Digital assessment in geriatrics
Comparison between 20-cents-test and 20-balls-test

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1. Introduction (20-cents-test - analog ---> 20-ball-test - digital)

Fine motor skills are important evereyone's daily activities. Examples are pick small parts, open knobs, press keys on telefone or keyboards, open/close zippers and writing, use scissors or fixing lances.
The 20-cents-test (1) is a common assessment tool to determine fine motor skills. Task: 20 coins arranged in a circle/ellipse have to be transferred into a small box and the time from start to finish is determined. Typically healthy patient need ca. 22 sec. Patients with impaired fine motor skills need much more time.
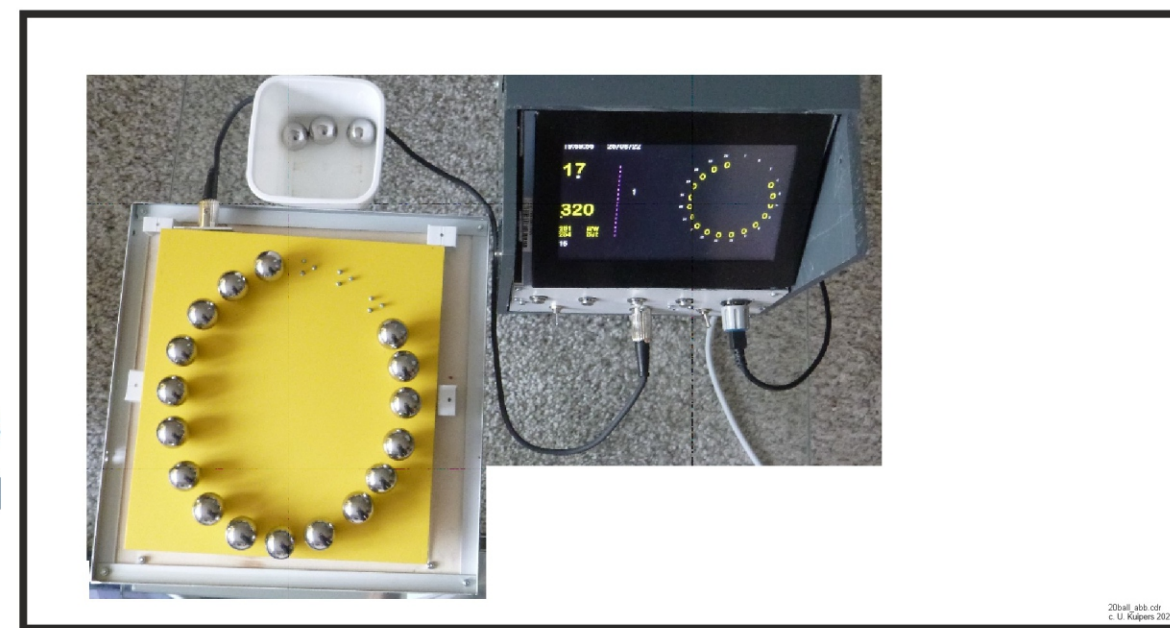

