Evaluation of the Efficacy of a Nonlatex Condom: Results from a Randomized, Controlled Clinical Trial

CONTEXT: *To reduce unintended pregnancy and HIV infection, it is critical to develop reliable male condoms that will attract consumers who reject conventional latex condoms.*

METHODS: *In a prospective clinical trial conducted in 1998–2000, 830 monogamous couples were randomized in equal numbers to use either a nonlatex condom or a commercial natural latex condom for six months as their only method of birth control. Couples completed detailed reports for the first five condom uses and recorded intercourse and condom use in coital diaries. Pregnancy rates associated with typical and consistent condom use were calculated using life-table analysis. Rates of clinical failure (condom breakage or slippage) were determined for the first five condom uses.*

RESULTS: *During the first five uses, the nonlatex condom had a higher frequency of breakage or slippage during intercourse or withdrawal (4.0%) than latex condoms (1.3%); the breakage rate for the nonlatex condom was about eight times that of latex condoms. The six-cycle typical-use pregnancy rate did not differ significantly between users of nonlatex (10.8%) and latex condoms (6.4%). The six-cycle consistent-use pregnancy rate was higher for nonlatex condom users than for latex condom users (4.9% vs. 1.0%).*

CONCLUSIONS: *The data present strong indirect support for public health messages that promote the use of latex condoms and, for individuals who cannot or are unwilling to use latex condoms, the use of nonlatex condoms for prevention of pregnancy and disease.*

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Male condoms are the only reversible method of contraception available for men and offer effective protection against the transmission of HIV[1] and several other sexually transmitted diseases.[2] Despite their value, the currently available natural rubber latex condoms are unacceptable to many consumers,[3] who seek products with improved comfort, sensation and attractiveness.[4] Furthermore, natural rubber latex can induce an allergic reaction, particularly after sustained exposure. Up to 3% of the U.S. population may be unable to use latex products for this reason.[5]

Assuming that the availability of more acceptable and less-allergenic condoms will increase the frequency of condom use, the development of condoms made of materials other than natural rubber latex could make a major contribution to public health. Ideally, these materials would be nonallergenic[6] and resistant to oil-based lubricants,[7] have a long shelf life regardless of storage conditions[8] and have aesthetic or performance characteristics appealing to condom users.[9] Currently, only two brands of nonlatex male condoms are commercially available in the United States: the Avanti condom, manufactured by London International Group, and the Trojan Supra condom, manufactured by Carter Wallace. Both are made of polyurethane, a material that is nonallergenic, odorless, transparent and not easily broken down by oil-based lubricants or ozone.[10] Unfortunately, the Avanti condom has been shown to break or slip off during intercourse or withdrawal more frequently than a latex control condom.[11] Comparable data on the Carter Wallace product have not been published. At present, polyurethane condoms constitute fewer than 2% of all condoms sold in the United States.[12]

Styrene ethylene butylene styrene (SEBS), a synthetic material known commercially as Tactylon, shares many of the characteristics of natural latex but does not initiate an allergic response in individuals with known allergies to natural latex.[13] In 1992, the first clinical evaluation of a SEBS condom found no statistically significant difference between the clinical breakage rate for the SEBS condom (1.2%) and a latex control condom (1.3%).[14] However, in two subsequent clinical trials, breakage rates for various SEBS condoms, ranging up to 4.2%, were higher than those of latex control condoms.[15] The SEBS condom style selected for our investigation, which closely resembles commercial latex condoms, had the lowest clinical breakage rate among the SEBS condoms in those trials (3.5%) and received significantly higher acceptability ratings than the latex control condom.[16] User ratings were also favorable in a subsequent acceptability study, in which male participants reported that the SEBS condom offered greater sensitivity than the latex condom.[17] Furthermore, more than two-thirds of both male and female participants in that study expressed a preference for one of the two nonlatex condoms, a strong in-

dication that condom consumers desire more choices.

In this article, we present results from a contraceptive efficacy study that compared the SEBS condom with two commercial latex condoms and that included a nested breakage, slippage and acceptability study to determine the rate of condom failure, product acceptability and adverse events for the first five uses of the study condoms. This randomized, controlled clinical trial conformed to all Food and Drug Administration requirements for clinical studies of a condom made of a new material.[18]

METHODOLOGY

Study Population and Design

We used multimedia advertising to recruit a study population that was ethnically and economically diverse and representative of couples who have chosen to use condoms for contraception. Of the 4,478 couples who responded to the advertisements, 18% were ineligible for the study, 57% were not interested in participating, 6% responded after enrollment ended and 19% were enrolled. All couples initially agreed to use their assigned condom as their only method of birth control for six complete menstrual cycles and six full calendar months. Enrollment took place from April 1998 to April 1999, and follow-up ended in February 2000.

