Standardisation of Ambulatory Urodynamic Monitoring

Report of the Standardisation Sub-committee of the ICS for ambulatory urodynamic studies.

Committee

Ernst van Waalwijk van Doorn (Chairman)
Kate Anders
Vik Khullar
Sigurd Kulseng-Hanssen
Francesco Pesce
Andrew Robertson
Derek Rosario
Werner Schafer

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1. INTRODUCTION

Ambulatory urodynamic monitoring (AUM) has become an established method of investigating lower urinary tract function. This report recommends standards for terminology, methodology, analysis and reporting of AUM in a uniform fashion to facilitate communication between investigators and to improve the quality of clinical practice and research. The document can be integrated with earlier reports of the International Continence Society committee on Standardisation with special reference to the collated ICS report from 1988 (1) and the ICS recommendations on good urodynamic practice (2).

AUM in contrast to conventional urodynamic studies frees the patient to be more independent of fixed urodynamic apparatus. This allows the patient to perform those activities that, he or she knows from experience, will provoke troublesome urinary symptoms.

2. INDICATIONS FOR AUM

- Lower urinary tract symptoms which conventional urodynamic investigation fails to reproduce or explain
- Situations in which conventional urodynamics may be unsuitable
- Neurogenic lower urinary tract dysfunction.
- Evaluation of therapies for lower urinary tract dysfunction.

3. TERMINOLOGY

The terminology applied to observations during AUM should wherever possible be consistent with terminology used during conventional urodynamic investigation.

3.1 Definitions

An Ambulatory Urodynamic investigation is defined as any functional test of the lower urinary tract predominantly utilising natural filling of the urinary tract and reproducing subject's normal activity.

The terms introduced by this definition are further explained below.

Ambulatory
This refers to the nature of monitoring rather than the mobility of the subject. Monitoring will usually take place outside a urodynamic laboratory.

Natural
This refers to the natural production of urine rather than an artificial medium. Stimulation by forced drinking or pharmacological manipulation must be stated in the methodology.

Remark: The bladder may be pre-filled with an artificial medium but this is not comparable with natural bladder filling. This method of investigation needs further evaluation.

Normal activity
Refers to the activities of the subject during which symptoms are likely to occur. These may include manoeuvres designed specifically to identify the presence of involuntary detrusor or urethral behaviour or to provoke incontinence.

9. METHODOLOGY

9.1 Signals

The following signals have been recorded by AUM
Pressure: intravesical
abdominal
urethral
intrapelvic (renal)
Flowrate
Micturition volume
Urinary leakage
Leakage volume
Urethral electrical conductance
Perineal integrated surface electromyography

As examples of AUM investigations, which have been established home uroflowmetry and ambulatory cystography can be mentioned: the first recording the flow(time) signal the latter at least recording the intravesical and abdominal pressure(time) signals

Additional information that should be recorded during any AUM investigation as event markers representing the following phenomena:

- initiation of voluntary voids
- cessation of voluntary voids
- episodes of urgency
- episodes of discomfort or pain
- provocative manoeuvres
- time and volume of fluid intake
- time and volume of urinary leakage
- time of pad change

4.2 Signal quality

AUM is more versatile than equivalent conventional urodynamic investigation, but for the same reasons AUM is associated with a greater risk of losing signal quality. Therefore although all signals should be recorded as recommended in the ICS recommendations on 'Good Urodynamic Practice', there are a number of cautions which apply specifically to AUM. These are described below.

4.3 Intravesical and Abdominal Pressure measurement

Although it is possible to measure intravesical and abdominal pressures using fluid-filled lines (water or air), the use of catheter mounted microtip transducers allows greater mobility during AUM. In the absence of continuous supervision, stringent checks on signal quality should be incorporated in the measurement protocol. At the start of monitoring, these should include testing of recorded pressure on-line by coughing and abdominal straining in the supine, sitting and erect positions. The investigator must be convinced that signal quality is adequate before proceeding with the ambulatory phase of the investigation. Prior to termination of the investigation and at regular intervals during monitoring similar checks of signal quality such as cough tests should be carried out. Such tests will serve as a useful retrospective quality check during the interpretation of traces. The following considerations must be taken into account when using microtip transducers:

- Transducers should be calibrated prior to every investigation.
- The “zero point” is atmospheric pressure (there is no fixed reference point). All transducers must be “zeroed” at atmospheric pressure prior to insertion of the catheters.
- Water filled pressure catheters have a fixed reference point at the upper edge of symphysis pubis whereas catheter mounted microtip pressure transducers have no fixed reference point.
- Microtip transducers will record direct contact with solid material (the wall of a viscus or faecal material) as a change in pressure. The use of multiple transducers may eliminate this source of artefact
- Under some circumstances, the pressure measured at the transducer surface will result in a discrepancy equal to the difference in vertical height between the two transducers. This can result in the estimated detrusor pressure being less than zero (i.e. negative) with, for instance, the patient in the supine position (see fig. 1 and 2).

4.4 Urethral pressure and conductance

The recording of urethral pressure is a qualitative measurement with emphasis on changes in pressure rather than absolute values. The use of urethral electrical conductance to identify leakage in association with pressure monitoring facilities interpretation of urethral pressure traces. Precise positioning and secure fixation are essential to maintain signal quality. The orientation of the transducer should be documented.

Remark: The use of multiple pressure transducers facilitates identification of movement artefact but increases catheter stiffness and thereby deformation of the urethra during recording.

4.5 Catheter fixation

As specified earlier, secure catheter fixation is essential to maintain signal quality. Methods that have been used include adhesive tape, suture fixation and purpose designed silicone-fixation devices

4.6 Recording of urinary leakage

The method of urine leakage determination should be recorded. It should be stated whether the urinary leakage is recorded as a signal with the pressure measurements, is dependent on the subject pressing an event marker button or completing a urinary diary.

4.7 Instructions to the patient

Detailed instructions as to recording of symptoms, identification of catheter displacement and hardware failure should be given to the patient. It is the recommendation of this group that such verbal instructions should be reinforced by written instructions and in addition to the hardware built into the system, the patient is provided with a simple diary to record events. This allows the common primary aim of all urodynamics i.e. to correlate the test outcome with symptoms.

5. ANALYSIS

5.1 Quality assessment

The first step in the analysis of an AUM traces is the assessment of the quality of data recorded. The specific points that should be addressed with regard to pressure measurement are:

- Is the trace “active” i.e. fine second to second variation in pressure rather than a fine line?
- Is the baseline static or highly variable?
- Are the cough tests or other activities causing abdominal pressure changes that can be used for signal plausibility check, regularly present?
- Is the subtraction adequate, e.g. minimal change in subtracted detrusor pressure with coughing?

If the technical quality of the traces is less than perfect, then, although the investigation may yield valuable clinical information, in the context of accurate measurement, the pressure recordings must be viewed as qualitative and further quantitative analysis can be flawed.

