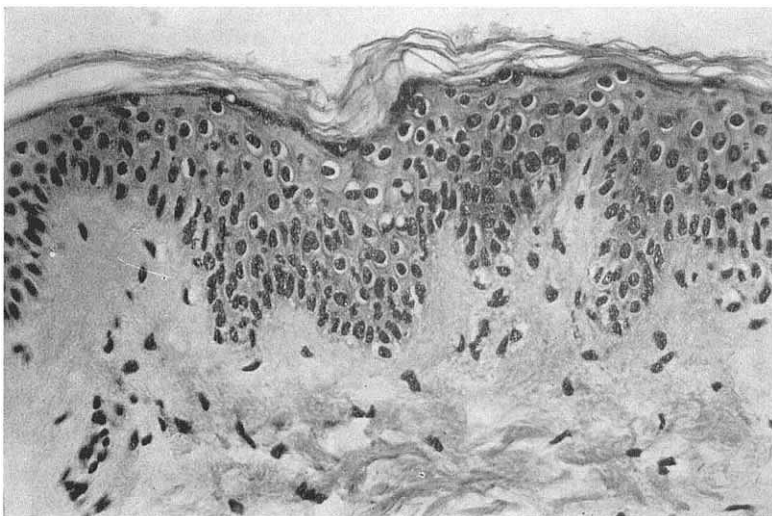


FIG. 6. Plate Series III B. Same as above. $\times 500$

this was the predominating type of reaction. Second, those which involved the cutis. The findings in the second type were infiltration and capillary dilatation. (It is to be noted that edema and parakeratosis are probably always present in skin irritation regardless of its cause.)

Although more detailed future studies may reveal differences in the character of the reaction, the results of the biopsy work speak at present against specific sensitizations as the sole factor in adhesive tape irritation, and indicate a considerable mechanical element in the injury to the skin. Why certain skins reacted to such trauma while others did not, remains to be answered.

A possibility existed that the immobilization of the skin beneath the patch tests played a role in the irritation picture. Therefore, 60 consecutive cases out of the group of non-allergic persons were tested with elastic adhesive tape in addition to the formulae A and B. The fabric employed for this tape was extremely "gross-grained." Contrary to expectation (table V), the incidence of reactions to "Elastic" exceeded by far those to the two surgical tapes.

It had been observed throughout the study that the skin of a number of patients to which the tape adhered especially well, showed as the only change a certain glistening appearance of the skin immediately after the removal of the patch. These areas tended to develop the "parchment-like" appearance at the time of the second or third reading. The patches were removed by grasping one corner of each and "ripping" it off the skin by a fast motion of the hand. It was considered likely that this technic caused a certain amount of mechanical injury. In order to evaluate the part which this injury might play, 90 consecutive cases of the non-allergic group were tested with two sets of patches each. The patches were placed in two parallel rows on the back, one beneath the other. Each set consisted of two rim-shaped pieces each of the tapes A and B. The upper one was removed in the ordinary way, whereas the lower one was soaked with mineral oil. After ten minutes the lower patches could be peeled off the skin by a gentle pull, or had even become separated from the skin entirely. The results are listed in table VI. While

there was no difference in the reactions at the first reading, there was a significant decrease in the number at the second as well as

TABLE V
Comparison of patch tests with formulae A and B, and elastic

FORMULA	READING	TOTAL NUMBER OF SUBJECTS	NEGATIVE	RESULTS			
				1 plus	2 plus	3 plus	Parchment
A	First	60	51	9	0	0	0
B			43	16	1	0	0
Elastic			22	36	2	0	0
A	Second	46	40	5	0	0	1
B			38	6	1	0	1
Elastic			25	14	1	0	6
A	Third	34	30	0	0	0	4
B			30	0	0	0	4
Elastic			21	2	0	0	11

TABLE VI
Comparison of two sets of patch tests
(One of which was ripped off, the other one removed with mineral oil)