Participants were partners in a monogamous, heterosexual relationship and not at known risk of infertility or sexually transmitted infection. Females were aged 18–40 years, while males were aged 18–50. Both partners were screened for eligibility, attended the enrollment visit and gave informed consent. We collected from each partner detailed social and demographic information, a reproductive history and a contraceptive history, including condom experience with past and present partners.

Couples received a three-month supply of the assigned study condom, a home-use penis-measurement kit, a condom-use report form to be completed for each of the first five study condoms used, a tube of water-based lubricant (Biofilm's Astroglide brand), a seven-month supply of diary forms, preaddressed and postage-paid envelopes for mailing diaries to the California Family Health Council on a monthly basis, an information sheet on emergency contraception and a set of instructions for correct condom use.

Research staff instructed study participants in the completion of each form and used a male anatomical model to demonstrate correct condom use. Participants were also instructed to notify study personnel if they suspected pregnancy, wanted to use emergency contraception or experienced persistent or severe adverse events so that an examination or pregnancy testing could be arranged if needed.

The condom-use reports collected detailed information on measures of product performance (breakage, slippage), including frequency and timing of problems and adverse events. Throughout the study, couples used the diary forms to record coital acts, condom use, onset of menses and any problems encountered with condom use.

At the enrollment visit, couples were instructed to delay using the study condom until onset of the woman's next menstrual cycle. Women were required to perform a urine pregnancy test within 14 days of beginning use of the study condom, and to call the research office with the result.

At the conclusion of each menstrual cycle or when pregnancy was confirmed, research staff conducted a phone interview to review diary entries and obtain information about problems with condom use. Women whose menses were overdue were scheduled for a clinic visit including a pregnancy test. Both partners attended an exit visit after the woman's seventh menses since study enrollment, and no earlier than the first menses after six months of participation. We asked both partners to summarize the condom's advantages, disadvantages and problems, and their physical reactions related to use.

The experimental SEBS condom is a product of the Sensicon Corporation. The condom has a lay-flat width of 52 mm, length of 190 mm and thickness of 0.065 mm, and is coated with a silicone-based lubricant.

As controls, we chose two commercial latex condoms that are typical of products sold in the United States: Trojan-Enz (a trademark of Carter Wallace) and LifeStyles (a trademark of Ansell Healthcare Products). Both have a lay-flat width of 52 mm, length of 180 mm and thickness of 0.06–0.07 mm. The Trojan-Enz condom is coated with an aqueous-based lubricant, whereas the LifeStyles condom is coated with a silicone-based lubricant. All three study condoms are cylindrical, with a reservoir tip.

Sensicon supplied the SEBS condoms, packaged in a plain foil wrapping identified as Tactylon. Both latex condoms were purchased commercially and were packaged in labeled foil wrappers. Persons not involved with conducting the study batched condom supplies in sealed, opaque containers labeled with participant identification numbers.

Using a computer-generated sequence of random numbers, we assigned half of the 830 couples to the SEBS condom and one-quarter to each latex condom. Restricted randomization in blocks of 12 was used so that the allocation was balanced for each block (six to SEBS, three to each latex condom). Although couples could identify their assigned condom type when they opened the opaque containers, we asked them not to disclose the type to study staff. Data collection forms did not contain information on condom type; thus, the staff and investigators were masked until data collection and processing were completed.

Outcome Measures and Analysis

Primary outcome measures were life-table pregnancy rates associated with typical, consistent and perfect use; secondary outcome measures were cumulative life-table study continuation and discontinuation rates. For the nested breakage, slippage and acceptability study, primary outcome measures were the rates of total failure and total clinical failure (clinical breakage and slippage); secondary outcome measures were the rates of total breakage and total slippage, as well as various measures of condom acceptability. The outcome measures (defined in detail in the appendix, page 85)

are consistent with those outlined elsewhere.[19]

Condom failure rates were derived from approximately 1,800 uses of each type of condom for the first five acts of vaginal intercourse by all couples. We combined results for the latex brands because there were no clinically important differences between the performance of the two brands. The number of condom uses provided 80% statistical power to obtain a statistically significant result (two-sided; alpha, <.05) if the failure rate of the latex control condom (based on results from our previous condom studies[20]) was as low as 1% and the failure rate of the SEBS condom was 2.3% or greater (which would yield an alpha of at least .05).

