FillerTest

DNA test to predict the risk of filler complications

Fillers are safe,
working with the best
doctors and best materials...
**but how does your immune
system react?**

✓ **Best** doctor

✓ **Best** materials

? Your **DNA**

DNA test to predict the risk of filler complications

Negative test result

✓ **Low risk group**: General low risk of complications
✓ You do NOT have the genetic predisposition
✓ You can use fillers, considering normal low risk

Positive test result

○ **High risk group**: high risk of complications
○ You have the genetic predisposition
○ Recommended **NOT to use fillers**
○ Alternative treatments (i.e. botox is possible)

○ **Positive result and already fillers?**
  ○ No further fillers
  ○ Vigilance of immune reactions

What complications?

Late onset Immune mediated reactions – an extreme reaction of your immune systems to fillers

What complications?

BIG?

Big because the problems are very serious, life long, not curable

SMALL?

Small because on average "only" 1 out of 50 could have them

What complications?

Local/Regional		Bsure / Systemic	
Immediate	**Intermediate**	**Late-onset**	**(rare but cases appear)**
Pain	Swelling	Induration	Sarcoidosis
Oedema	Nodules	Oedema	Granulomatosis
Ecchymosis	Fistulisation	Nodules	Systemic sclerosis
Pigmentation	Abscesses	Granuloma	Panniculitis
Pruritus	Necrosis	Pigmentation	Hepatitis
Elevation	Scars	Pseudo abscess	Pneumonitis (acute/chro)
Embolism	Granuloma	Combination of	Sjogren syndrome
Erythema	Pigmentation	them all	Human Adjuvant Dis
			Multisystemic failure
			Primary Biliary Cirrhosis
			Vasculitis
			Fibromyalgia /C.F.S.

severe ++

Delayed immune mediated severe adverse events.
3-6 to 60 months after implanting, possible livelong impact.

Who should do the test?

1 People who have immune diseases, lots of allergies, immune disorders or high general sensibility

2 People who have had complains and/or complications with fillers and/or other implants

3 People who want to start with fillers, do not have specific immune issues but are careful and worried about possible consequences
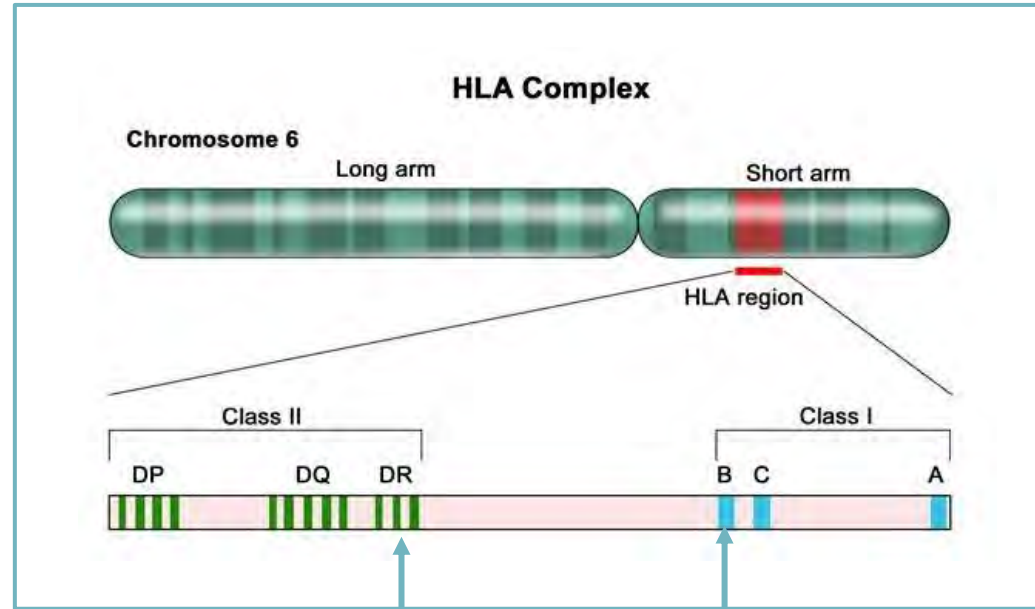
4 People who already have fillers and no complications (for some years), but are careful and worried