Fig. 1: 20 ball test equipment

2. Methods

2.1 Specification book

Precondition 20-balls-test (2)
Rules for assessment on hospital ward
- portable (yes, 8 kg weight)
- quick set-up time (whithin few minutes)
- medical device fulfils rules of medical
  products law (no, in house manufacture)
  CE mark (not neccessary)
  safety
    electrically safe (medical power supply)
    thermal secure, no hot parts (yes)
    cleanable (yes)
    no sharp parts (yes)
    electromagnetic proofed (EMV) (no, in preparation)
- quick start (yes, within 10 sec)
- quick results (yes, immeadly after stop)
- high accuracy (yes, time better than 50 ms)
- high resolution for each ball (yes, time stamp for each ball)
- operation simple to learn (yes)
- requires no laboratory rooms (yes)
- privacy of data (yes)
- design simple, easy, functional (yes)
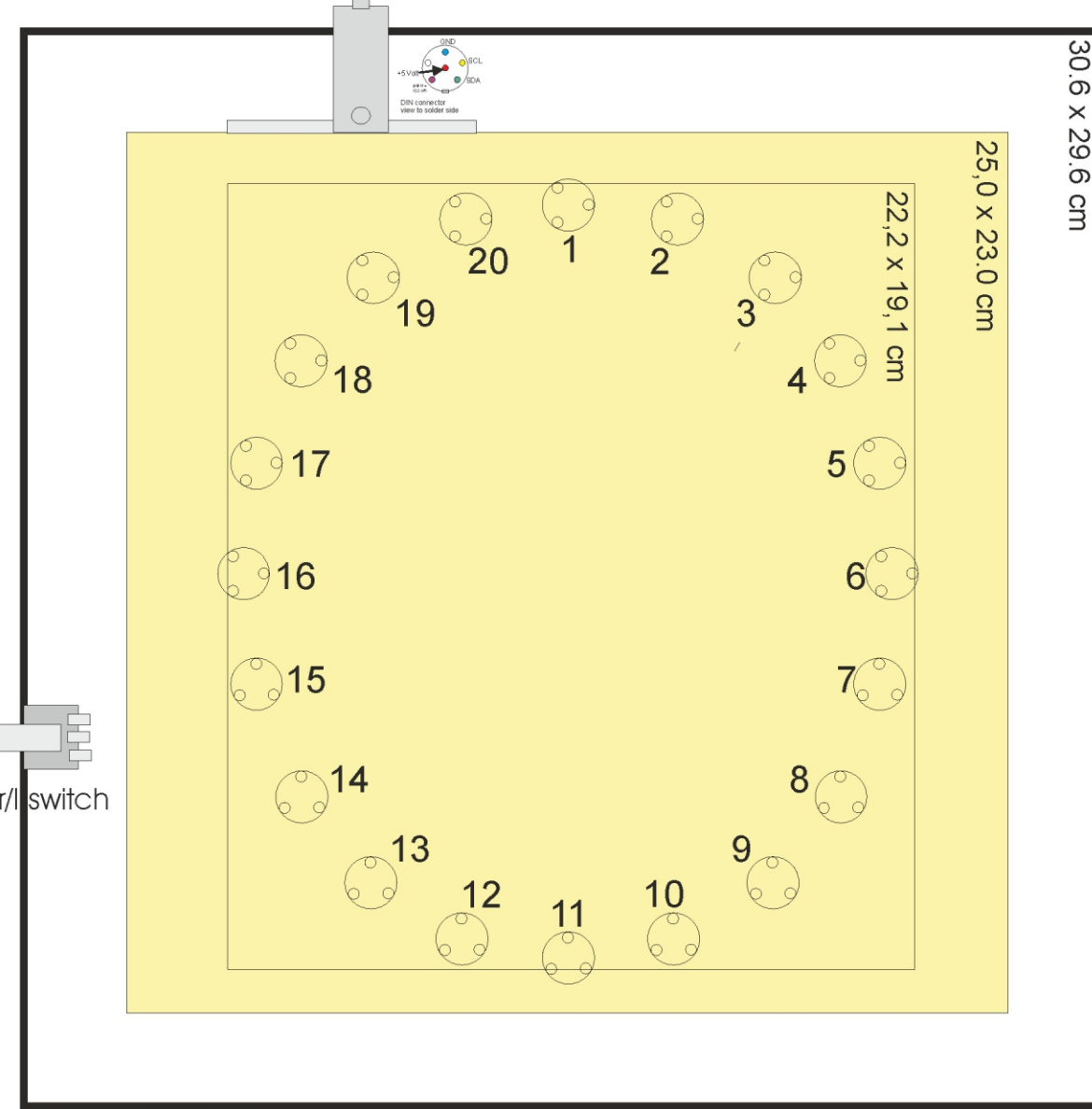Comment: (in brackets checked for 20-balls-test)

