

RESULTS OF TRANSURETHRAL INJECTION OF SILICONE  
MICROIMPLANTS FOR FEMALE INTRINSIC SPHINCTER DEFICIENCY

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**RUNNINGHEAD:** Transurethral injection of silicone microimplants

**KEY-WORDS:** urodynamics/ urinary incontinence/ stress/ silicone injections/  
treatment outcome.

## ABSTRACT

**Purpose:** We evaluated the medium-term efficiency of silicone microimplants injected into women with intrinsic sphincter deficiency.

**Materials and Methods:** Twenty-one women with intrinsic sphincter deficiency underwent transurethral injection of silicone microimplants between August 1996 and February 1997. Each patient was assessed preoperatively by questionnaire, physical examination and urodynamic study. The results were evaluated by questionnaire at 1 month, 1 year, and 2 years after silicone injection. The outcome was classified as dry in all circumstances, improved or failure.

**Results:** All patients (median age: 68 years, range: 46 to 83) had undergone previous anti-incontinence or prolapse surgeries. At one month, 2 patients (10%) were dry, 9 (42%) were improved and 10 (48%) were failures. At one year (median: 16 months, range: 14 to 22), 2 patients (10%) were dry, 8 (38%) were improved and 11 (52%) were failures. At the last follow-up (median: 31 months, range: 24 to 34), 4 patients (19%) were dry, 6 (29%) were improved and 11 (52%) were failures. None of the 6 patients with bladder neck hypermobility were dry.

**Conclusions:** Our results of silicone transurethral injection are disappointing but comparable to other bulking agents without a time-dependent decrease in efficiency. The use of silicone microimplants is an alternative in the treatment of intrinsic sphincter deficiency in patients without bladder neck hypermobility and who have failed to improve after sling procedure.

## INTRODUCTION

Urinary incontinence, which is the involuntary loss of urine during stress, afflicts 10-30% of women of all ages.<sup>1</sup> In women, there are two main types of sphincter abnormality: bladder neck hypermobility and intrinsic sphincter deficiency (ISD). ISD may often account for a higher failure rate of surgical procedures to cure stress incontinence. Historically, a sling has been the chosen procedure, but the use of this operation may increase and produce a significant incidence of urinary retention. Periurethral bulking agents, less invasive techniques, have been used to treat ISD for many years avoiding recurrent surgical procedure. Periurethral injectables are able to coapt the urethra mucosa and resist raised abdominal pressure. Polytetrafluoroethylene (PTFE) paste consists of microparticles that vary in size from 1 to 100  $\mu\text{m}$ ., with 90% smaller than 40 $\mu\text{m}$ ., resulting in distant migration and granuloma formation.<sup>2</sup> The long-term results were disappointing. Indeed, Kiilholma and Mäkinen reported that only 18% of patients were continent five years after PTFE injection.<sup>3</sup> Collagen is expensive and may cause allergic reactions in 1% to 3% of patients.<sup>4</sup> In most studies, incontinence returned gradually with a median duration of continence of 23 months.<sup>5</sup> Repeated injections are also necessary to achieve sustained continence, increasing the cost. The main disadvantage of using autologous fat relates to the variability of resorption, requiring repeated injections. At 1 year of follow-up, only 28% of the patients are cured.<sup>6</sup> Silicone microimplants (Macroplastique™) are the most recently developed injectable material. Until now, only three reports using silicone particles for treatment of female stress urinary incontinence have been published.<sup>7-9</sup> These reports have produced extremely encouraging results. Only one study reported results over a period of 2 years.<sup>7</sup> The purpose of this study was to evaluate the efficiency of an injection of silicone microimplants for the treatment of female urinary stress incontinence due to ISD.

## MATERIALS AND METHODS

Between August 1996 and February 1997, 21 women with stress urinary incontinence due to ISD were enrolled in the study. Before silicone injection, each patient was assessed by questionnaire, physical examination and urodynamic study.

Subjective assessment was based on number of pads used daily and the degree of incontinence according to Stamey.<sup>10</sup> Briefly, Grade I included women who lose urine due to coughing, sneezing or lifting heavy objects. Grade II included those who lose urine during minimal activity such as walking or arising from the sitting position. Grade III included those who are totally incontinent in the upright position and who cannot hold urine in their bladder.

Physical examination was performed in the lithotomy position with the bust sat at 30° and the thighs flexed at 45°. The patients were hydrated (½ liter) one hour before clinical examination. Loss of urine was obtained after coughing and during stress.