Specially people of group 1, 2 and 3 have interest and already gave positive test results
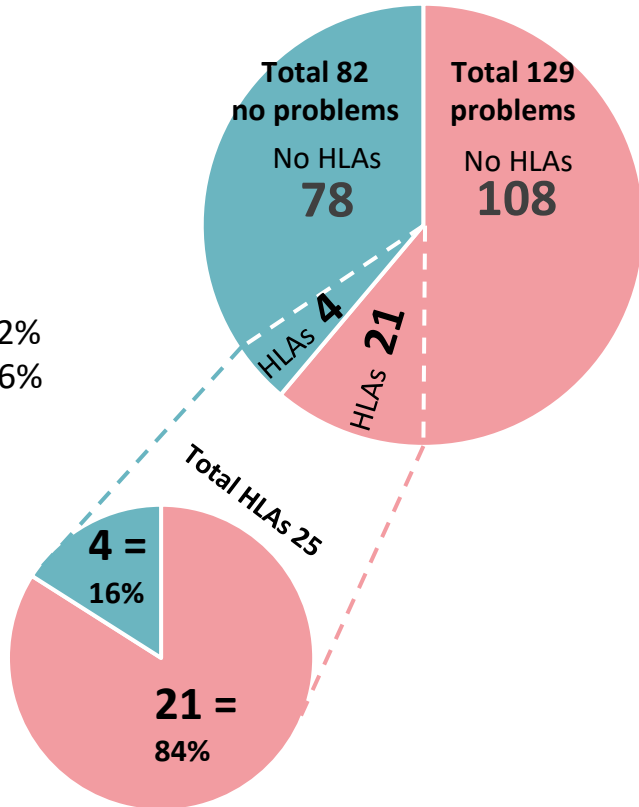
Fagron genomics

Science of the test: **HLA combination**

The scientific research behind the Bsure DNA test for fillers showed a specific combination of two HLAs cause an increased risk for late onset immune mediate adverse reaction to foreign body implants.

HLA-DRB1*03

HLA-B*08

Science of the test: **The research study**

Total study group 211

Total 82 no problems
No HLAs
78

Total 129 problems
No HLAs
108

HLAs **4**

HLAs **21**

P value = 0,008
OR = 3,79
Specificity = 95,12%
Sensitivity = 16,26%

Total HLAs 25

4 = 16%

21 = 84%

1,6% of EU population has the HLAs combination

- The patented test is based on scientific research, executed by a team of renown doctors and researchers from the Vall D'Hebron Univeristy hospital, the Amsterdam University MC and the Erasmus University MC.
- The study showed that patients in the study population with a **combination of two specific genes had more than 80% chance of serious complications from filler treatments**. Medical complications that can occur include chronic and/or localized inflammation that may require months or years of medical treatment and can cause **lifelong symptoms**.
- An article on the study and results was published in PUBMED in January 2021
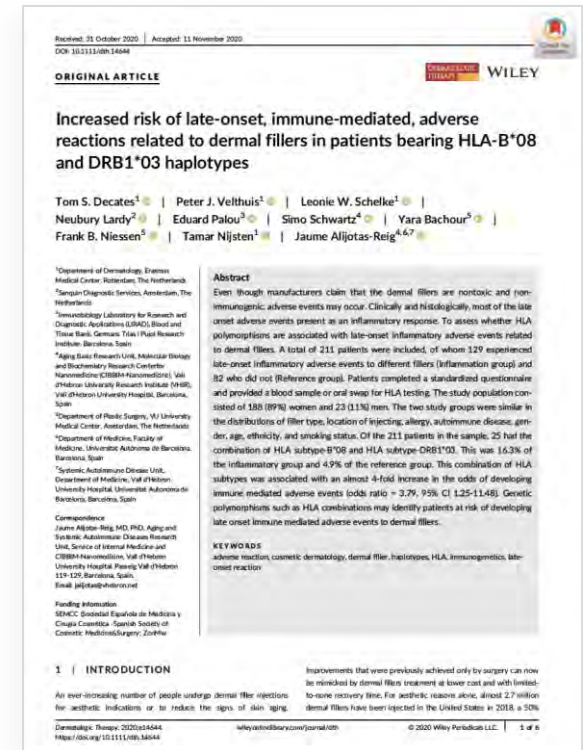
ORIGINAL ARTICLE

Increased risk of late-onset, immune-mediated, adverse reactions related to dermal fillers in patients bearing HLA-B*08 and DRB1*03 haplotypes