Fig. 2: 20 ball panel

2.2 Hardware

Development environment
Easypic6 evaluation board
  (Mikroelektronika (https://www.mikroe.co fdm/)
20 ball panel (custom)
20 ball housing with modules (custom)
- timer xtal driven + timer read (custom)
- real time clock (custom)
  memory FRAM 4 x (custom)
- TFT Display (display visions, electronic assembly)
- delay_board (custom)
- front panel: 4 buttons, 1 rotary sw. (custom)
medical power supply 5 V, 2 A
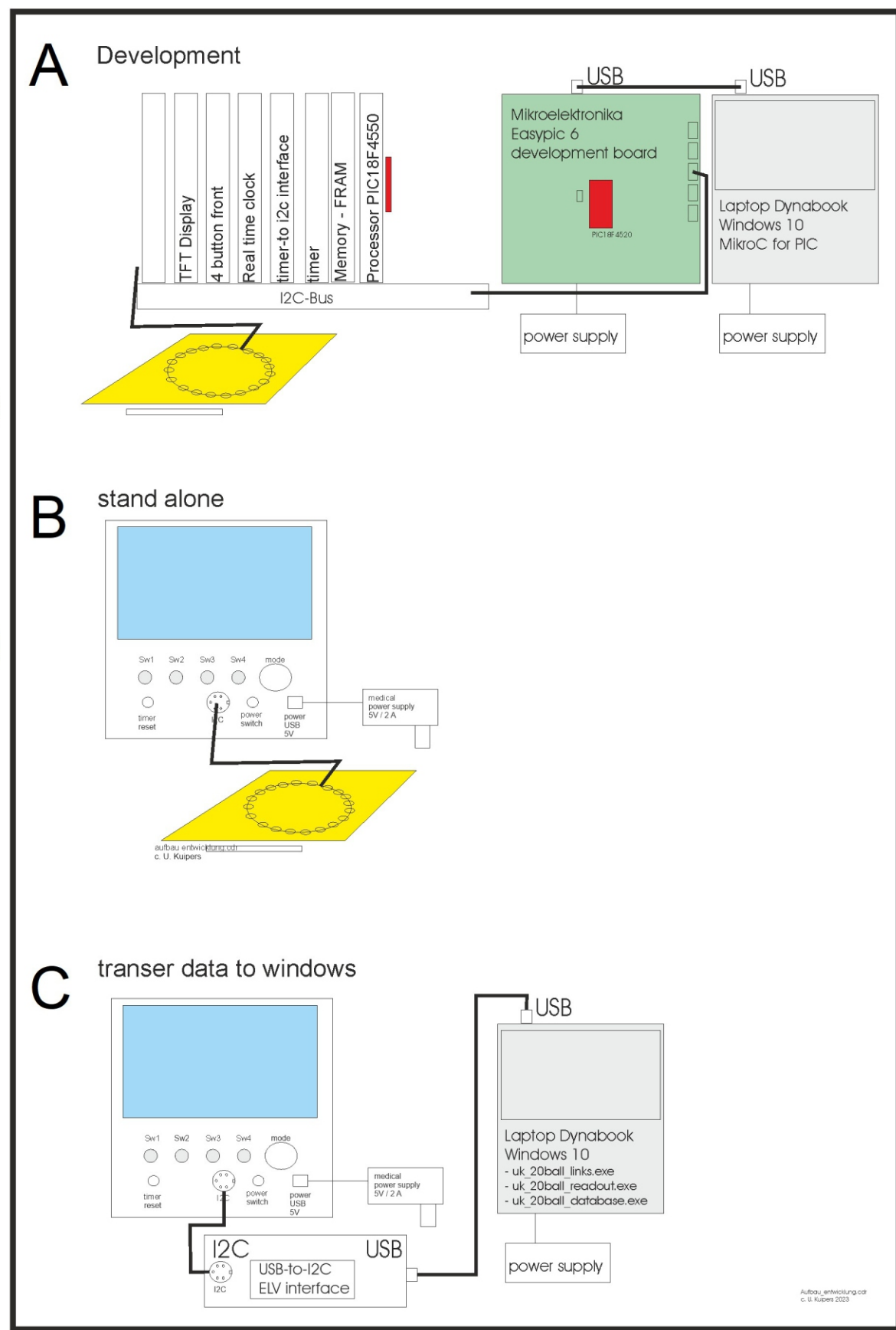- Friwo FOX6-XM-USB/Leicke ULL USB-10-W
- interface I2C-to-USB
    (https://de.elv.com/elv-usb-i2c-interface)