5.2 Phase identification

Depending on the purpose of the investigation, markers must be placed to identify voluntary voids and allow differentiation of such events from involuntary events, which may be associated with changes in recorded pressure. The protocol of the investigation should specifically state the point at which the markers identifying commencement and cessation of a voluntary void are placed. Analysis of the voiding phase follows the same principles and terminology used during conventional pressure-flow investigation.

5.3 Events

The use of a patient diary considerably improves the detailed analysis of events occurring during AUM and is strongly recommended. The events usually recorded during AUM have been identified in section 4.1. Typical events occurring during the filling phase are detrusor contractions, urethral relaxations and episodes of urgency and incontinence.

Remark: *At least for research purposes it is strongly advised to define and validate variables for quantitative interpretation. Validation means to establish data on healthy volunteers and specific patient groups, test retest reproducibility, interrater validity and sensitivity to treatment modalities.*

6. CLINICAL REPORT

The report should be tailored to the urodynamic indication(s) and can include the following:

Indication(s) and/or urodynamic question(s) (*obligatory*)

- Duration of recording
- Fill rate, timing, method and volume of any retrograde filling prior to commencing AUM
- Dose and timing of diuretics if administered
- Volume of fluid drunk during the test
- Number of voids
- Total and range of voided volumes and post micturition urinary residual
- Episodes of urgency, urinary incontinence and pain
- Detrusor activity during the filling phase (frequency, time, duration, amplitude, area, form)
- Pressure/flow analysis
- Results of provocative manoeuvres employed during the test
- Reasons for termination of recording if prematurely terminated

7 SCIENTIFIC PRESENTATION

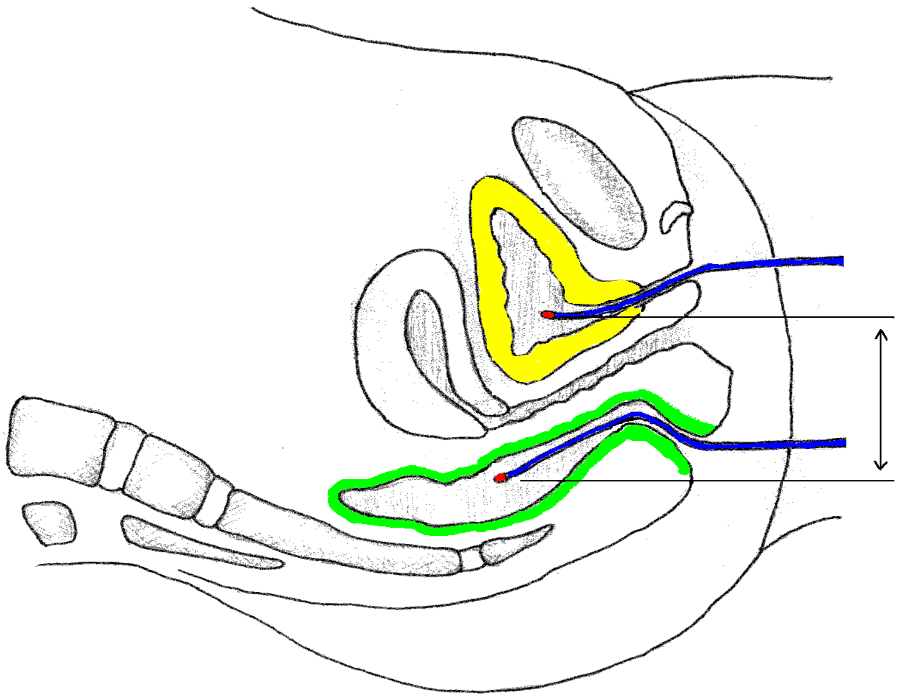
To facilitate clear communication and evaluation regarding AUM the following guidelines should be applied:

Description of AUM protocol which should include:

- Planned duration of recording
- Actual duration of recording
- Specification of recording device i.e. manufacturer, type, sampling rates, events button(s)
- Catheter – type, transducer, location, route and fixation technique
- Leakage detection method or device
- Urinary flow transducer
- Protocol for diuresis
- volume and timing of fluid drunk during test
- dose and timing of diuretics administered
- Fill rate, timing, method and volume of any retrograde filling before or during AUM
- Events recorded by diary or electronic markers
- Detrusor activity during the filling phase with any associated urgency, incontinence and pain
- Pressure/flow analysis (according to ICS standards)
- Any provocative manoeuvres employed during the test
- Reasons for premature termination of recording
- Presentation of urodynamic curves should include:
    - channel identification
    - Units of measurement
    - minimum scale for pressures should be two millimetres per five centimetres of water
    - minimum scale for time should be four centimetres per minute

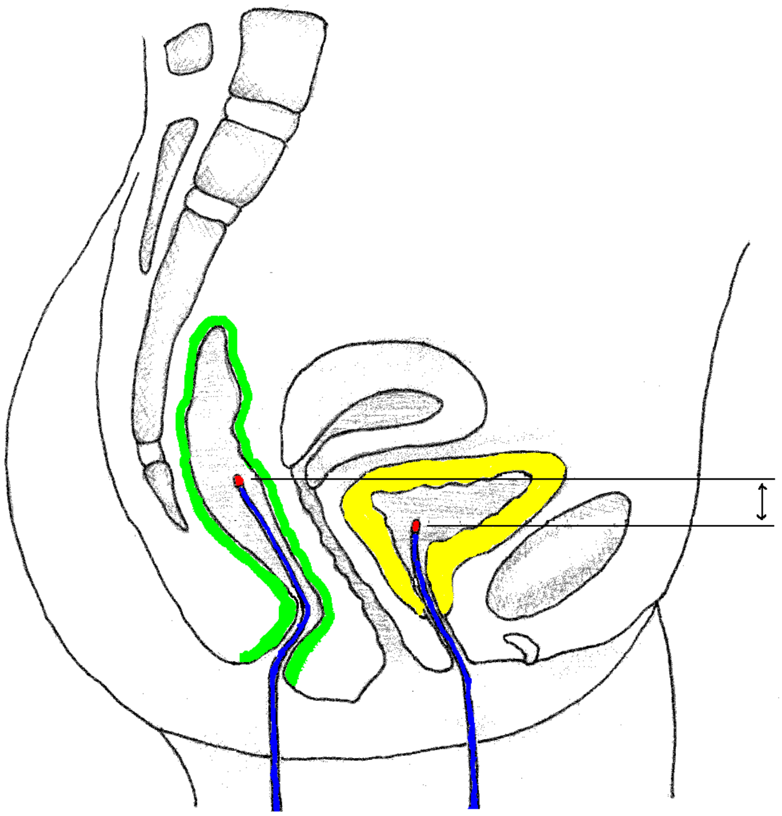
References

1. Abrams P., Blaivas J.G., Stanton S.L., Anderson J.T. The standardisation of terminology of lower urinary tract function. Scand J Urol Nephrol Supp 114: 5-19, 1989
2. Good urodynamic practice (in preparation)



10.