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Abstract

Even though manufacturers claim that the dermal fillers are nontoxic and non-immunogenic, adverse events may occur. Clinically and histologically, most of the late onset adverse events present as an inflammatory response. To assess whether HLA polymorphisms are associated with late-onset inflammatory adverse events related to dermal fillers. A total of 211 patients were included, of whom 129 experienced late-onset inflammatory adverse events to different fillers (Inflammation group) and 82 who did not (Reference group). Patients completed a standardized questionnaire and provided a blood sample or oral swab for HLA testing. The study population consisted of 188 (89%) women and 23 (11%) men. The two study groups were similar in the distributions of filler type, location of injecting, allergy, autoimmune disease, gender, age, ethnicity, and smoking status. Of the 211 patients in the sample, 25 had the combination of HLA subtype-B*08 and HLA subtype-DRB1*03. This was 16.3% of the inflammatory group and 4.9% of the reference group. This combination of HLA subtypes was associated with an almost 4-fold increase in the odds of developing immune mediated adverse events (odds ratio = 3.79, 95% CI 1.25-11.48). Genetic polymorphisms such as HLA combinations may identify patients at risk of developing late onset immune mediated adverse events to dermal fillers.

KEYWORDS

adverse reaction, cosmetic dermatology, dermal filler, haplotypes, HLA, immunogenetics, late-onset reaction

1 | INTRODUCTION

An ever-increasing number of people undergo dermal filler injections for aesthetic indications or to reduce the signs of skin aging.

Improvements that were previously achieved only by surgery can now be mimicked by dermal fillers treatment at lower cost and with limited-to-none recovery time. For aesthetic reasons alone, almost 2.7 million dermal fillers have been injected in the United States in 2018, a 50%

increase since 2010.[1] A recent study in the Netherlands shows that each year, 1 out of 49 women receive at least one injection treatment.[2]

Physicians have different types of dermal fillers at their disposal, consisting either of resorbable or nonresorbable materials. Manufacturers claim that marketed fillers are nontoxic and nonimmunogenic, which are requirements for any biomaterial intended for aesthetic uses. However, unwanted adverse events of various clinical relevance may occur in a low percentage of patients implanted with dermal fillers, such as medical grade silicone, polyalkylimide, hyaluronic acid, poly-L-lactic acid, polyacrylamide, or methacrylate fillers.[3-6] Reports suggest incidences of 0.3%-0.4% for hyaluronic acid (HA)[7] and of 5% for acrylamides.[8-10] Early onset inflammatory adverse events start within 2-4 weeks after injection.[3] Late onset inflammatory adverse events to dermal fillers appear between 1 and 60 months postimplantation, with 14 months as mean period.[3] Clinically and histologically, most of the late onset adverse events present as an inflammatory response.[3] In fact, a variety of adverse events has been associated with fillers, including granulomas, inflammatory nodules, angioedema, skin induration, human adjuvant disease, sarcoidosis and sarcoid-like disease, panniculitis, Sjögren syndrome, autoimmune thyroiditis, localized and systemic sclerosis, inflammatory myosis, autoimmune inflammatory syndrome related to adjuvants (ASIA), and cutaneous vasculitis.[14,15] Most of these adverse events seem to have an immunological basis, where the fillers act as adjuvants more than as direct T-cell activators, on a possible background of genetic predisposition.[16] Even though the origin of these complications is not completely clear, they can be due to exacerbated immune responses of the body against foreign body material.[16] Problems with long term safety and reversibility of adverse events due to foreign body material also occur in plastic surgery (breast implants),[11] cardiology (pacemakers),[12] and orthopedics (hip implants).[13] When looking at the genetic predisposition leading to immune-mediated, adverse reactions, and genes within the major histocompatibility complex (MHC) have been shown to be associated with auto-immune diseases as M. Bechterew.[17] And there is also speculation about the HLA subtype-B*08 and HLA subtype-DRB1*03 in immune mediated disorders in women with silicone breast implants.[18-23] Because of the low-prevalence of late-onset immune-mediated complications, we hypothesize about the potential role of genetic polymorphism affecting immune-related gene functions, as a subjacent cause.

Genetic polymorphisms are defined as the occurrence of multiple alleles at a given locus, where at least two alleles occur with a frequency greater than 1%.[24] Accordingly, the human leukocyte antigen (HLA) system is the most polymorphic region within the human genome.[25] The HLA system is a super locus that contains a large number of genes clustered on a 4 Mb-segment of the short arm of chromosome 6 in humans, related to immune system function. Indeed, HLA region comprises six major classical HLA loci that encode structurally homologous proteins which are classified into HLA class I (HLA-A, B, Cw) and class II (HLA-DRB, DQ, DP).[26]

In this candidate gene study, we tested all HLA subtypes A, B, and DRB for their association with late-onset immune-mediated adverse reactions related to foreign biomaterials, used as implant fillers.