We used chi-square tests of homogeneity or, where expected cell sizes were small, Fisher's exact test to assess the equality of the breakage, slippage and failure rates for the SEBS and latex condoms. All p-values presented are two-sided. We calculated approximate Taylor series 95% confidence intervals for the ratio of the failure rates for the two condom types, with individual uses as the analysis unit. These estimates were not corrected for multiple testing or adjusted for multiple failures by couples.

We calculated typical-use, consistent-use and perfect-use cumulative life-table pregnancy rates for the first six menstrual cycles of condom use. To facilitate comparison with data from previous contraceptive efficacy trials, we also calculated typical-use pregnancy rates for the first six months of condom use.

We enrolled a sufficient number of couples to ensure that at least 260 couples in each group contributed both six complete menstrual cycles and six calendar months of follow-up or a study outcome (pregnancy). This provided 80% statistical power to obtain a statistically significant result for a one-sided test of the null hypothesis of equal rates if the six-cycle typical-use pregnancy rate was 7% for the latex group (as in our previous condom efficacy trial[21]) and 14% or greater for the SEBS group. We used a one-sided test because we were concerned only that the pregnancy rate for the SEBS condom not be significantly higher than that for the latex condom.

We performed life-table analysis (using BMDP Program 1L) to compare the typical-use pregnancy rates of the two groups. In the calendar life table, a couple entered the life table on the date of the woman's first menses after study enrollment and exited on the date of her first menses after six calendar months or six complete menstrual cycles of follow-up, whichever came later. Couples who withdrew from the study early exited the life table on the date of their last condom use.

We censored all exposure (including pregnancies) after the date emergency contraception was used in calendar life tables or after the cycle in which it was used in the cycle life tables. We used the estimated date of conception for the exit date of couples who discontinued because of pregnancy. We confirmed pregnancies with a commercial urine pregnancy test performed after menses was delayed by more than one week. To avoid missing an early pregnancy that might not be detected by the pregnancy test administered at the exit visit, we followed women who left the study early until their next menses after study departure. Couples who were lost to follow-up exited the life table on the date of their last interview or diary entry.

The cumulative life-table rates presented in this article were obtained by subtracting the estimated cumulative proportion surviving (not pregnant) the sixth month or the sixth cycle from 1.0 and then multiplying by 100. The resulting rate allows the reader to evaluate the estimated probability of an event (pregnancy or discontinuation) per 100 participants over the period of follow-up (either six months or six cycles). The generalized Wilcoxon test statistic was used to evaluate the equality of survival curves. To facilitate comparisons between the condom types, we calculated rate ratios and approximate Taylor series 95% confidence intervals from the rate of pregnancy per cycle or month of condom use.

The life-table pregnancy rates associated with consistent condom use were based on all cycles in which the study condom was used for every act of intercourse, regardless of whether any condoms broke or slipped off. Perfect-use pregnancy rates were based on all cycles in which participants used the study condom for every act of intercourse and followed all condom use instructions (see appendix).

Since couples often contributed a mixture of cycle types, we constructed consistent-use and perfect-use life tables that allowed us to assign cycles to the appropriate intervals. We were thus able to use all consistent-use and perfect-use cycles, even when they had been preceded by cycles of inconsistent use.

We used Greenwood's formula[22] to obtain approximate 95% confidence intervals for all pregnancy rates when all life-table intervals (months or cycles) for both condom groups contained at least one pregnancy (typical-use rates); when one or more intervals contained no pregnancies (consistent-use and perfect-use rates), we used Peto's formula.[23] We compared the cumulative pregnancy-free survival for the two condom groups through six cycles, using an approximate z test of equal probabilities of pregnancy with variances estimated using Peto's formula.

RESULTS

Characteristics of Participants

On average, participants were 26 years old; the majority were married or cohabiting, had more than a high school education and were employed (Table 1, page 82). While 75% of participants had a yearly household income of more than $20,000, the sample represented a wide range of incomes: Thirty-eight percent reported a yearly household income of $20,001–40,000, and only 15% reported more than $60,000 (not shown). Slightly more than half (54%) were members of a racial or ethnic minority group (31% Hispanic, 7% black, 6% Asian and 10% other minority—not shown).