Urethral pressure profilometry was performed with a Uromedic 2001 system (Electromed, Evry, France). A catheter with 2 side-holes (laboratory Vermed, Neuilly en Thelle, France) was inserted into the patient's bladder and filled with sterile water (filling at 2 ml per minute). Intrinsic sphincter deficiency (ISD) was determined by maximal urethral closure pressure less than 30 cm. water or less than  $(110 - \text{age}) \times 0,80$ .

The bladder neck mobility was assessed by lateral cystourethrography at rest and during stress, and clinical examination including cotton swab test. All terms and definitions are in accordance with the International Continence Society.<sup>11</sup>

*Operative technique.* Silicone microimplants used for transurethral injection were sterile, solid, textured polymethylsiloxane particles (vulcanized silicone rubber), suspended in a polyvinylpyrrolidone hydrogel (Macroplastique™, Uroplasty inc., Maastricht, The Netherlands). The patients were placed in the lithotomy position after confirmation of sterile urine and the perineum was prepared under sterile conditions and draped. The procedure

using videocystoscopy was performed under local anesthesia, injected transurethrally (1% lidocaine solution). Two ml of silicone microimplants were injected via a 21 CH cystoscope through a specially designed needle (7 CH) with a hub 1 cm. from the tip. The injections were placed under direct vision in the transurethral tissues from inside the urethra at 2 and 10 o'clock, 2 cm. distal to the bladder neck until submucosal bulking and occlusion of the proxima urethra occurred. A senior surgeon performed all injections. All patients were discharged within 24 hours if they could void spontaneously. All patients received broad-spectrum antibiotics for 2 days after the procedure.

Urodynamic studies were repeated 1 month after silicone injection. The patients were followed up for at least 2 years to evaluate the duration of continence. To assess subjective results, patients were asked by an independent party to answer a questionnaire by phone, based on a questionnaire for women with stress incontinence previously described by Black et al and translated into French.<sup>12</sup> Our definition of cure was the patient being dry in all circumstances by the end of the follow-up period. Improvement was defined as patients experiencing only rare or minimal leakage. Failure was defined as patients who had no significant improvement or had undergone recurrent surgery. The other results were based on degree of urinary incontinence, number of pads per day. For the patients who had undergone recurrent surgery after silicone microimplants, symptoms of stress incontinence were observed before the recurrent surgery. In patients requiring several transurethral injections, outcome results derive from the time of the last injection.

Statistical analysis was performed using non-parametric tests. Wilcoxon rank test was used for paired ordinal data, Mann-Whitney test for unpaired ordinal data, and Fisher's exact test for unpaired qualitative data.  $P < 0.05$  was considered statistically significant.

## RESULTS

The median age of the patients was 68 years (range 46-83 years). The median body mass index was 22.6 kg/m<sup>2</sup> (range 19.9 to 32). Two patients were nulliparous, 9 had given birth to one child, 5 had given birth to two children and 5 to three or more children. Nineteen patients were postmenopausal. All patients had undergone previous anti-incontinence or prolapse surgeries. Twenty patients had had previous anti-incontinence surgery, which included 14 retropubic suspension, 2 vaginal sling procedures, 3 Kelly plication procedures and 1 transvaginal suspension. Ten patients had had previous prolapse surgery.

Nineteen patients underwent only one procedure and two had a second injection 3 and 5 months respectively after the primary injection.

All patients had ISD proven by clinical examination and urethral pressure profilometry (median maximum urethral closure pressure: 23 cm. water, range: 11 to 41). Of 21 patients, 15 had ISD only (type I or III) and 6 had associated bladder neck hypermobility (type II) according to the classification of Blaivas.<sup>13</sup> All patients answered the questionnaire. The subjective results of treatment were evaluated at 1 month, 1 year (median 16 months, range 14 to 22) and 2 years (median 31 months, range 24 to 34).

One month after the procedure, 2 patients (10%) were dry, 9 (42%) were improved and 10 (48%) were failures.

Sixteen months after transurethral injection, 2 patients (10%) were completely dry, 8 (38%) were improved and 11 (52%) were failures.

After 31 months, 4 (19%) patients were completely dry, 6 (29%) were improved and 11 (52%) were failures. Two patients in the improved group had urge incontinence only and were no longer suffering from stress incontinence. The two patients who had received twice injections were failures. At the last follow-up, five patients in the failed group required alternative surgical treatment with abdominal sling procedure (n = 1) and Tension free

Vaginal Tape (n = 4) 8, 23, 29, 30 and 33 months after transurethral injection. Of the 5 patients requiring alternative operations, 2 were dry, 2 were improved and 1 was a failure.