2 | MATERIAL AND METHODS

2.1 | Study population

We used a convenience sample of 211 patients, of which 92 were from of the Systemic Autoimmune Diseases Unit at Vall d'Hebron University Hospital in Barcelona and 119 of the Dermatology Department, Erasmus MC, the Netherlands in the period between 2016 and 2018.

Late onset immune mediated adverse event was defined as the appearance of two or more local clinical signs of inflammation (ie, edema, skin induration, swollen/tender nodules with or without fistulation, or discharge of pus or filler material) three or more months after initial filler injection. Patients with these inflammatory complaints formed the Inflammation group (N = 129). The Reference group (N = 82) was formed by people treated with dermal fillers at least 3 months earlier, without any inflammatory complaints. Patients with isolated soft lumps without inflammatory signs were also included in this Reference group.

Patients with and without late-onset inflammatory complaints were compared through HLA genotyping and a questionnaire regarding age, ethnicity, smoking status, autoimmune diseases, type I or IV allergies, and location of the injection of the dermal filler.

2.2 | HLA genotyping

DNA was obtained by means of oral swab or blood extraction. Briefly, DNA was isolated from the buccal swabs using QIA-AMP kit according to the manufacturer's instructions (Qiagen, Venlo, the Netherlands). Blood was collected from the antecubital vein of arms through Vacutainer method (Becton Dickinson, Franklin Lakes, New Jersey). Samples were stored at −80°C until further analyses. Low-intermediate resolution genotyping of HLA-A, HLA-B, and DRB alleles of all patients were performed by sequence-specific oligonucleotide probe (SSOP) methods using the Luminex microbead technology in Barcelona, Spain (Lifecodes HLA typing kits, Gen-Probe, San Diego, California) and in Amsterdam, Netherlands. (Sanquin Diagnostic Services, Amsterdam, the Netherlands). This method maps all alleles of the HLA-A, HLA-B, and HLA-DRB subtypes.

2.3 | Statistical analysis

Descriptive statistics were reported comparing the distribution of patient and filler characteristics possibly associated with adverse reactions to filler injections between the inflammatory group and the reference group. The degree of association between adverse reactions and having a possible specific HLA-A, HLA-B, and DRB alleles combination was estimated by the odds ratio (OR) with 95% confidence interval (CI) and Nagelkerke's R,[2] along with a likelihood ratio (chi-square) test.

To assess the impact of potential confounders and effect modifiers on the estimated odds ratio, we first conducted contingency table analyses to see if there were any significant associations among the selected characteristics of the patients and both the presence of the HLA combination and the appearance of adverse reactions.

Variables considered as potential confounders or moderators were filler type, location of injecting, allergy, autoimmune disease, gender, ethnicity, and smoking status. A full assessment of possible confounding and effect modification was conducted. For all analyses, the significance level was set to 0.05. To evaluate the predictive properties of the logistic regression model we also calculated the sensitivity, specificity, and the area under the curve (AUC) parameters. Analyses were conducted with SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Apple, Version 25.0. Armonk, NY: IBM Corp.).

The study was approved by the medical ethics committee of both University Hospitals.[27]

3 | RESULTS

A total of 211 patients were eligible for this study, of whom 129 experienced late-onset inflammatory adverse events to different fillers (Inflammation group) and 82 did not (Reference group). Table 1 displays selected characteristics of the two groups. No systemic complaints potentially related to the filler adverse event was seen in the inflammatory group. The distributions of filler type, location of injecting, allergy, history of autoimmune disease, gender, age, ethnicity, and smoking status were comparable between two groups. Both groups were also comparable in types of fillers received, being nonresorbable ones (polyalkylimide, liquid silicone) and resorbable hyaluronic acid fillers (of various brands).