Participants reported having had an average of eight sexual partners. Three-fifths had ever been involved in a preg-

TABLE 1. Percentage of individuals participating in condom trial, by selected characteristics at enrollment, Los Angeles, 1998–1999

Characteristic	% (N=1,660)
Social/demographic/physical	
Racial/ethnic minority	54
Married to/living with partner	77
>H.S. education	74
Employed	72
Annual household income >$20,000	75
Currently smoke	21
Consume alcohol daily or weekly	22
Circumcised (men)	74
Sexual activity	
Ever pregnant/caused pregnancy	63
Ever had/partner ever had abortion	41
Usually have intercourse >12 times per month	31
Use lubrication at least occasionally	45
Had unprotected intercourse >5 times in past 3 months	17
Condom use	
Currently using condom	81
Ever used ≤10 condoms	9
Ever used ≤10 condoms with current partner	17
Have had >5 condom breaks with previous partners	2
Have had >5 condom breaks with current partner	2

nancy, and nearly one in five had recently had unprotected intercourse (Table 1). Eighty-one percent were currently using condoms; most were experienced condom users who had had few condoms break.

There were no clinically meaningful differences between the groups assigned to each condom type, except that couples assigned to use latex condoms were more likely to have used 10 or fewer condoms during their life than couples assigned to the SEBS condom.

Ten percent of couples—roughly equal proportions of the SEBS group and the latex group—contributed no efficacy data because they were found to be ineligible after enrolling or they dropped out before using the study condoms. The most common reasons for ineligibility were that the woman was pregnant at the enrollment visit (SEBS, 15 couples; latex, 18 couples) and the couple were not sexually active (seven in each group). Only 10 couples in the SEBS group and 13 in the latex group dropped out or were lost to follow-up before contributing efficacy data.

Condom Performance

• *First five uses.* Eight percent of the couples withdrew from the study before ever using their assigned condom. The remaining 92% contributed data for more than 88% of the condoms distributed—1,820 SEBS condoms and 1,821 latex condoms—for the first five acts of intercourse (Table 2). Only 28 SEBS condoms were not used for intercourse, mainly because they did not unroll properly, broke, did not fit or were defective. Twenty-six latex condoms were not used for intercourse; most of these did not unroll properly, broke, were defective or were put on in the wrong direction.

For the first five uses, the clinical breakage rate, reflecting breakage during intercourse or withdrawal, was 3.5% for the SEBS condom and 0.4% for the latex condoms, for a rate ratio of 7.8 (Table 3). The total breakage rate, assessing breakage at any time, including during donning, also was higher for the SEBS than for the latex condoms (3.7% vs. 1.1%), for a risk ratio of 3.4. SEBS condom breaks were distributed among 11% of couples, whereas latex condom breaks were limited to 2% of couples (p<.0001—not shown). Some clustering of SEBS condom breaks occurred: Nearly one-third of the 42 couples who broke SEBS condoms experienced more than one break in their first five uses, whereas none of the latex condom users experienced multiple breaks.

SEBS condoms slipped completely off the penis during intercourse less often than they broke (Table 3). The clinical slippage rate was 0.6% for the SEBS condom and 0.9% for the latex condoms (rate ratio, 1.6).

The total clinical failure rate, which includes condoms that broke or slipped off the penis during intercourse or withdrawal, was 4.0% for the SEBS condom and 1.3% for the latex condoms, for a rate ratio of 3.0. The total failure rate, which includes all condoms that broke or slipped off the penis, as well as condoms that could not be used for intercourse, was 5.5% for the SEBS and 2.7% for the latex condoms, for a rate ratio of 2.0. The differences between the failure rates for the two condom groups were statistically significant (p<.0001—not shown).

• *Six months.* The clinical failure rates calculated from the diaries participants kept throughout the study were 2.0% for the SEBS condom and 0.7% for the latex condoms, for a rate ratio of 2.9 (Table 3). Although these rates were lower than those obtained from the first five uses, the differences between groups remained statistically significant (p<.0001). For both types of condom, clinical breakage and slippage rates based on diaries also were lower than the rates obtained from the first five uses.