Fig. 1 The difference in reference level between the vesical and rectal pressure sensor in supine position is shown schematically.



11. 8. EXPLENATORY EXAMPLES

This chapter aims to support this report and stimulate the further growth of use of AUM by giving examples of AUM traces with specific events. The examples with the explanatory text will also help to increase ones ability to interpret AUM traces (see fig. 3 – 13).

General information on traces:

- The analysis of AUM traces asks for the ability to look at different time and signal scales. To study these examples, it is necessary to look every time at the x an y-axis scales and the pressure ranges.
- Every example shows from top to bottom: the intravesical, abdominal (rectal), detrusor (subtracted) and urethral pressure signals followed by two urethral conductance signals (proximal and distal)
- For recording Gaeltec micro transducer catheters (5 French) and a Gaeltec MPR3 recorder is applied with the maximum sample frequency for storage set at 16 Hz.
- At the bottom of each figure, one can see which window, where in the complete investigation, is shown.
- Filling and voiding phase are separated by event markers (‘E’) at the x-axis.
- Detrusor contractions are indicated by a bar under the contraction curve.

Text to figures:

Fig 3 Typical traces of a double and single cough in supine position at 16 samples per second (x-axis 7 seconds).

Fig 4 On the left, typical traces of a contraction of the urethral sphincter mechanism, followed on the right by squeezing again combined with a change in position causing displacement of urethral sensor

Fig 5 in the middle typical movement artifact on the urethra pressure trace, causing sensor displacement; after the movement artifact the urethra pressure level has decreased. The conductance signals show an increased level indicating a displacement of the catheter towards the bladderneck.

Fig 6 Typical traces showing walking (first half), respiration (third quarter), walking (last quarter). Of course, the pressure waves caused by breathing can also be detected during walking. Generally it can be stated that the pressure waves due to respiration are affected by the type of respiration, the physical activity and patient's stature.

Fig 7 Typical abdominal and detrusor traces during rectal activity. Here, the patient is at rest and hardly any effect of respiration can be detected in the traces.

Fig 8 This example shows the traces during about 90 seconds. Because the sample rate for the pressure signals is 16 Hz it is not possible to plot every single sample value in the trace. The double lines represent the envelop of the pressure signals. This means, at every dot on the x-axis, the minimum and maximum pressure values of the time interval, represented by that dot, are plotted.
In this plot we see a sequence of events: the patient is sitting (left), stands up (movement artifact urethra signal and abdominal activity in the vesical and abdominal traces), walks a few steps (difference between double lines increases). At the cursor position a 'reaching' phenomenon is seen, where the urethra sensor moves shortly towards the highest pressure region in the urethra and at the same time the abdomen is enlarged causing a pressure dip in the vesical and abdominal pressure signals. At 11:10:40, 11:11:10 and 11:11:25 a same kind of movement phenomenon can be seen. In between the patient walks some steps. At 11:11:30 the patient sits again.
The next two figures show the same events in detail.

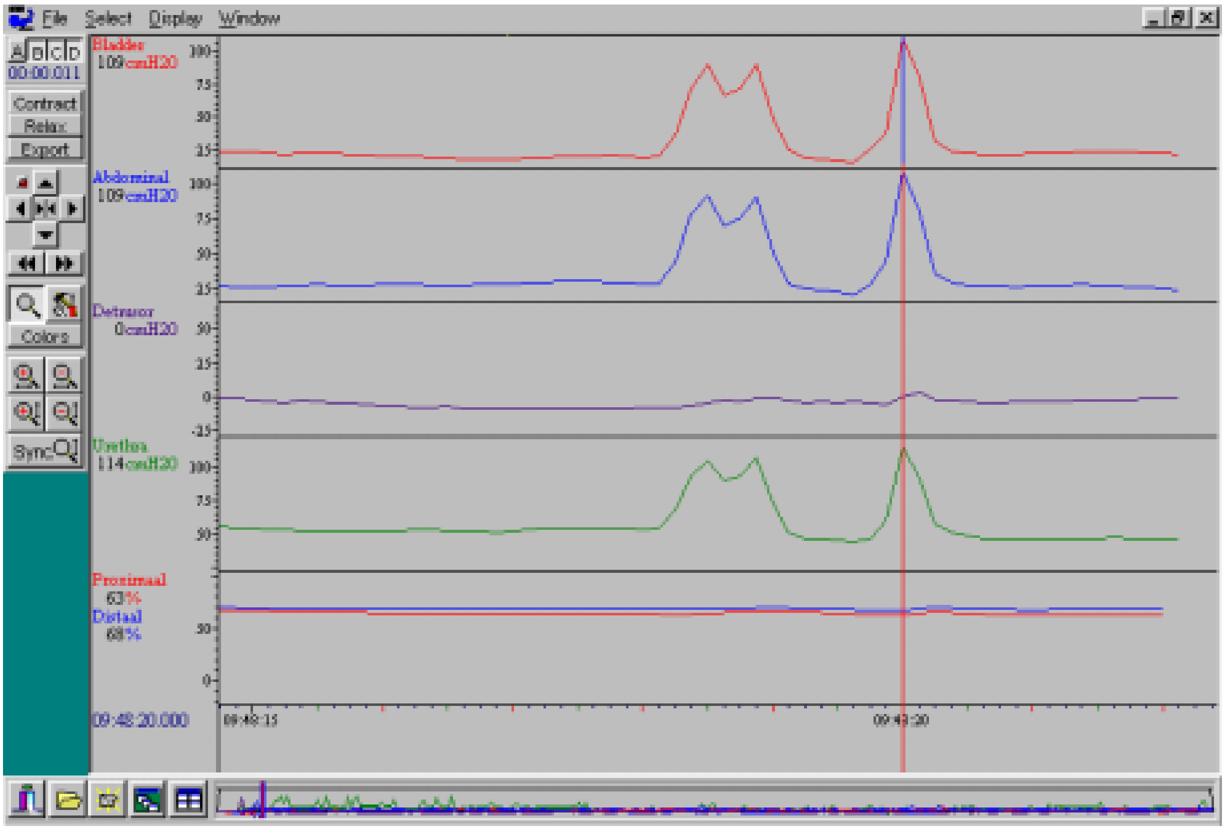
Fig 9 and 10 These traces show the sequence of events described at fig . 6 in detail. Depending on the patients activity and the signal quality on should choose an adequate time resolution for analysis.