Of the sample of 211, there were in total 25 patients with the HLA combination of HLA subtype-B*08 and HLA subtype-DRB1*03 (11.8%; 95% CI 8.2%-16.9%). The proportion of patients with this specific combination was significantly higher in the Inflammation

TABLE 1 Descriptive statistics of patient characteristics for inflammation and reference group

	Inflammation	Reference	χ^2	P-value
Gender				
Female	114	74	0.18	.671
Male	15	8		
Age (in years)				
Mean (SD)	53.2 (10.6)	54.3 (10.0)	t = 0.69	.490
Ethnicity				
Caucasian	120	77	0.06	.803
Non-Caucasian	9	5		
Smoking				
Yes	28	26	2.63	.105
No	101	56		
Autoimmune diseases				
Yes	16	6	1.39	.239
No	113	76		
Allergy				
Drugs	10	5	1.41	.494
Atopy	25	11		
No	95	66		
Filler type				
Nonresorbable	99	62	0.04	.580
Resorbable	30	20		
Injection location				
Periorbital	10	9	5.50	.358
Lips	27	14		
Nasolabial folds	35	29		
Cheeks	26	12		
Zygoma	27	18		
Buttocks/legs	4	0		

Note: χ^2, Chi-square value for test for independence.

B*08/DR3	Inflammation	Reference	Total	OR (95% CI)	P-value[b]
No	108	78	186	3.79 (1.25, 11.48)	.008
Yes	21	4	25		
Total	129	82	211		
B*08	Inflammation	Reference	Total	OR (95% CI)	P-value
No	103	71	174	1.63 (0.76, 3.51)	.203
Yes	26	11	37		
Total	129	82	211		
DR3	Inflammation	Reference	Total	OR (95% CI)	P-value
No	98	68	166	1.54 (0.76, 3.10)	.224
Yes	31	14	45		
Total	129	82	211		

TABLE 2 Risk of adverse events[a] after dermal implantation for Inflammation and Reference group in relation to presence of HLA haplotype (B*08, DR3, or B*08/DR3 combined)

Abbreviations: 95% CI, 95% confidence interval; OR, odds ratio.
[a]Adverse events include granulomas, inflammatory nodules, angioedema, skin induration, human adjuvant disease, sarcoid-like disease, cutaneous vasculitis.
[b]Likelihood ratio test.

TABLE 3 Predictive measures

Specificity	Sensitivity	AUC
.951	.163	.557

Note: The cut-off value is set to .70.
Abbreviation: AUC, area under the curve.

group (n = 21, 16.3%) than in the Reference group (n = 4, 4.9%), giving χ^2 = 6.98, P = .008.

Table 2 presents the cross tabulation of the presence of HLA subtype-B*08, the presence of HLA subtype-DRB1*03, and the simultaneous combination for both the Inflammatory group and the Reference group. The presence of either the antigen HLA subtype-B*08 or HLA subtype-DRB1*03 was not significantly associated with the risk of developing dermal filler induced adverse reactions (Table 2). However, the combination of HLA subtype-B*08 and HLA subtype-DRB1*03 was associated with an increased risk of late-onset adverse reactions (Nagelkerke's R^2 = .04). The odds ratio was 3.79 (95% CI 1.25-11.48), indicating that the likelihood of developing adverse reactions may increase by a factor 3.8 in people showing this HLA combination.

The analyses showed that there were no other statistically significant associations among the selected characteristics of the patients and both the presence of the HLA combination and the appearance of adverse reactions (all P-value's >.10). Accordingly, based on the present model, the probability of correctly classifying that a patient will experience adverse reactions is about 16.3% (Table 3). The AUC of 55.7% indicates that model-based classification is only marginally better (5.7%) than classification based on random guessing.

4 | DISCUSSION

In this study we found a significant correlation between the combined presence of HLA subtype-B*08 and HLA subtype-DRB1*03 and

inflammation in a group of patients with dermal fillers. We used clinical signs to distinguish between inflammatory and noninflammatory reactions. Also, we had to rely on patient's clinical history regarding the absence of past adverse reactions. An inflammatory response to dermal fillers develops slowly and insidiously and may even spontaneously subside. In fact, it is conceivable that some of the subjects in the Reference group may develop an inflammatory response later in life or may have had subclinical symptoms. In this context, the HLA subtype-B*08 and HLA subtype-DRB1*03 combination was found in 5% of the Reference group. The expected percentage within the general population in Europe is 1.6%.[28] Also, in the inflammatory group some patients might have had a nonimmunological condition leading to inflammation, that is, bacterial infection of the implant. Therefore, it can be argued that both groups are not homogeneous. Accordingly, in this study positive HLA subtype-B*08 and HLA subtype-DRB1*03 combination has low sensitivity 16.26% and high specificity 95.12%. The HLA combination identifies only one out of six people at risk for an inflammatory adverse event after filler use. Further testing in prospective studies on larger groups and with tighter criteria may reveal higher sensitivity.