Contraceptive Efficacy

Although 90% of couples in the SEBS group and 89% of those in the latex group contributed efficacy data, only 54% and 60%, respectively, completed both six complete men-

TABLE 2. Number of condom-use reports recording various experiences in the first five uses per couple, by type of condom

Experience	SEBS	Latex
Total uses attempted	**1,820**	**1,821**
Nonclinical failures	**28**	**26**
Could not put on/unroll	9	5
Tried to don in wrong direction	0	3
Broke while unwrapping	4	4
Broke while putting on	2	8
Did not fit	6	0
Defective	6	1
Other reason	1	5
Clinical failures	**72**	**24**
Broke during intercourse or withdrawal	62	8
Slipped off during intercourse	7	13
Slipped off during withdrawal	1	2
Slipped off, timing unknown	2	1
Completed intercourse	**1,720**	**1,771**
Broke during removal	1	1
Successfully used	1,719	1,770

TABLE 3. Rates of selected types of condom failures, and rate ratios (and 95% confidence intervals), by timing of use and type of condom

Timing of use and type of failure	SEBS	Latex	Rate ratio
FIRST FIVE USES	(N=1,792)	(N=1,795)	
Clinical failure	**4.0**	**1.3**	**3.0 (1.9–4.8)**
Breakage	3.5	0.4	7.8 (3.7–16.2)
Slippage	0.6	0.9	1.6 (0.7–3.5)
FIRST FIVE ATTEMPTED USES	(N=1,820)	(N=1,821)	
Total failure	**5.5**	**2.7**	**2.0 (1.4–2.8)**
Breakage	3.7	1.1	3.4 (2.1–5.6)
Slippage	0.5	0.9	1.6 (0.7–3.5)
Other †	1.2	0.8	1.6 (0.8–3.1)
THROUGHOUT STUDY	(N=17,980)	(N=19,898)	
Clinical failure	**2.0**	**0.7**	**2.9 (2.4–3.5)**
Breakage	1.7	0.2	8.5 (6.1–11.8)
Slippage	0.3	0.5	1.7 (1.2–2.3)

†Condoms not used for intercourse because they could not be unrolled or donned, did not fit, broke before use or were defective. *Note:* Rates may not add to subtotals because of rounding.

strual cycles and six complete calendar months of participation. Thirty-four pregnancies occurred among SEBS condom users, and 24 among latex condom users. Most of the pregnancies occurred in cycles in which the condom had not been used consistently (25 and 12, respectively). Only six pregnancies among SEBS condom users and two among latex condom users occurred in cycles in which the study condom had been used correctly for every act of intercourse; three of these SEBS condom users reported at least one condom break, and one of these latex condom users reported that a condom had slipped off. No pregnancies occurred among consistent users of either type of condom during cycles 4–6.

Although couples reported more than 1,000 acts of unprotected intercourse and nearly 500 condom failures, we recorded only 16 uses of emergency contraception by 14 SEBS condom users and 10 by latex condom users. Only three of these uses followed episodes of unprotected intercourse; all other uses followed condom failures. No pregnancies occurred in cycles in which emergency contraception was used. Given that any act of sexual intercourse has an average 0.031 probability of resulting in a clinical pregnancy,[24] we estimate that emergency contraception prevented less than one pregnancy among users of each condom type.

According to the life-table analysis of calendar months of condom use, the six-month typical-use pregnancy rates for the SEBS condom and latex condoms (10.8% and 7.9%, respectively) were statistically indistinguishable (Table 4). For the SEBS condom, the six-cycle and the six-month typical-use pregnancy rates were identical; for the latex condoms, the six-cycle typical-use pregnancy rate (6.4%) was similar to the six-month rate (7.9%).

In 57% of the cycles contributed by SEBS condom users and 63% of those contributed by latex condom users, condoms had been used for every act of intercourse. The six-cycle consistent-use pregnancy rate, based on these cycles, was significantly higher for the SEBS condom than for the latex condom (4.9% vs. 1.0%, p=.04).

The study condom was used consistently and correctly (perfectly) throughout 46% of the cycles contributed by SEBS condom users and 50% of the cycles contributed by latex condom users. The six-cycle perfect-use pregnancy rate was greater for the SEBS condom than for the latex condom (5.1% vs. 0.7%, p=.03).

Continuation

Fifty-four percent of couples assigned to the SEBS condom and 60% of those assigned to the latex condoms completed six months of study participation. However, the six-month life-table continuation rates for the SEBS and latex groups were not significantly different (69% and 74%, respectively).