The other results after silicone injection are shown in table 1. At 16 months, the severity of urinary incontinence (in accordance with Stamey classification<sup>10</sup>) was decreased for 9 patients, unchanged for 11 patients and increased for 1 patient ( $p = 0.01$ , Wilcoxon rank test). At 31 months, the severity of urinary incontinence was decreased for 13 patients and unchanged for 8 patients ( $p = 0.001$ , Wilcoxon rank test). Most of the failures were associated with bladder neck hypermobility (table 2). Indeed, all patients with bladder neck hypermobility (n = 6) were wet at 16 months. Five were failures and only one was improved at 31 months.

The urodynamic studies before and after treatment are shown in table 3. A significant increase in functional urethral length (FUL) was found at a 1 month follow-up compared with the preoperative condition (median FUL: 27.9 versus 31.5 mm. after injection,  $p = 0.04$ , Wilcoxon rank test). There were no statistic difference in increasing FUL between the 4 patients who were dry at the last follow-up and the other patients (median increasing FUL: 3.2 versus 1.45 mm.,  $p = 0.77$ , Mann-Whitney test). The 4 patients who were dry at the follow-up had a lower pre-operative maximum urethral closure pressure (MUCP) compared with the other patients (median preoperative MUCP: 16.5 versus 27 cm. water), but the difference was not significant ( $p = 0.1$ , Mann-Whitney test).

No complications occurred during or after surgery.

## DISCUSSION

Our results are disappointing and less encouraging than those previously reported using silicone microimplants (table 4).<sup>7-9, 14</sup> But these results are similar to other bulking agents like Collagen or PTFE.<sup>15</sup> In our study, 2 injection sites were used in contrast with those studies using 3 or more injection sites.<sup>7-9</sup> The difference in the number of injection sites alone cannot explain our disappointing results. Indeed, we believe that several injections can cause more disruption of the mucosal surface than benefit. Likewise, Khullar et al showed injection site at 12 o'clock is of no benefit for Collagen.<sup>16</sup> To our knowledge, there has been no documented study of how many sites are necessary for transurethral injection of silicone. The method of injection is difficult. The agent is viscid and elastic, flows slowly and ejection is delayed (in order to prevent the syringe from exploding, due to the excessive pressure needed to inject the agent, an armored syringe was used). If the agent is injected too superficially under the submucosa then extravasation occurs either down the needle tract or soon after surgery. Conversely, if the bulking agent is injected too deeply then the desired coaptation of the urethral mucosa is not achieved. Obviously, experience and training in these new techniques are required. These disappointing results can also be related to the severity of urinary incontinence in patients treated. All our patients had severe ISD with low pre-operative MUCP (median preoperative MUCP: 23 cm. Water). All patients, except one, had failed previous anti-incontinence surgery and 19 patients (90%) had moderate or severe stress urinary incontinence. Six patients (29%) had bladder neck hypermobility which may increase the failure rate. Different definitions for success may also explain variations observed in the literature available.

It seems that a second injection does not improve the patient's condition, and is not cost effective. Indeed, in this study the two patients who received a second injection were not improved. Further reports are needed to evaluate the number of injections and quantity of



Silicone microimplants injected per patient to achieve continence.

We observed that only 2 patients were dry and 9 were improved 1 month after transurethral injection. Of these 9 patients who were improved, 2 patients asked by phone at 1 month that urinary incontinence were few only with coughing. At 31 months, these 2 patients asked that they were dry in all circumstances. They underwent only 1 injection without other treatment of urinary incontinence. These two patients who were improved at 1 and 16 months after injection became progressively dry by adapting their lifestyle to avoid urinary incontinence. Asked by phone at 31 months, they confirmed that they have no further urinary incontinence because they reduced their fluid intake and urinated regularly during the day.

