



## Performance survey on a new standardized formula for oral signal suppression in MRCP

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### ABSTRACT

**Background:** Orally administered substances, which reduce image contamination by overlying gastrointestinal fluid signals, can be used to enhance the quality of MRCP images. Recently, a new standardized formula consisting of biological substances has become available. The objective of this study is to provide a first assessment of achievable MRCP image quality, taste and palatability of this new dedicated agent.

**Methods:** In January 2015 to May 2015 practicing radiologists in Germany, Austria and Switzerland were asked to evaluate image quality as well as taste and palatability when using the new agent (LumiVision<sup>®</sup>; b.e. imaging; Baden-Baden; Germany) in MRCP questionnaire. Both criteria were rated with a 6-point Likert scale ranging from “1” (best) to “6” (worst).

**Results:** A total 185 of 475 radiologic institutions (39%) submitted feedback on image quality, 187 (39%) on the taste/palatability. Assessments of image quality regarding presence of disturbing gastrointestinal fluid signal resulted in a median of 2. The majority of patients rated the subjective taste as very good (median of 1). No side effects of relevance were recorded.

**Conclusion:** This large survey shows that the tested product is considered effective by radiologists regarding MRCP image quality. Patients’ feedback on taste and palatability was very positive.

### 1. Introduction

Heavily T2-weighted (T2-w) sequences in magnetic resonance cholangiopancreatography (MRCP) are used to visualize the fluid in biliary and pancreatic ducts and serve as the non-invasive imaging technique of choice for the evaluation of the biliary and pancreatic ductal system [1–4]. High signal intensity of fluids in the upper gastrointestinal tract, like salivary juice, bile, or pancreas secretions, can obscure ductal structures and cause degradation of image quality even in fasting patients [5]. To avoid misinterpretation or non-diagnostic images in advance, a reduction or better yet elimination of signals caused by fluids in the upper gastrointestinal tract is preferable. Besides fasting prior to the examination, orally administered negative contrast agents with a strong T2-shortening effect and subsequent ability to suppress overlaying high intensity signals are commonly used for patient preparation [6–8]. In daily practice however, such measures are undertaken arbitrarily and applied substances vary from commercially standardized products to regular viands (juices) [7,9–11]. With regard to the existing literature, the ideal oral signal suppressor for MRCP should show an even distribution of the product and the homogenous

saturation of the T2-signal in the upper gastrointestinal tract with good MRCP image quality and proper visualization of the biliopancreatic ductal system [7,8,11–17]. Furthermore, the product should ideally be reasonably priced, widely commercially available and preferably from natural origin [16,18–21]. Good taste, small required amount and a high product safety (low rate of undesirable side effects, good tolerance) are described as beneficial factors for patient compliance [8,10,16,19,20].

LumiVision<sup>®</sup> (b.e. imaging GmbH, bender gruppe, Baden-Baden, Germany) was commercially launched as a potential alternative to existing oral signal suppressants in use today. It is an after European conformity (CE) certified liquid substrate made up of a standardized ratios of pineapple juice concentrate, organic agave syrup, black currant juice concentrate, water, and guar gum (thickening agent) and defoamers [22]. The product is designed to sufficiently homogenise and suppress image signals from the gastrointestinal system in T2-w MRCP, and to ensure adequate image quality of the pancreatobiliary ductal system (Fig. 1).

The purpose of this study was to provide a first assessment of MRCP image quality, taste and palatability of a new oral signal suppressant.