Sixteen percent of couples who used the SEBS condoms discontinued participation for reasons related to the study condom—pregnancy (34 couples), discomfort (11), breakage (10) and dislike of the condom (five). In comparison, 11% of couples who used the latex condoms exited for condom-related reasons—pregnancy (24 couples), discomfort (eight) and dislike of the condom (11). Reasons unrelated to the study condom (e.g., the couple's breaking up, inability to keep up with the study's paperwork and health problems) accounted for 23% of discontinuations among SEBS users and 21% among latex users. Three couples in each group were lost to follow-up.

The six-month life-table discontinuation rate for reasons related to the study condom was 18% for SEBS users and 13% for latex users. These rates were not significantly different. Similarly, the two assignment groups did not differ with respect to the proportion of early discontinuations for reasons unrelated to the study condom (25% for SEBS vs. 22% for latex).

TABLE 4. Life-table pregnancy rates (and 95% confidence intervals) associated with condom use, by use interval and type of condom

Interval of use and type of condom	No. of mos./ cycles	No. of pregnancies†	6-mo./6-cycle pregnancy rate (%)	Rate ratio
CALENDAR MONTHS‡				
Typical use				
SEBS	1,769	32	10.8 (7.2–14.4)	1.6 (0.9–2.7)
Latex	1,818	21	7.9 (4.8–11.0)	na
MENSTRUAL CYCLES§				
Typical use				
SEBS	1,758	33	10.8 (7.3–14.3)	1.5 (0.9–2.6)
Latex	1,806	22	6.4 (3.7–9.1)	na
Consistent use††				
SEBS	999	8	4.9 (1.5–8.3)	4.5 (1.0–21.3)
Latex	1,131	2	1.0 (0.0–2.5)	na
Perfect use‡‡				
SEBS	800	7	5.1 (1.5–8.7)	8.0 (1.0–64.7)
Latex	911	1	0.7 (0.0–2.1)	na

†In all, 34 pregnancies occurred among SEBS condom users, including two after six calendar months and one after the sixth menstrual cycle. In all, 24 pregnancies occurred among latex condom users, including three after six calendar months and two after the sixth menstrual cycle. ‡Based on the first six months of follow-up. §Based on the first six menstrual cycles of follow-up. ††Approximate variances for consistent-use rates were based on 150 sixth cycles contributed by SEBS condom users and 170 sixth cycles contributed by latex condom users. ‡‡Approximate variances for perfect-use rates were based on 132 sixth cycles contributed by SEBS condom users and 143 sixth cycles contributed by latex condom users. *Note:* na=not applicable.

TABLE 5. Percentage distribution of male study participants, by measures of condom acceptability, according to type of condom

Measure	SEBS (N=370)	Latex (N=365)
Recommendation of study condom*		
Strongly recommend	39	41
Recommend	38	44
Recommend with reservations	12	9
Not recommend	11	7
HOW STUDY CONDOM COMPARED WITH LATEX CONDOMS USED PREVIOUSLY:		
Better lubricated		
Strongly agree	37	33
Agree	34	37
Somewhat agree	17	18
Disagree	13	12
More attractive		
Strongly agree	11	6
Agree	40	43
Somewhat agree	39	38
Disagree	10	13
Easier to put on		
Strongly agree	15	12
Agree	37	43
Somewhat agree	39	35
Disagree	9	9
Provided more sensitivity*		
Strongly agree	26	11
Agree	42	40
Somewhat agree	22	35
Disagree	9	15
Smelled better *		
Strongly agree	31	21
Agree	42	39
Somewhat agree	20	25
Disagree	7	15
Total	100	100

*Distributions are significantly different at p<.05.

Acceptability and Preferences

There were no serious adverse events related to the use of any study condoms. Although no men experienced genital discomfort severe enough to require treatment, women treated themselves or sought treatment after 12 uses of SEBS condoms and three uses of latex condoms. Most of these events were described as genital irritation (five SEBS condom uses) or genital itching (four SEBS condom uses, one latex condom use), and all resolved without complication. Untreated genital discomforts (irritation, itching, constriction) were more common. Men in both groups reported genital discomfort (mostly penile constriction) after 3% of uses. Women reported genital discomfort after 3–4% of uses. Women most commonly characterized discomfort as either irritation or burning (85% of reports of discomfort associated with SEBS condoms, 71% with latex condoms). None of these differences was statistically significant.