Fig 11 On the left, walking a few steps followed by a reaching movement artifact can be detected, causing a pressure dip in the vesical and rectal traces and a positive wave in the urethral pressure and conductance; at the cough pressure peak there is decreased transmission towards the urethral sensor, due to distal position of the urethral sensor. That the urethral sensor is displaced distally can be concluded, because there is no change in urethral conductance signals during the cough.

Fig 12 This example shows the most common sequence of events in a patient suffering from bladder overactivity and imperative voiding. On the left the traces start showing with walking, followed by a urethral relaxation and detrusor contractions. Then walking towards the toilet with increasing detrusor activity with a moment of urine loss (see conductance signals). Finally the patient enters the toilet at the E-vent mark (bottom).

Fig 13 This traces show the continuation of the previous figure; the patient enters the toilet with detrusor activity continuing, sits down and a nice urethra relaxation and voiding contraction can be seen, while the conductance curves show the flow phase. At the end of the voiding the urethra closure pressure recovers to the pre-voiding level.

####### THE FOLLOWING FIGURES HAVE TO BE NUMBERED FIG 3 – 13 #####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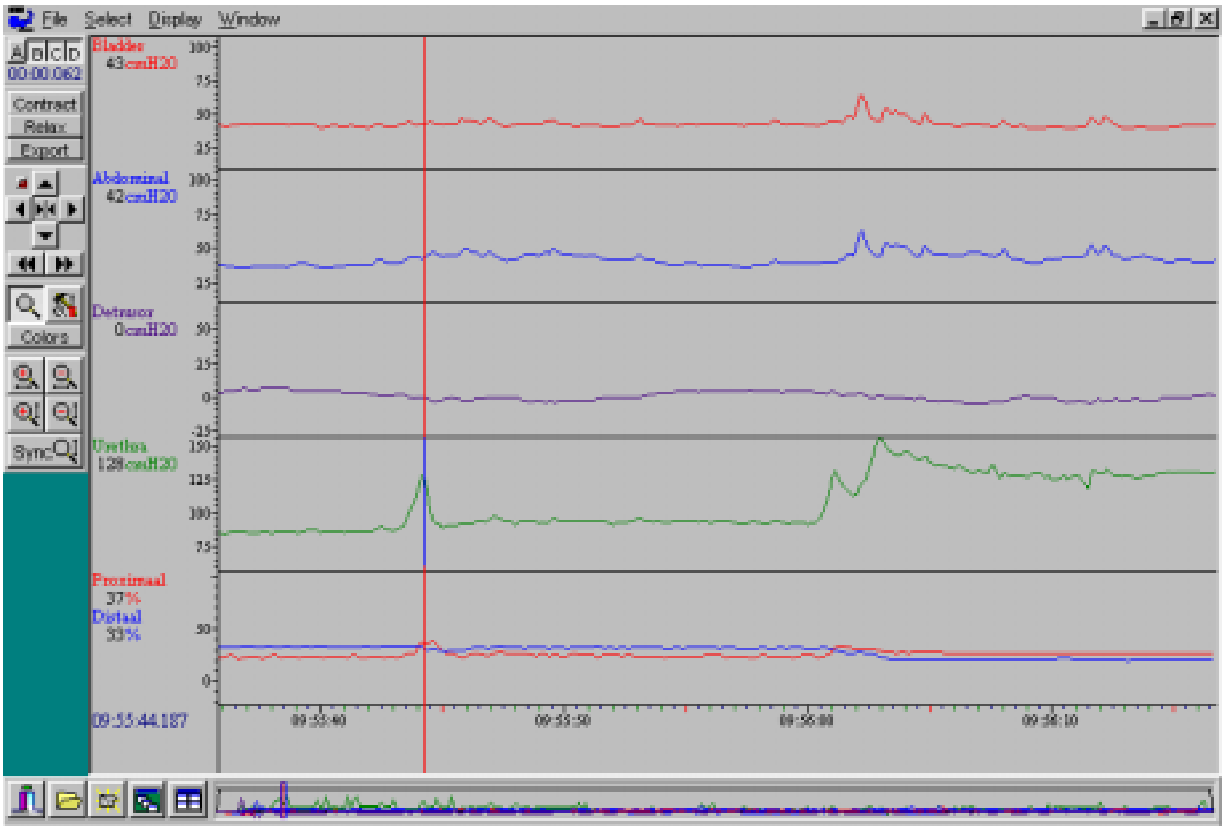