READING	TOTAL NUMBER OF SUBJECTS	FORMULA	NEGATIVE		POSITIVE REACTIONS							
					Inflammatory				Parchment-like			
					Positive from 1st reading on		Negative at previous readings		Positive from 1st reading on		Negative at previous readings	
					Rip	Oil	Rip	Oil	Rip	Oil	Rip	Oil
First	90	A	73	68	17	22	—	—	—	—	—	—
		B	54	63	36	27	—	—	—	—	—	—
Second	89	A	69	80	6	3	14	6	—	—	—	—
		B	63	80	14	3	12	6	—	—	—	—
Third	86	A	63	78	—	1	—	—	12	4	11	3
		B	59	79	1	1	—	—	19	4	7	2

at the third reading. Thus, a considerable number of persistent reactions were avoided by changing the procedure of removal of the tape. It is likely that this decrease was due to avoidance of

mechanical damage to the skin. The possibility cannot be excluded, however, that the decrease of inflammatory reactions at the second reading was due to a more thorough removal of chemical irritants by the modified procedure.

4. What ingredients of adhesive tape may be specific causes of its irritating properties?

In order to determine the incidence of reactions to the various ingredients of adhesive tape, a total of 126 persons who had been found to develop skin reactions of varying degrees to adhesive tape were tested with 19 different substances; these substances were believed to include the majority of the raw materials which go into surgical adhesive tape.

Forty-two subjects showed no reaction to any ingredient. In the 84 patients who showed specific reactions, a total of 236 reactions to individual substances were found (table VII). Reactions to rubber were most numerous, "gutta siak" with 7 reactions being the least irritating of the rubber group tested. Rosins were the second largest group of offenders, Burgundy pitch leading with 10 reactions. Even the least irritating rosin caused 6 reactions. Among the miscellaneous ingredients, olibanum and orris root produced the highest incidence of irritation.

As controls, 68 persons who gave negative patch tests to adhesive tape, were tested with the same 19 single ingredients and with five different adhesive mixtures. Of this group, 43 persons showed no reaction. A total of 44 reactions were observed in the remaining 25 subjects. The reactions never exceeded 1 plus, while some 2 plus and 3 plus reactions had been encountered in the sensitive group.

Further information was sought as to whether occupation, previous contact with certain irritants, or known sensitivity or other contact substances affected the incidence of intensive reactions.

An automobile worker developed a 3 plus reaction to para rubber and to orris root, and lesser reactions to rosin II and Burgundy pitch. A die maker had a positive reaction to all the rosins, to para rubber, and to smoked sheet rubber. A metal

polisher showed intense reactions to para rubber, pale crepe rubber, rosin IV, and Burgundy pitch. On the other hand, a painter who habitually used turpentine to clean his hands showed a 2 plus reaction to all formulae of adhesive tape tested, but did

TABLE VII

Reactions to the ingredients of adhesive tape

Comparison of persons who had been sensitive to adhesive tape in previous tests and persons who had not reacted to tape.

	SENSITIVE TO TAPE	NOT SENSITIVE TO TAPE
Total number of subjects.....	126	68
Negative to all ingredients.....	42	43
Positive to:		
Rosin I.....	6	0
Rosin II.....	8	0
Rosin III.....	7	0
Rosin IV.....	8	1
Burgundy pitch.....	10	0
Beeswax.....	3	0
Lanolin.....	0	0
Petrolatum.....	4	1
Orris root powder.....	6	1
Zinc oxide.....	4	1
Starch.....	5	1
Olibanum.....	8	2
Paraffin.....	2	0
Tricesyl phosphate.....	1	0
Para rubber.....	57	19
Balata rubber.....	19	1
Pale crepe rubber.....	37	8
New smoked sheet rubber.....	44	9
Gutta siak rubber.....	7	0
Total number of reactions.....	236	44

not have a reaction to any of the 19 ingredients. A tire factory worker was not sensitive to any of the different rubbers. One electrician who had had frequent contact with many of the ingredients of tape, and gave a history of contact dermatitis, did have reactions to rosin II and para rubber and a 3 plus reaction to copper sulfate, which had been the cause of a dermatitis seven

years before. Another electrician with the same contacts but with no history of dermatitis had 2 plus reactions to all the rubbers.