Men who used latex condoms were more likely than those who used SEBS condoms to say that they would recommend or strongly recommend their condom to others—85% vs. 77% (Table 5). Although the proportion of users who would not recommend their study condom was low for both condom types, men who used the SEBS condoms were significantly more likely than men who used latex condoms to say that they would not recommend their condom to others (11% vs. 7%). When asked to compare their study condom with latex condoms used previously, SEBS condom users were no more likely than latex condom users to prefer the lubrication, attractiveness or ease of donning of their study condom. However, men in the SEBS group were significantly more likely than men in the latex group to prefer the sensitivity and lack of odor of their study condom (p<.05 for each).

DISCUSSION

Study Design and Execution

This randomized, controlled efficacy study had several strengths. Using radio and print advertisements to recruit participants produced an ethnically and economically diverse study population. The enrollment of both partners in the study enhanced compliance and provided an opportunity to collect information on the study condom from both genders. Only three couples assigned to each type of condom were lost to follow-up. The collection of breakage and slippage data for the first five uses of the study condoms provided detailed information on condom performance. Finally, the collection of coital data organized by menstrual cycle helped us to categorize cycles more accurately for the purpose of estimating perfect-use, consistent-use and typical-use pregnancy rates.

This study faced challenges that are inherent in condom efficacy trials. Since condom use is so widespread, it is not feasible to have prior condom experience as an exclusion criterion. Thus, the study population consisted largely of experienced condom users, who might be expected to have lower pregnancy and discontinuation rates than a study population composed of inexperienced or former condom users.

Because a pregnancy test administered at enrollment would not have reliably detected a pregnancy that had begun within the previous 5–10 days, we asked couples to delay use of the study condom until the onset of the woman's first menses after entry into the study. Eight percent of couples withdrew before ever using the study condom, approximately half of them because the woman had an undetected pregnancy at the time of enrollment.

Condom failures are conspicuous events that give participants an opportunity to leave the study before a pregnancy can result. Such early discontinuations could result in a lower pregnancy rate than would be expected if couples who experienced condom failures remained in the study. Another difficulty in evaluating male condoms is the high frequency of nonuse that is characteristic of coital-dependent methods. Although reliance on self-reporting might be expected to result in underestimating nonuse, nearly half of the menstrual cycles in this study could not be used to estimate the consistent-use pregnancy rate because couples reported one or more acts of unprotected intercourse or use of nonstudy methods, primarily withdrawal. This lack of compliance greatly reduced the power of

the study to identify differences between the pregnancy rates of the study condoms when used consistently. Statistical power was further reduced by the fact that more than 20% of the study participants dropped out of the study before completing six cycles of condom use for reasons unrelated to the study condom. Finally, participants knew the identity of their assigned condom because the study condoms were wrapped in labeled packaging. This knowledge could have affected their assessment of condom reliability. However, research staff who collected or analyzed data were masked until all data had been collected.

Condom Breakage

Data from the first five uses of the study condom revealed that the SEBS condom broke more frequently during intercourse or withdrawal than the latex condoms, and breakage was not confined to a few couples. For both condom types, the clinical breakage rates obtained from six months of diary data were approximately one-half those obtained from reports of the first five condom uses. The lower estimates from the diary data could have resulted from early discontinuation among users who experienced condom failures, changes in the way the condom was used to avoid breaks or underreporting over the course of follow-up. However, both data sources indicated that the SEBS condom was about eight times as likely to break as the latex condoms.

Contraceptive Efficacy

The typical-use pregnancy rates of both study condoms suggest that their contraceptive efficacy was comparable to that of other barrier methods. The 12-month typical-use pregnancy rates for female barrier methods range between 20% and 40%.[25] Doubling the six-month cumulative life-table rates results in 12-month typical-use estimates of 15.8% for the latex condom and 21.6% for the SEBS condom.

Although the number of consistent-use cycles available for analysis was limited (999 SEBS cycles, 1,131 latex cycles), we found statistically significant differences between the consistent-use and perfect-use pregnancy rates for the two condom types. It is difficult to extrapolate an annualized rate from the data. If we assume that the risk of pregnancy for cycles 7–13 is the same as the risk for cycles 1–6, we can calculate a 13-cycle consistent-use pregnancy rate of 10.6% for the SEBS condom and 2.2% for the latex condoms. However, since no pregnancies were observed in cycles 4–6 among consistent users of either condom type, our calculations probably overestimate the annual consistent-use pregnancy rates.