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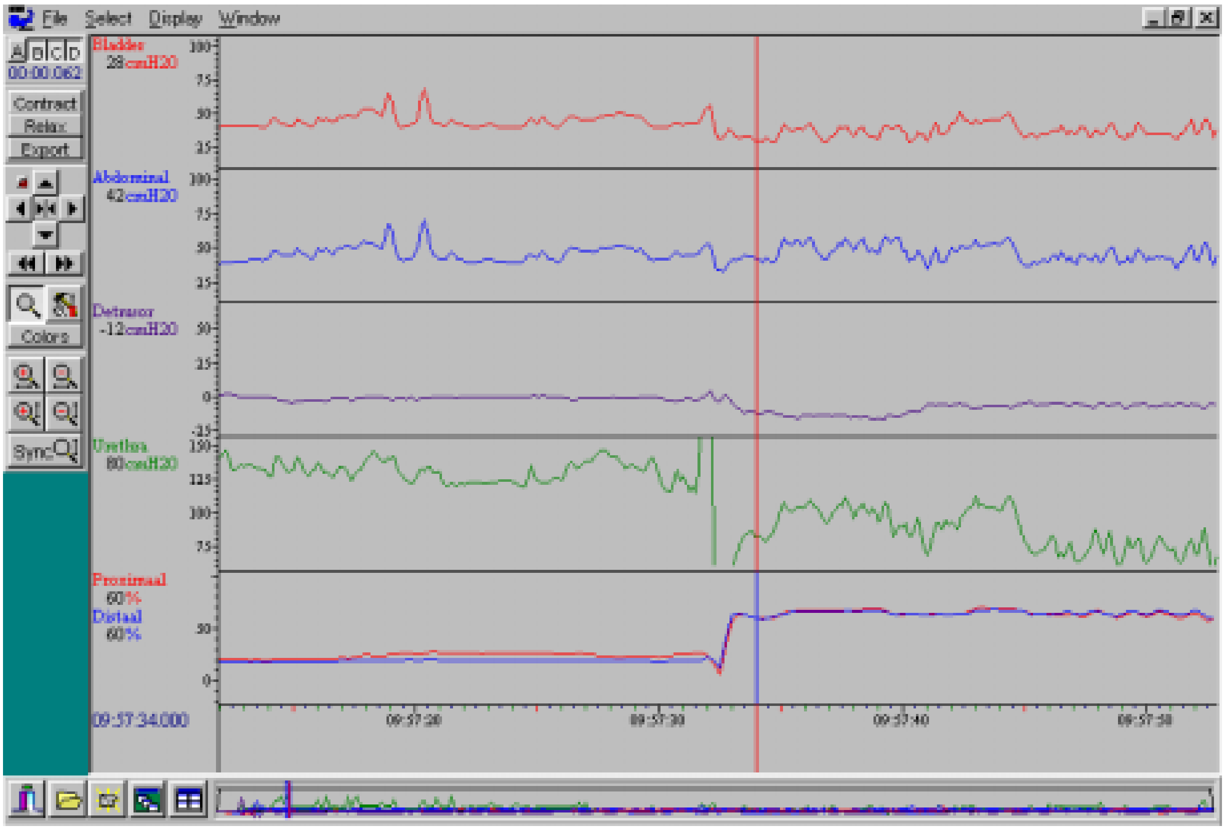
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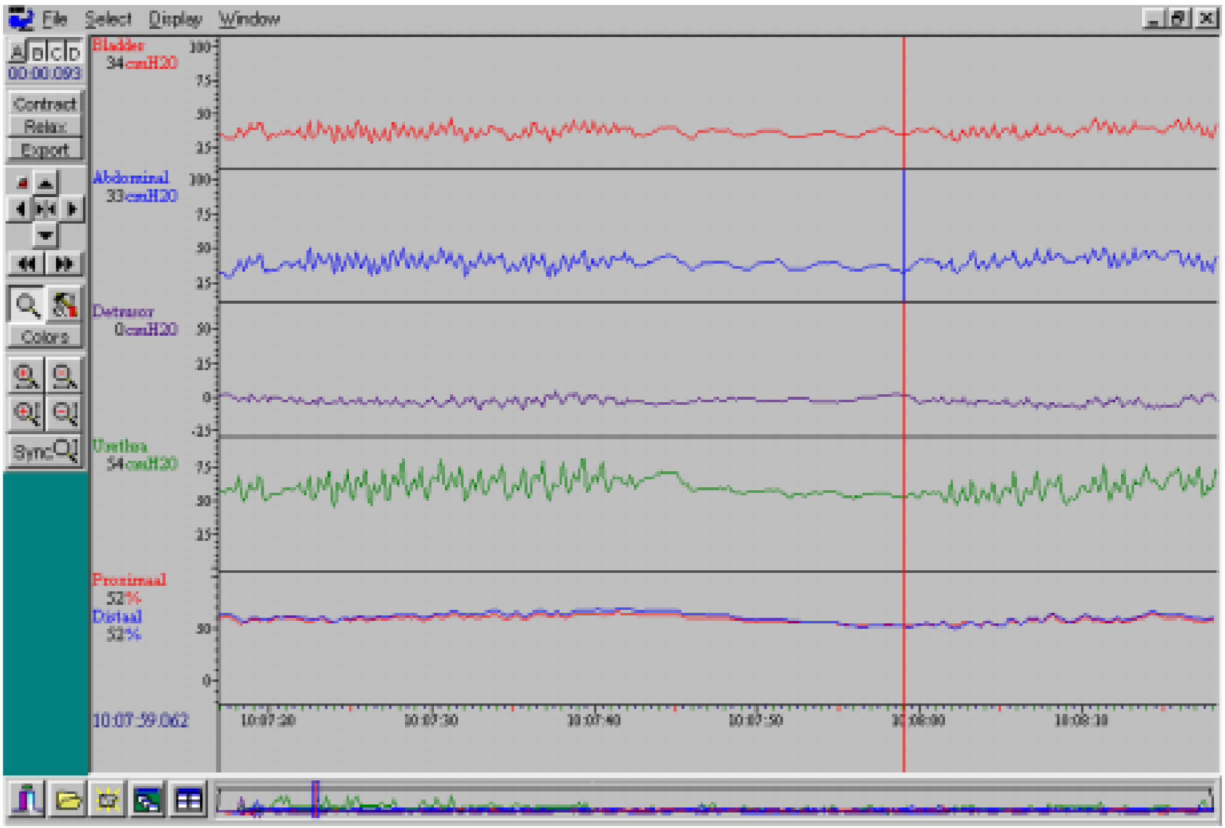
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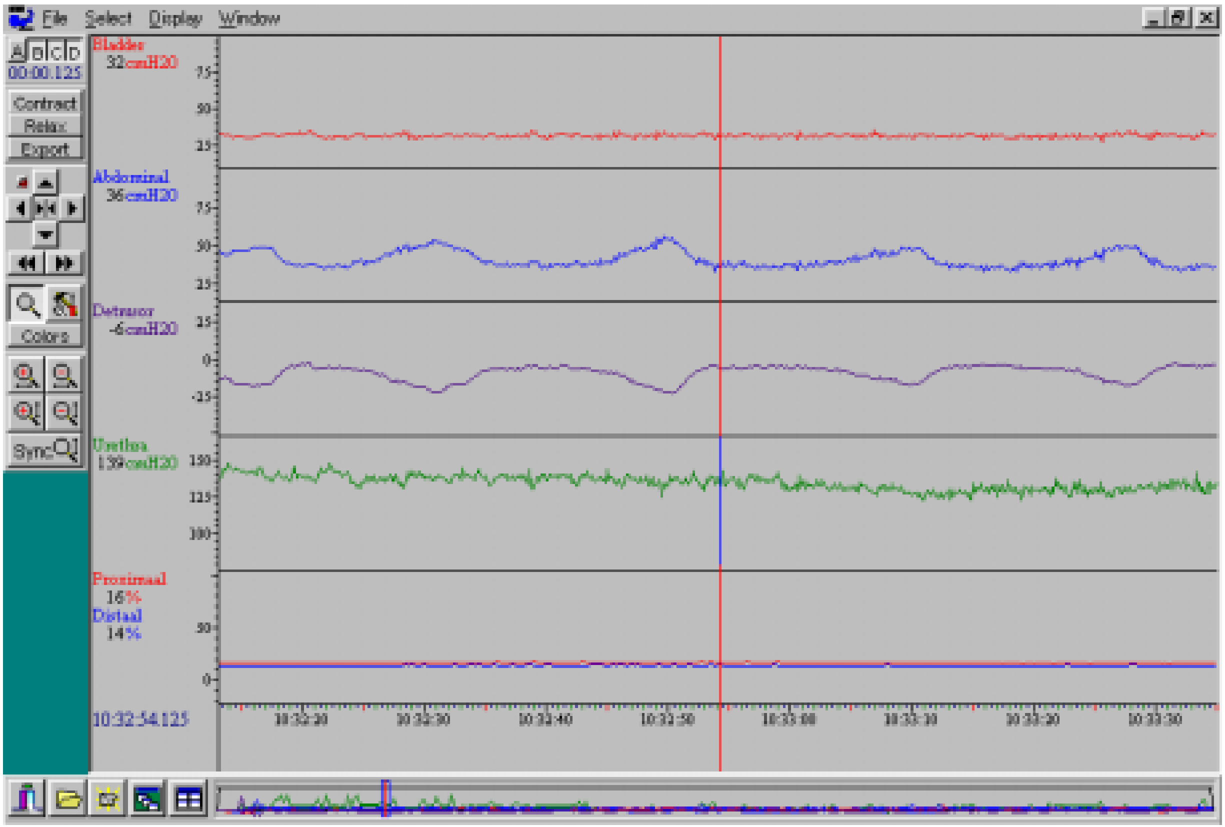
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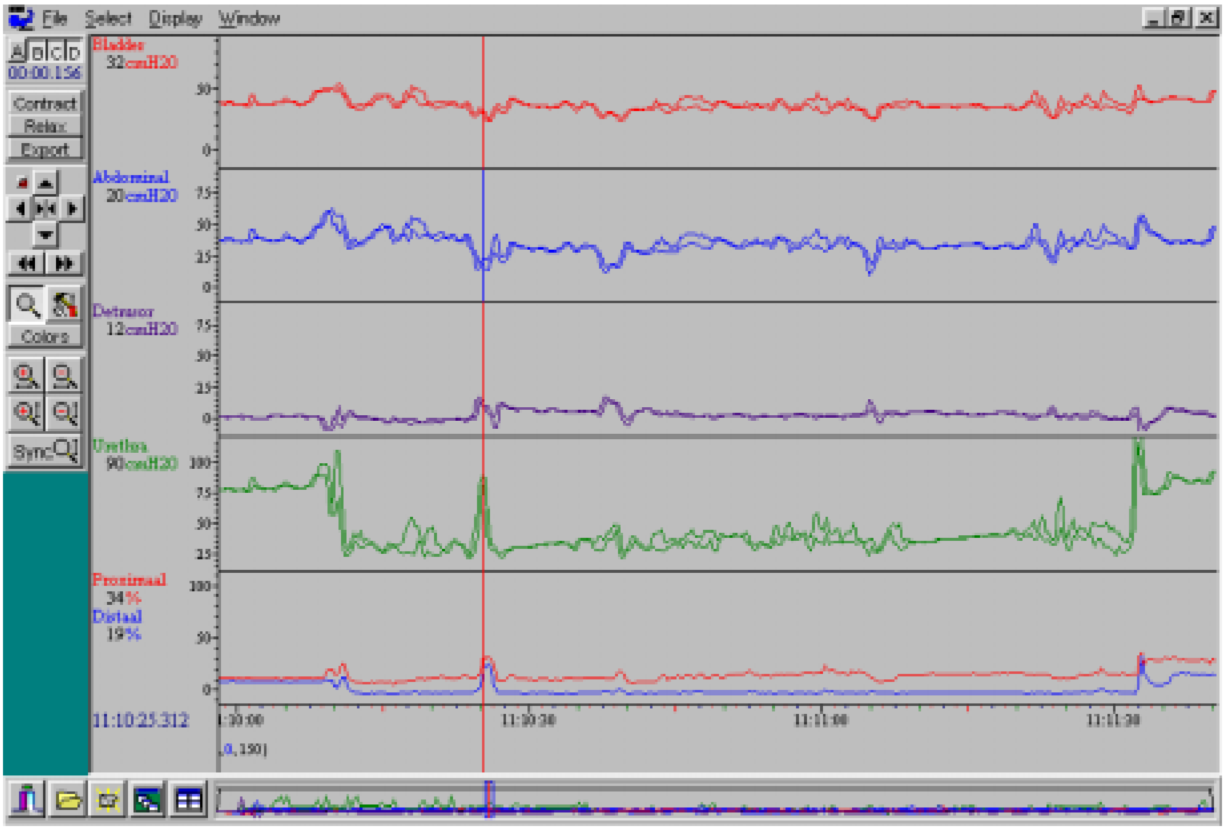
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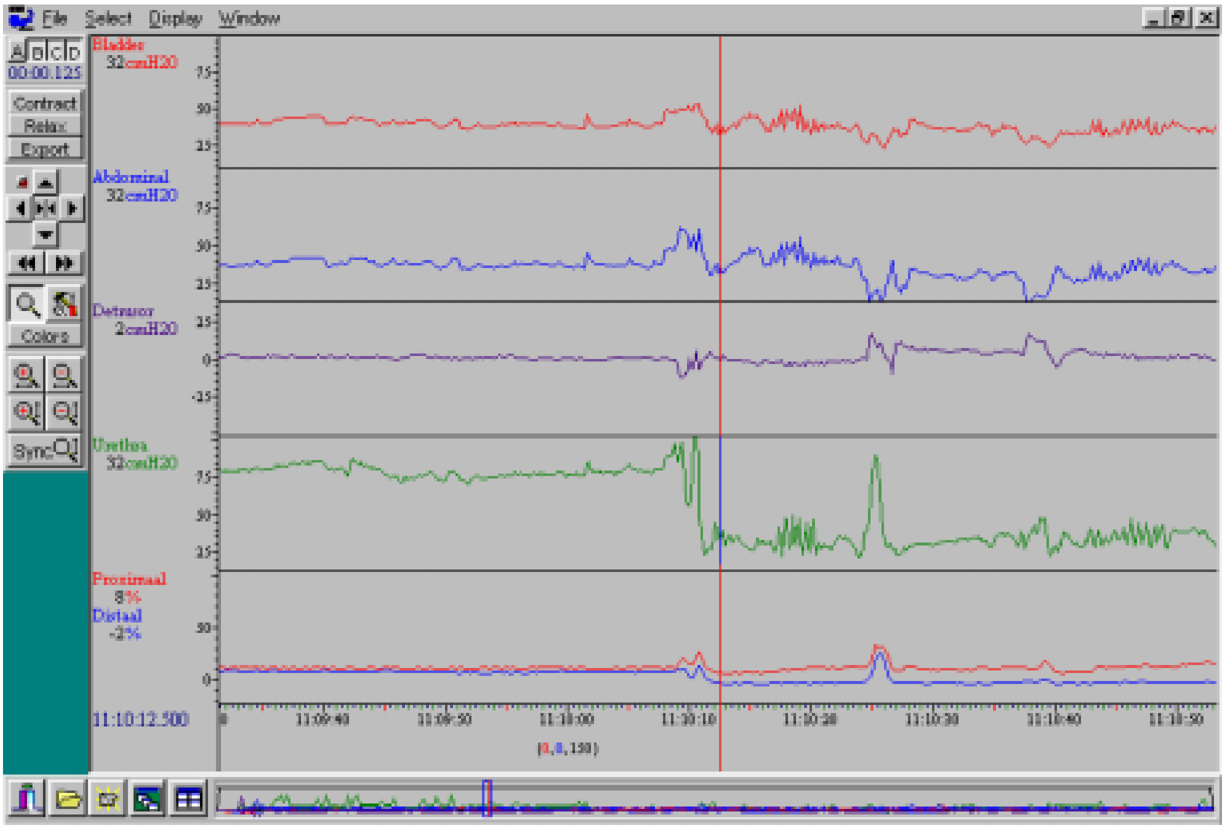