In the final series of over 1,000 unselected individuals who were tested with several formulae of adhesive tape, including new types devised to minimize irritation, a few reactions occurred also in individuals who were known to have previous contacts and sensitivities to certain adhesive substances. In order that these results may be viewed in relation to the sensitizations discussed above, they are presented at this point.

Only four persons of the group tested with tape had a history of having been irritated by tape in the past. One of them showed 3 plus reactions to three types of tape at the second reading. It was possible to test one of these subjects with the tape ingredients: he showed a 2 plus reaction to gutta siak at the second reading. Another man did not recall any eruption from adhesive tape but had been strapped with tape after an abdominal operation one year previously. One reaction developed into a large bulla. The patient with the reaction showed 3 plus tests to the rosins, orris root, petrolatum, zinc oxide, starch, and olibanum. The rubbers were entirely negative. None of these subjects had any skin eruption when the tests were made.

Two men reported having had previous skin eruptions of unknown etiology. One of them showed 2 plus reactions to all tapes tested, and 2 plus reactions to beeswax, orris root, tricresyl phosphate, and para rubber. The other one had taken turpentine by mouth as treatment for his recurrent skin eruption. He reacted 3 plus to one tape, 2 plus to olibanum, 1 plus to rosin II, rosin IV, Burgundy pitch, and para rubber.

Three cases with active skin lesions were investigated. A patient with ragweed oil dermatitis had 3 and 4 plus reactions to two types of tape. When the tests were repeated after his dermatitis had subsided at the end of the ragweed season, the same tapes showed only 1 plus reactions at the second reading, even when left in contact with the skin for as long as 72 hours. There were no reactions to the ingredients at that time. A druggist with sycosis simplex who had 1 plus reactions to three

adhesive tape formulae, showed 3 plus reactions to pale crepe and smoked sheet rubbers.

A man with stasis dermatitis in whom no contact irritation was suspected gave 2 plus reactions to three formulae tested, from the second reading on. Four days later, 19 ingredients were tested under cellophane glued to the skin with "Frisket" rubber cement (rubber dissolved in benzene (2) (4)). When the

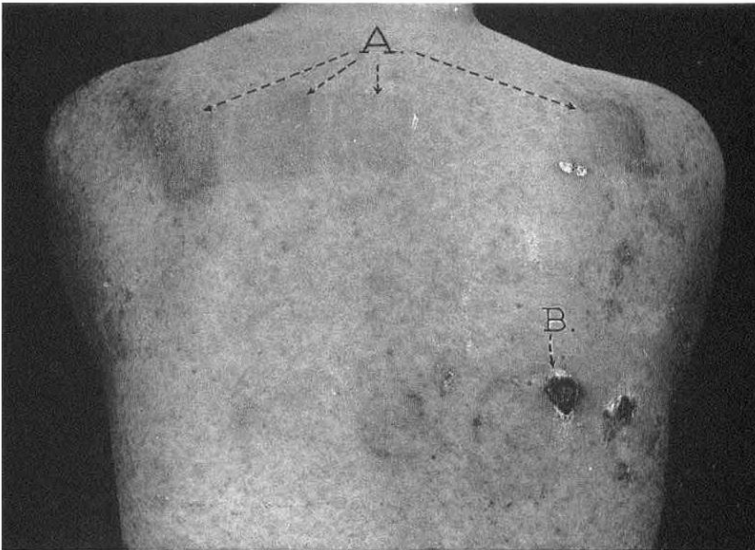


FIG. 7. Generalized maculo-papular eruption occurring 2 days after the administration of patch-tests fixed with cellophane and "Frisket."

A = sites where adhesive tape had been applied.