The six-cycle consistent-use pregnancy rate for the SEBS condom (4.9%) was considerably higher than that for a polyurethane condom studied in a similar randomized, controlled trial (2.4%), even though the clinical breakage rates for the first five uses of both condom types were nearly identical (3.5% and 4.3%, respectively).[26] Thus, condom breakage appears to be reflected in a higher consistent-use pregnancy rate in the current study, but not in the earlier polyurethane condom study. These paradoxical results suggest that condom failure rates may not be a reliable predictor of contraceptive efficacy.

Annualized perfect-use pregnancy rates for both study condoms were remarkably similar to consistent-use rates, even though consistent-use cycles included common behaviors such as starting intercourse without a condom, not holding on to the condom ring during withdrawal and failing to withdraw while the penis was still erect. Extrapolating to 13 cycles of perfect use yields a pregnancy rate of 11.1% for the SEBS condom, compared with 1.5% for the latex condoms. The perfect-use pregnancy rate of the SEBS condom is within the range of the 12-month "perfect-use" (consistent and correct) cumulative life-table estimates reported in the literature for female barrier methods (6–26%),[27] whereas the perfect-use pregnancy rate of the latex condom group is considerably lower. Thus, our data suggest that male condoms offer contraceptive protection at least as efficacious as female barrier methods when used consistently.

Conclusion

Breakage and slippage results from this clinical trial are consistent with the findings of our earlier contraceptive efficacy trial, which compared a polyurethane condom with a conventional latex condom.[28] Both synthetic condoms failed more frequently than latex control condoms. Whereas the latex control condoms in both studies had clinical failure rates of less than 2%, the failures rates of the nonlatex condoms were 4.0% for the SEBS condom and 8.5% for the polyurethane condom.

Results from the current study suggest that condom breaks exerted an upward influence on the consistent-use and perfect-use pregnancy rates of the SEBS condom. Moreover, assuming that condom breakage results in exposure to semen and the pathogens that it might harbor, the higher rate of SEBS condom breaks suggests that these nonlatex condoms may provide less protection than latex condoms against some sexually transmitted infections. Nonetheless, nonlatex condoms remained intact during 96% of uses, substantially reducing the female partner's exposure to semen compared with exposure associated with unprotected intercourse.

Clinical trials that directly address the extent of disease prevention afforded by condom use are greatly needed. However, such trials confront many obstacles, including ethical considerations, large study size, long follow-up requirements and compliance issues.[29] Until results from disease prevention trials are available, we believe that our results, particularly the low condom breakage and slippage rates based on six-month data, provide strong indirect support for public health messages that promote the use of latex condoms and, for individuals who cannot use latex condoms because of allergy or personal objections, the use of nonlatex condoms for disease prevention.

Appendix: Definitions of Failure Rates and Cycles

Nonclinical failure rate: Number of condoms that could not be used because of breaks, donning problems or defects, divided by the number opened for use.

Total clinical failure rate: Number of condoms that broke during intercourse or withdrawal, plus the number that slipped off the penis during intercourse or withdrawal, divided by the number used. Using the same denominator, we also calculated separate rates of clinical breakage (the number of condoms that broke during intercourse or withdrawal) and clinical slippage (the number that slipped off during intercourse or withdrawal).

Total failure rate: Number of nonclinical and clinical condom failures, divided by the number of condoms opened for use. Using the same denominator, we also calculated total breakage (the number of condoms that broke during package opening, donning, intercourse or withdrawal), total slippage (the number that slipped off the penis during intercourse or withdrawal) and other failure (the number that could not be used for reasons other than breakage, such as donning problems or defects).

Typical-use cycles: All cycles in which participants reported at least one act of intercourse.

Consistent-use cycles: Excluded cycles in which participants reported unprotected intercourse, intentional removal of an intact condom before completing intercourse or use of a method other than the study condom (withdrawal or other barrier method).

Perfect-use cycles: Excluded cycles excluded from consistent-use cycles, as well as cycles in which participants reported that they had failed to follow instructions—i.e., they put the condom on after starting intercourse; did not store the condom in a cool, dry place; did not push the air out of the condom tip; used an oil-based lubricant; did not hold on to the condom ring during withdrawal when the condom was intact; or did not withdraw while the penis was still erect.

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