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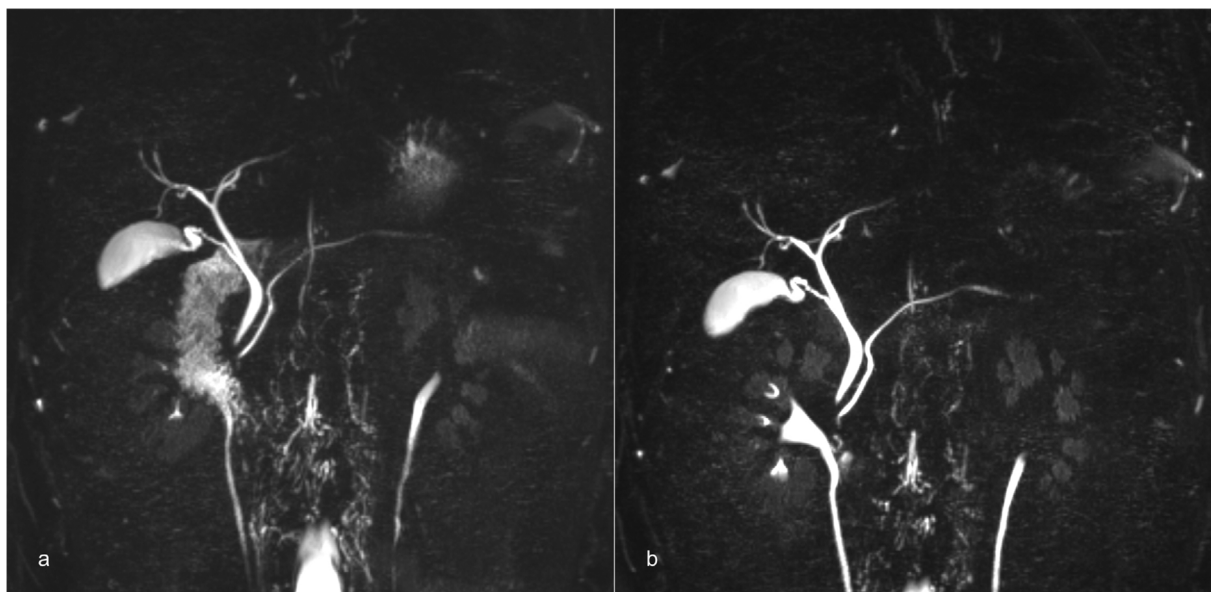


Fig. 1. MRCP obtained without (a) und with (b) newly introduced oral signal manipulator (healthy volunteer). Without contrast agent (a), high intensity signals in stomach and duodenum cause superposition of the pancreatic and biliary ductal system, which are reduced in MRCP with contrast material (b).

## 2. Material and methods

From January 20th, 2015 to May 8th, 2015, 487 radiological institutions in Germany, Austria, and Switzerland were asked to take part in the assessment of a newly introduced oral contrast agent for routine diagnostics. No payments were made or promised to any of the participating institutions. All participating facilities fulfilled the following criteria: MRI system with dedicated MRCP sequences, magnetic field strength of 1,5 T or 3 T, and a minimum of n = 20 MRCPs performed monthly.

98% of the contacted institutions confirmed to have received product samples (n = 475). Overall, 762 free samples of the contrast agent were distributed. The majority of the institutions received 1–2 bottles of the product (Table 1). Three or more bottles were delivered to 20 of the 475 institutions (4%). Application instructions were provided along with the product information [22]. An adult patient was recommended to drink a mixture of one bottle of the substance (250 ml) and the same amount of water (250 ml) approximately 20–30 min prior to the examination. Fasting periods prior to the examination were left to the discretion of the radiologist. The execution of the examination by general radiologic standards was assumed.

The radiologists were asked to fill out a brief questionnaire on image quality and taste/palatability. The image quality was graded on a Likert scale ranging from “1” to “6”; “1” corresponding to very good diagnostic image quality or very good signal elimination of the upper gastrointestinal tract; “6” corresponding to poor diagnostic image quality or a poor signal elimination of the upper GI tract. The patients’ subjective taste and palatability experienced after oral intake of the product were directly assessed by the radiologist. Taste and palatability were combined into one criterion as subjective taste of the product is bound to directly influence the patients’ willingness to drink the required amount of the product. The radiologist recorded the results on a Likert scale ranging from “1” (very good taste) to “6” (poor taste or not palatable). Considerable undesirable side effects, such as diarrhoea, aches, cramps, or similar reactions were also noted and included in the

grading category “6” (Table 2). Both spontaneous and subsequently reported observations concerning both image quality as well as taste and palatability were to be recorded in free text form.

The questionnaire were statistically analysed using Microsoft® Excel for Mac (Version 15.33), all results are provided as median and range for each criterion.