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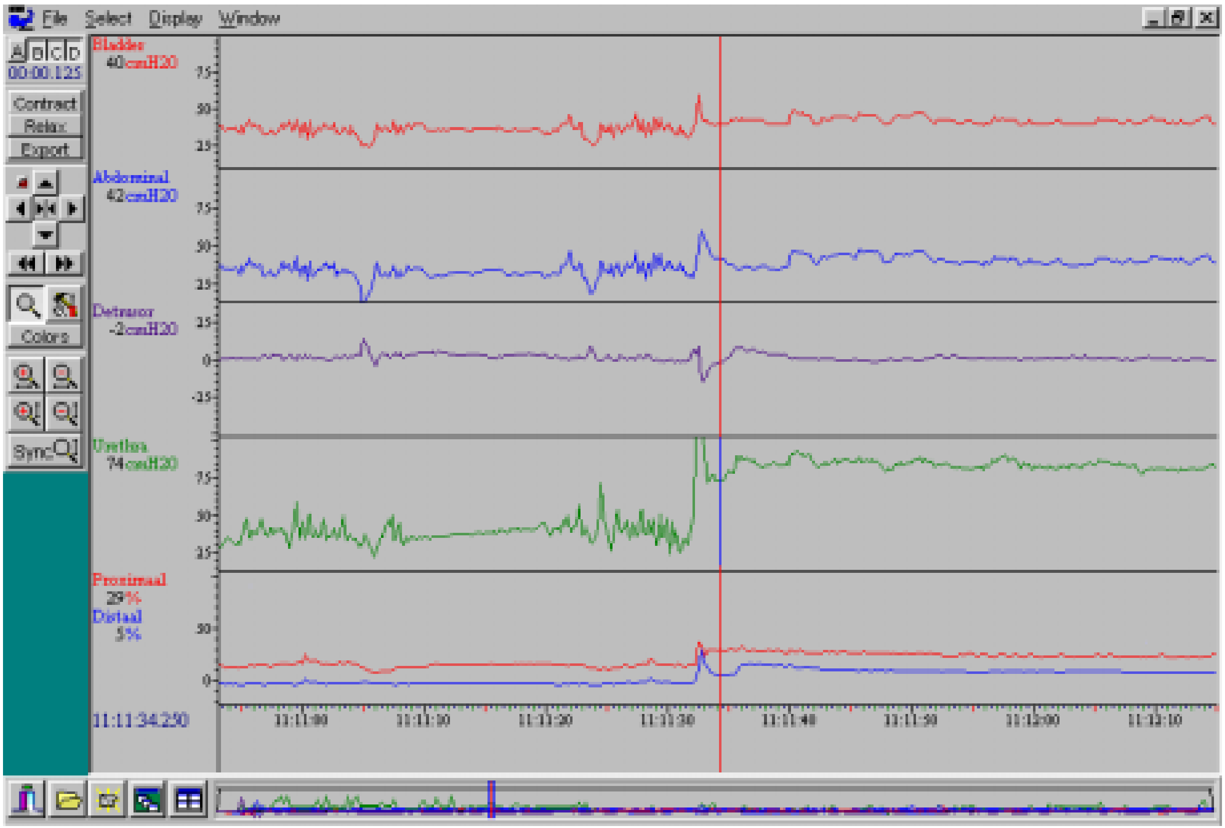
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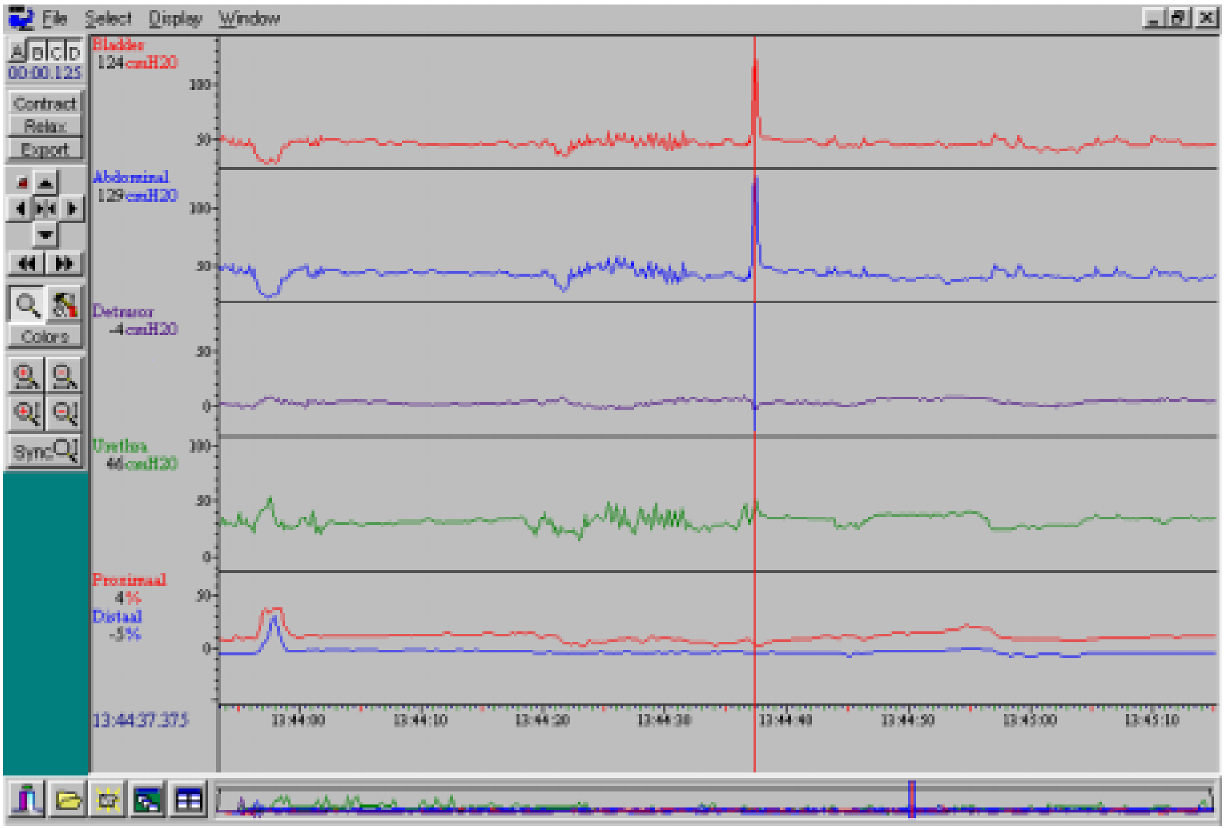
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Distaal
-5 %
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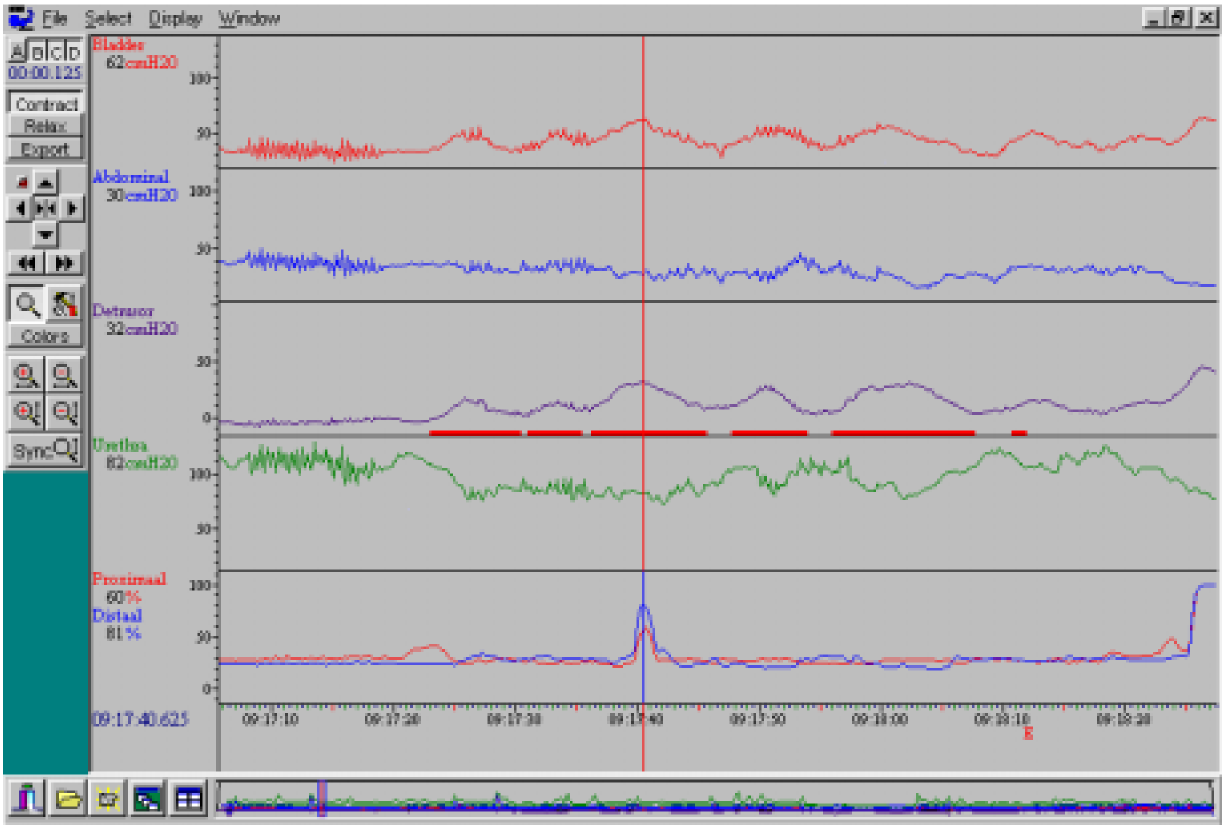
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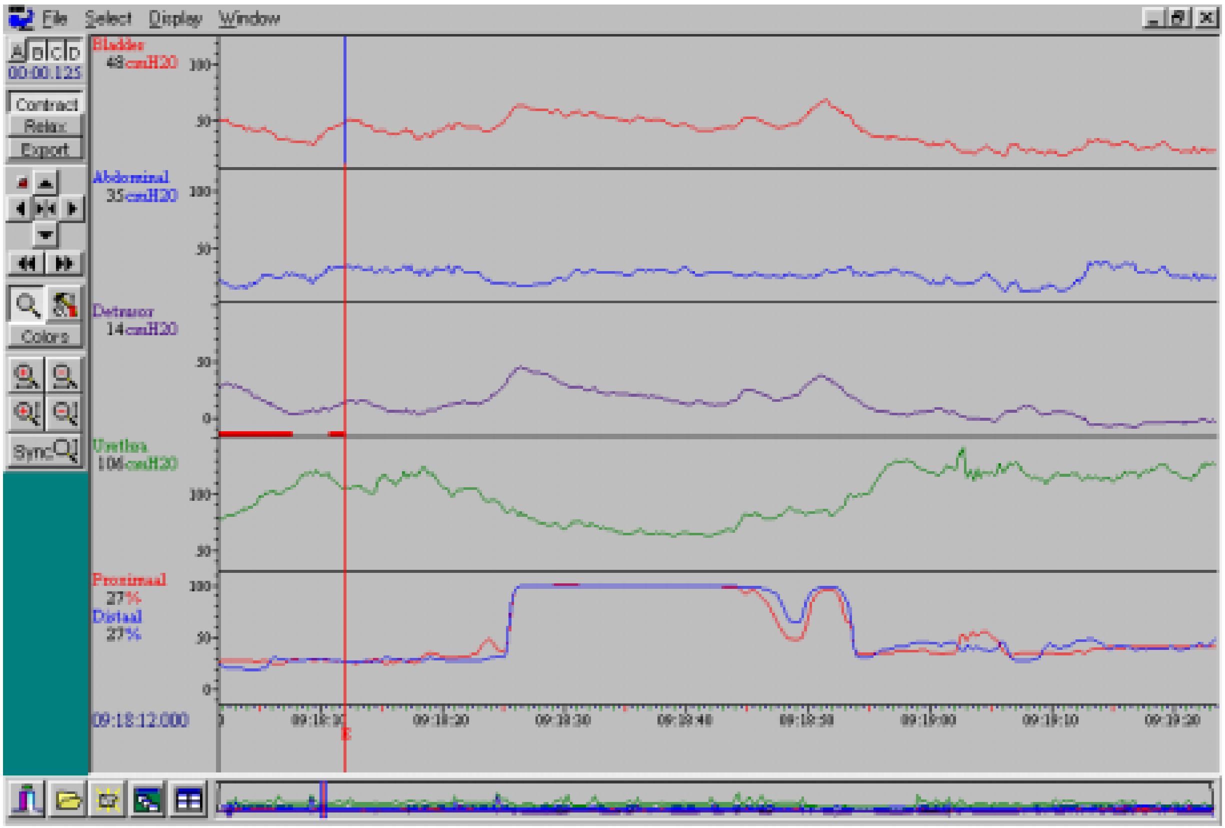
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