In this study, our results were maintained in the longer-term. If patients did not receive any benefit (quoted as dry or improvement) from the silicone microimplant within the first month, they did not do so at a later date. Indeed, about half of the patients were dry or improved at 1 month and continued to be so at 2.5 years post-operatively. This is in direct contrast to other studies using silicone microimplant.<sup>7-9</sup> They found that results were time-dependent. Possible explanation is that larger silicone particles injected into periurethral tissues produce an encapsulated fibrous sheath maintaining the implant sites intact. Indeed, it is generally accepted that smaller particles (<50µm) were both susceptible to ingestion by macrophages and migration to local and distant sites.<sup>17</sup> The manufacturers admit that 94.6% of silicone particles are larger than 80µm., reducing the risk of migration and remaining at the site of injection for a long period. In the same way, no complications of distant migration of silicone microimplants were reported in literature available.<sup>15</sup>

In this study, bladder neck hypermobility seems to decrease the chance of favorable outcome. Indeed, 83% of patients with bladder neck hypermobility were failures at 2.5 years after transurethral injection against 40% of patients with ISD. These results are in accordance with Sheriff et al <sup>8</sup> using silicone and Herschorn et al <sup>18</sup> using injectable Collagen.

Our urodynamic studies showed that silicone microimplants are associated with an increase in the FUL of the urethra rather than MUCP. These results were in accordance with Monga et al using collagen injectable.<sup>19</sup> Long-term cure is probably due to that maintenance of increased FUL. In the same way, patients who were dry at the last follow-up had lower MUCP pre-operatively, compared with patients who were not dry (MUCP: 16.5 versus 27 cm. water).

In our study, no complications were found. In other studies using silicone microimplants, there were no deaths and complications, including transient urinary retention requiring urethral catheterisation and urinary tract infection which are few.<sup>7-9, 14</sup>

## CONCLUSIONS

With almost 50% of patients dry or improved, the results of silicone injection are similar to other bulking agents. The main interest is that results are maintained in the longer-term. Patients can resume their normal activities quickly. In any case, silicone microimplants do not compromise future options and they have a low complication rate. However, the effect of silicone microimplants on continence over a five to ten years period is unknown. The use of silicone microimplants is an alternative in the treatment of ISD, in patients without bladder neck hypermobility and who have failed to improve after sling procedure.

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## Tables

TABLE 1. Results of silicone injection in 21 patients

Urinary Troubles	Before Injection	After Injection	
	No. (%)	At 16 Months No. (%)	At 31 Months No. (%)
Degree of stress urinary incontinence			
(in accordance with Stamey classification <sup>10</sup> )			
no stress incontinence	0	2 (10)	6 (28)
grade I (coughing)	2 (10)	8 (38)	5 (24)
grade II (walking)	12 (57)	7 (33)	8 (38)
grade III (total)	7 (33)	4 (19)	2 (10)
total	21 (100)	21 (100)	21 (100)
Urge incontinence	14 (67)	18 (86)	14 (67)
Number of protections			
<1 pad daily	5 (24)	12 (57)	11 (53)
1-4 pads daily	9 (43)	6 (29)	7 (33)
> 4 pads daily	7 (33)	3 (14)	3 (14)
total	21 (100)	21 (100)	21 (100)

TABLE 2. Results of silicone injection compared to the bladder neck mobility at 16 and 31 months

	16 Months After Injection		31 Months After Injection	
	No. (%)		No. (%)	
	Dry or Improved	Failed	Dry or Improved	Failed
Patient without bladder neck mobility (n = 15)	10 (67)	5 (33) *	9 (60)	6 (40) †
Patient with bladder neck mobility (n = 6)	0	6 (100) *	1 (17)	5 (83) †

\* p = 0.01, Fisher's exact test

† p = 0.15, Fisher's exact test

TABLE 3. Comparison of median urodynamic data before and 1 month after injection of silicone

Urodynamic Data	Before Injection	After Injection
Median maximum urethral closure pressure (cm. water)	23	22
Median functional urethral length (mm.)	27.9	31.5*

\* p = 0.045, Wilcoxon's matched pairs test



TABLE 4. Results of studies of silicone injection for stress urinary incontinence from the English literature

Authors	Patients No.	Previous Incontinence Surgery No. (%)	Preoperative MUCP (cm. water)	Injection Sites No.	Follow-up (months)	Results (%)		
						Dry	Improved	Failed
Buckley et al <sup>14</sup>	144	NS	NS	NS	14	70	10	20
Harris et al <sup>7</sup>	40	15 (37)	NS	4	36	40	18	42
Sheriff et al <sup>8</sup>	34	34 (100)	NS	3	24	NS	NS	52
Koelbl et al <sup>9</sup>	32	28 (87)	25	3	12	NS	NS	41
Present study	21	20 (95)	23	2	31	19	29	52

NS : not stated.