## 3. Results

In total, 185 out of the 475 radiological institutions that received samples of the new product provided feedback regarding image quality (39% response rate). 187 radiological institutions (39%) provided feedback concerning taste and tolerance of the product. 31 institutions added free text comments (7%); 16 comments concerned image quality, 7 concerned the subjective taste or tolerance of the product, and 11 were general or abstract comments. All institutions reported correct application of the signal suppressor as specified by the manufacturer. None of the institutions noted the use of more than one bottle of the substance (250 ml) and the same amount of water (250 ml) per patient.

Overall, 57 radiological institutions (31%) rated the image quality after administering the contrast agent as “1, very good”, while 91 institutions chose category “2, good” (49%; median, 2; range, 1–6; Fig. 2). Comments concerning image quality, especially with regard to the degree of signal suppression, ranged from confirmation of reliable signal suppression to low effects and missing signal manipulation despite dosage according to the provided product information (n = 1). One institution reported poor signal suppression based on an inadequate waiting period between oral administration and the examination. Two facilities mentioned inferior signal suppression by the product compared to personal experience on ferumoxsil (n = 2; 1%).

The criterion “taste and tolerance” was rated as “very good” in 111 of 187 institutions (59%) and as “good” in 65 (35%; median, 1; range, 1–4; Fig. 3). Free text comments by the participating radiologists included one report of slight diarrhoea after the examination. Another facility emphasized the relatively high level of containing bread units

Table 1

Overview of the amount of provided samples of the contrast material per contacted radiologic institution (in n and %).

Number of the provided samples per radiologic institution	1	2	3	4	5	6	7	8
Number and percentage of radiologic institutions with received sample	231 (49%)	224 (47%)	8 (2%)	8 (2%)	1 (0%)	1 (0%)	0 (0%)	2 (0%)

**Table 2**  
Categories for the assessment of the subjective taste and tolerance of the new contrast material.

Scale		Observations or annotations concerning taste and tolerance of the new contrast material
1	Very good	No comments on the part of the patient or the evaluating radiologist whatsoever
2	Good	Patient had merely insignificant/nonspecific comments, e.g. a dislike to the taste
3	Satisfactory	Patient had few concrete comments, e.g. excessively sweet taste. However, no problems in compliance occurred
4	Adequate	Patient was only able to drink parts of the provided amount of agent. No further observations of unpalatability
5	Inadequate	Agent caused discomfort or any other reactions of intolerance with fast remission
6	Poor/not palatable	Considerable diarrhoea, aches, cramps or similar reactions. Any report of undesirable side effects.

(BU) per bottle (6.5 BU [22]) compared to blueberry juice, which is typically used at this particular institution and which contains only 3 BU. No relevant undesirable side effects were recorded.

**4. Discussion**

This study presents the results of a survey on a newly introduced and recently certified oral signal manipulator for MRCP in routine diagnostics, which is commercially available in Europe. The product was considered effective in improving image quality of MRCP by the participating radiologists. Patient feedback on taste and palatability was very positive.

The introduction of a new product with characteristics of an ideal signal suppressor in MRCP would be desirable, since all other substances in use are neither standardized, nor certified, officially approved or commercially available in Europe at the moment [8].

The assessment presented herein addresses the performance of such a product in routine diagnostics of a representative sample in Switzerland, Austria and Germany. The assessment categories, the questioning of patients and the objective evaluation of palatability of the product are methodical and acceptable to assess the combined criterion “taste/palatability”. In regard to the criterion “image quality”, the study design allowed only for a qualitative analysis with pragmatic scores. This approach is comparable to a majority of studies published on this topic to date [9,11,12,14,15,18,20,23–26].