For this study HLA class I A, B, and HLA class II DR (and DR subtypes) were selected because of the relationship between HLA-B and HLA-DR and the predisposition to suffer autoimmune and/or granulomatous disorders.[17,19-22]

HLA-C was left out because of its very high polymorphic complexity and very complicated to relate with human pathology.[28] HLA-D or HLA-E appear to play a major role in the viral responses (NK cells and NK-KIR receptors) and in women, with the tolerance degree to embryo-paternal antigens by maternal NK cells and Tregs, but no relation to human diseases have been described as far as we know.[29]

This study suggests a link between specific HLA-subtypes and an immune mediated reaction to a foreign implant, meaning that some persons may be more prone to display a reaction than others based on their immunogenetic profile. We found that people with HLA

subtype-B*08 and HLA subtype-DRB1*03 combination have a 3.8-fold increase in risk of developing inflammatory adverse events due to fillers in clinical practice.

Interestingly, certain auto-immune diseases like inflammatory arthritis are also related to the presence of specific HLA subtypes, in particular HLA-B27 and HLA-DR1-11, DR3, and DR4.[31,32] In addition to this, there is increasing evidence that adverse reactions to implanted materials like scleroderma-like syndromes are also related to certain HLA combinations.[24] Bell et al. demonstrated in 1996 that an increased frequency of HLA-A1, HLA-B1, and HLA-B2 in patients with chronic graft-vs-host disease (cGVHD) who developed scleroderma-like complications.[32] This suggests that a genetic predisposition may be linked to the development of more severe scleroderma-like symptoms in cGVHD. Of note, when looking to our patient group, the presence of the combination of HLA subtype-B*08 and HLA subtype-DRB1*03 was also associated higher rates of fibrotic reactions of the skin. None of the patients from the Reference group did show any of those reactions.

This study on late-onset inflammatory adverse events after dermal fillers injections can be a starting point in genetic research for the prediction of adverse events of dermal filler treatments. This study provides for the first time an in vitro method for the analysis of the genetic predisposition of an individual to develop late onset immune mediated adverse events related to dermal fillers.

In conclusion, this is the first study to show that HLAs B*08 and DRB1*03 is associated with late-onset cutaneous inflammatory adverse events to dermal fillers injection, suggesting an immunological pathway for this problem in some patients. Although this HLA combination may be biomarker for these adverse events induced by biomaterials, larger studies including genetic polymorphisms such HLA subtypes are warranted before they can be used to identify people at risk of developing cutaneous inflammatory adverse events due to fillers in clinical practice.

CONFLICTS OF INTEREST
JA-R and SS have an issued patent related to the use of HLA haplotypes as risk markers of adverse reactions in dermal filler implantations (P201030604).

DATA AVAILABILITY STATEMENT
Data available on request from the authors.

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Fagron Genomics
FillerTest

AVERAGE SPENDING OF CONSUMERS ON FILLER TREATMENTS

- 1 ml filler on average cost €400
- Most common treatments costs (on average amounts of filler used):
  - Lips: between 0,5 and 1ml per treatment – 2 times a year   → 400-800 /y
  - Tears trough: between 0,2 and 0,5ml per tear trough - 1 time a year → 100-200 /y
  - Cheek filler: between 1 and 3ml per cheek – 1 time a yearyear   → 400-1.200 /y
  - Nasolabial folds: between 0,5 and 1 ml for each side – 2 times a year → 400-800 /y
  - Marionette lines: between 0,5 and 1ml for each side – 2 times a year→ 400-800 /y
  - Neck wrinkles treatment: 3x 1ml in period of approx. 3 months, then repeat every year   → 1.200/y
  - "liquid facelift": between 3ml and 6ml per treatment – every 1,5 year approx.   → 800-1.600 /y

- Average woman of 35-65, with medium to high purchase power (approx. 40% of all filler users) spend on average €400 to €1200 per year on filler treatments in the Netherlands (which is the country where people spend less on cosmetic treatments). In the UK and Spain this it is double (€800 to €2400).

- Considering the FillerTest test is for life, spending one time €400 to be sure about your risk of having serious adverse events with filler treatments is considered a low price to pay

Thank You