B = disrupted bulla at the site of Frisket application.

patches were removed 24 hours later, large bullae had formed under the rubber cement. Of the ingredients, rosin I, rosin III, beeswax gave 2 plus, while responses to para rubber and pale crepe were 1 plus. There was an "Aufflammungs" phenomenon at the site of the first tests (fig. 7). There followed a papulo-macular eruption over the entire body. Seven days after the first tests the original patch tests were still infiltrated. The dermatitis did not begin to heal until 13 days later.

5. Is it necessary, desirable, and possible to prepare a less irritating type of adhesive tape?

In summary, it is apparent that reactions to adhesive tape were of two types: (1) Those due to mechanical irritation, probably arising at the time of removal of the tape; (2) Those due to chemical irritation, or specific sensitization to one or more of the ingredients of the adhesive mass.

Obviously, reduction of the incidence of mechanical injury from tape must be sought in improved methods of removing the tape and in regulation of the adhesiveness, to obtain optimum results. The incidence of chemical or allergic reactions to adhesive tape, however, seemed large enough to justify studies on the development of a more satisfactory, less irritating adhesive mass. In collaboration with the research laboratories of a leading manufacturer of adhesive tape, new types of adhesive mass were prepared and were tested through the research department of that company and a preferred formula selected for final test.

A series of 1,022 unselected individuals were subjected to patch tests in order to evaluate this new tape against formulae previously used by this manufacturer. This group consisted of 773 men, 114 women, and 135 children, and latter being under 14 years of age. The technique used in this large group was as follows.

The patches of adhesive tape were in solid ovals with a large diameter of $1\frac{1}{2}$ inches. These were uniformly applied to the skin of the back in a horizontal row just below the angle of the scapula and were left in place for 48 hours. The reactions were first read one-half hour after removal, and a second time 48 hours later. Only two readings were taken in this study, because it was found from previous experience that there are very few instances of latent reactions which did not show up within the first 48 hours. The results are shown in table VIII.

It is to be noted that tape A, which represented the tape developed for the purpose of minimizing skin reactions, gave definitely fewer reactions. When all types of reactions were

considered, from 40 per cent to over 80 per cent more reactions were observed with the older formulations than with the new type of tape. When 2 plus and 3 plus reactions only were considered, that is, the more severe types of reactions, it was apparent that this new tape was even more strikingly superior.

Even the cases in which 1 plus readings were observed with the new tape, the degrees of reactions were of milder type than were those due to the other formulations tested. One individual did have a distinct reaction to the new tape, but this was a true allergic reaction, dependent upon the previous contact with materials used in the tape, and to which the individual had become sensitized. While the new tape was developed with the idea of eliminating substances to which frequent sensitizations

TABLE VIII

Final comparison of three adhesive tape formulae including special tape A

TOTAL NUMBER TESTED	FORMULAE	NEGATIVE	POSITIVE	PER CENT POSITIVE
1,022	A	764	258	25.2
	B	646	376	36.8
	E	550	472	46.1

were found, it is doubtful if occasional instances of this type of reaction can be entirely eliminated. It is noteworthy, in this connection, however, that in the new type of tape troublesome ingredients have been replaced, insofar as possible, with chemicals highly purified and in some instances new and unique to this type of product.

GENERAL SUMMARY

Lack of adequate information on the incidence, causative factors, and possible means of preventing reactions to adhesive tape have led to the present study, which has included a statistical analysis of the factors involved in adhesive tape irritation, together with histological observations of biopsy material from selected cases.

It was ascertained that an appreciable incidence of skin ir-

ritation follows the application of adhesive tape. The frequency of these seemed to be little influenced by sex, but is definitely higher among children than among adults. There did not appear to be a significant difference in reactions in allergic and non-allergic persons. While mechanical irritation is responsible in part for irritation from adhesive tape, many and particularly the more severe reactions seem to be due to specific allergenic responses to single ingredients of the tape. Following a series of tests, employing the substances which are commonly used in the manufacture of surgical adhesive tape, a new type of tape which had been prepared by one of the leading manufacturers of this product was tested in comparison with the older tapes of this manufacturer. The older tapes gave from 40 to over 80 per cent more reactions than the new type of tape.

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