The majority of the participating radiologists graded the criterion “image quality” as good and very good (median, 2 (“good”)). Previous studies on image quality in MRCP after the intake of pineapple juice, which is one of the components of LumiVision®, and other fruit juices, such as acai and blueberry juice, show varying results. Most of the studies indicate an improved image quality after oral intake of one of the juices mentioned above due to an efficient elimination of superimposing signal from the gastrointestinal tract and a significantly better

delineation of biliopancreatic ductal structures [11,16–18]. However, some authors describe no improvement of visualization of the pancreatic duct, intrahepatic ducts or gallbladder compared to MRCP without an oral contrast agent [11,16,18]. The degree of improvement of overall image quality seems to depend on the iron or manganese content, type of juice, and manufacturer [9–11]. One the one hand, the existing literature states that the image quality of MRCP after the intake of pineapple juice is comparable to the image quality of MRCP with ferumoxsil [9]. On the other hand, it also has been shown that pineapple juice is less effective in suppressing fluid signal from the upper gastrointestinal tract compared to ferumoxsil [19]. These findings are in line with the observation that some of the participating radiological institutions made, indicating weaker signal suppression of the new product compared to personal experience with ferumoxsil. However, possible causes for the weaker signal suppression effects (e.g. waiting periods after oral intake too long/short, lack of movement in waiting intervals, lack of fasting, variation of applied amount or concentration, inadequate suspension/mixture with water) were not recorded by the participating institutions. Thus, this first qualitative assessment shows promising results, which are in line with the results of published studies on image quality of pineapple juice, one of the contents of LumiVision®. A comparison of LumiVision® to ferumoxsil, which is known to be effective and was widely used before ceasing commercial distribution, is currently underway.

Patient compliance is another important factor for image quality as it influences the amount of agent ingested by the patient. Also, taste and palatability are responsible for patient acceptance in repeat examinations. The previously widely used contrast agent ferumoxsil, which contains nano-sized iron oxide crystals coated with siloxane, is appreciated for its’ capability to improve of image quality in MRCP, but also known for a displeasing, metallic taste. The latter decreases patient compliance and leads to an incomplete consumption of the product prior to the examination [7,9,10,19]. No significant undesirable side

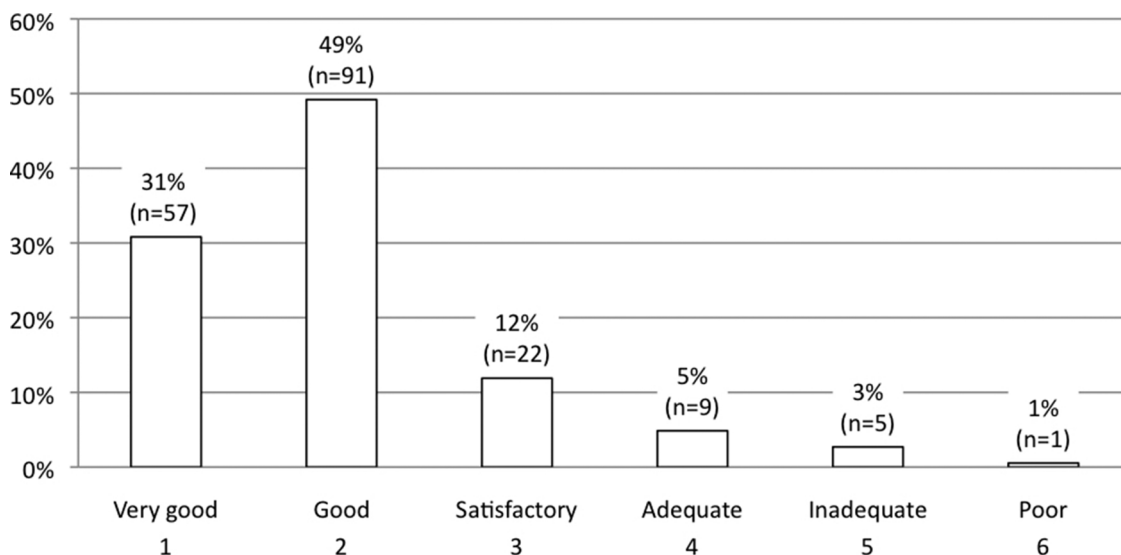


Fig. 2. Assessment of the image quality itemized by the amount of responses (in% and absolute number (n)) compared to each category of the evaluation scale.

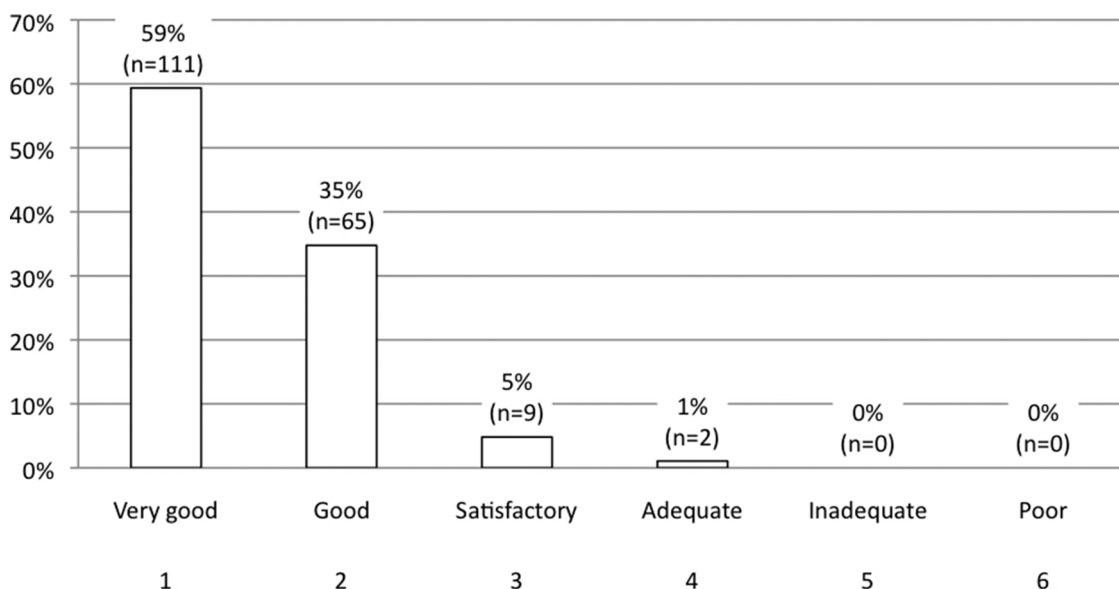


Fig. 3. Assessment of the subjective taste and tolerance itemized by the amount of responses (in% and absolute number (n)) compared to each category of the evaluation scale as described in Table 2.

effects after the intake of LumiVision® were noted in the conducted questionnaire survey, which is likely due to the fact that it is made up of mostly fruit juices. The assessment criteria “taste” and “tolerance” reached very good results (median, 1) and no relevant impairment of patient compliance was mentioned. Hence, the new product fulfils important characteristics of an ideal oral signal suppressor for MRCP. One participating radiologic institution was concerned about the product’s relatively high BU per bottle so that the evaluation of patient acceptance, especially in diabetic patients, is necessary at a larger scale.

Limitations of the presented study include a possible selection bias of institutions, the relatively low response rate, the small number of administered doses regarding the expectedly low rate of adverse effects, the small number of samples per institution meaning that some institutions just evaluated one patient (considering the dosage of 250 ml contrast agent (1 bottle) per patient) was employed), and the subjective scoring system. The examination procedure was assumed to be in line with radiologic standards, however the actual circumstances of each examination were not documented in detail (e.g. amount of the used product, time between intake and examination, status of fasting etc.). Signal quantification and systematic comparisons with native MRCP or other substances were not performed; this, however, is not possible with a broad survey-based investigation like ours. Such an approach is limited to single institutions [7,13,16,17,21,27]. All of these limitations seem acceptable considering that this survey-based study lays out a representative opinion of radiologic experts in Germany, Switzerland and Austria, and provides the legitimacy, as well as the foundation for further studies with a more quantitative and objective approach.

## 5. Conclusions

According to the results presented in this paper, the newly introduced agent is suitable to achieve sufficient gastrointestinal fluid signal suppression on MRCP images. The new product was also rated as “good” to “very good” by patients concerning taste and palatability, which could improve patient compliance. Further studies with a more quantitative and objective approach regarding the image quality and efficacy of the product would be desirable to underline whether or not the product is coequal to already known oral contrast agents.

## Conflict of interest & funding

A. Frisch, B. Hamm, and T. Denecke rendered an expert opinion for the Federal Joint Committee on the quality assessment of LumiVision® conducted by b.e. imaging GmbH. T. Denecke received honoraria for product related scientific presentations.

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