2.3 Software

Development environment for 20-balls-test

- C-Compiler MikroC pro for Pic
  (Mikroelektronika)

- Coreldraw SE.exe (https://www.coreldraw.com/de/)
- develop ment of circuit boards
- Estlcam.exe - CNC-Software
    http://www.estlcam.de/e25_hilfe.php
- Mach3.exe* - CNC-Software (Artsoft)
- Eagle.exe - Layout-Editor
    https://www.autodesk.de/products/eagle/overview

Borland Delphi Embarcadero Vers. 10.1 Berlin
- UK_20ball_links2: shell to (custom)
- 20_ball_readout.exe: (custom), transfer data to Microsoft programs
- 20_ball_database.exe: (custom)
- UK_Schaltplan: layout editor (custom)
- UK_Elektronikteile: database electronic parts (custom)

Software is running on Microsoft Win 7 - 11,
  except Mach3.exe only with Microsoft Windows XP

2.4 Documents

- 20-balls-test Untersuchungsbogen Ergänzung.cdr
- 20-cents-test

- information sheet, informed consent
- medical device act
- declaration of security
- declaration of privacy of data
- in house manufacture
- circuit board schematics

Fig. 3: Hardware configurations
A: Program microcontroller
B: 20 ball test as alone
C: Transfer data to windows computer

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4. Results: Fine motor skills with peripheral or central lesions

The picking up time of coins and balls does not differ. The placing of balls takes more time than their pic-up. Woman are faster than men. The dominant hand is faster than the other hand. The greatest time loss is observed in patients with central disruptions. Cognition, vigilance, action planning and eye-hand function are relevant.

Tab. 1: Diagnoses - controll / peripheral / central

group: controll

internal medicine
- arterial hypertension 3, artrial fibrillation 1, chronic bronchitis 1, COPD 1, diabetes mellitus 1, heart failure 2, hyperlipidemia 2, hypothyreosis, nicotin consumption 1, obesity 3, reflex disease

neurology
- myelon edema 1, restless legs 1, spinal canal stenosis 1, spinal cord syndrome

(trauma) surgery / orthopedia
. arthrosis 1, chronic low back pain 1, fracture: tibia 2, pelvic ring, heel spur, spine disease,
geriatric syndrome
- fall 1

group: peripheral

internal medicine
- coronary heart disease KHK 7, atrial fibrillation 2, aortic anerysma 1, arterial hypertension 3, hyperlipidaemia 3

neurology
- polyneuropathia 2, foot drop 1, restless legs 1, dizziness 1, hypacusis 1, macula degeneration 1, depression 1,

(trauma) surgery / bone diseases
- fractures: tibia 3, vertebral 3, acetabulum 3, pelvic 1, rheumatoid arthritis 1, arthrosis 1

geriatric syndromes
- falls and gait disorders 2

group: central nervous system

internal medicine
- arterial hypertension 4, anemia 1, atrial fibrillation 2, choledocholithiasis 1, gout 1, infenction 1, kidney cyst, left bundle branch block 1, renal insufficiency 1, vitamin d deficny

neurology
- stroke 7, delirium 2, attention deficit 1, aphasia 1, visual impairment 1, apraxia 1, hemiparesis 1, tetraparesis 1

(trauma) surgery/orthopedia
- fracture clavicula 1, os pubis 1, spinal canal stenosis
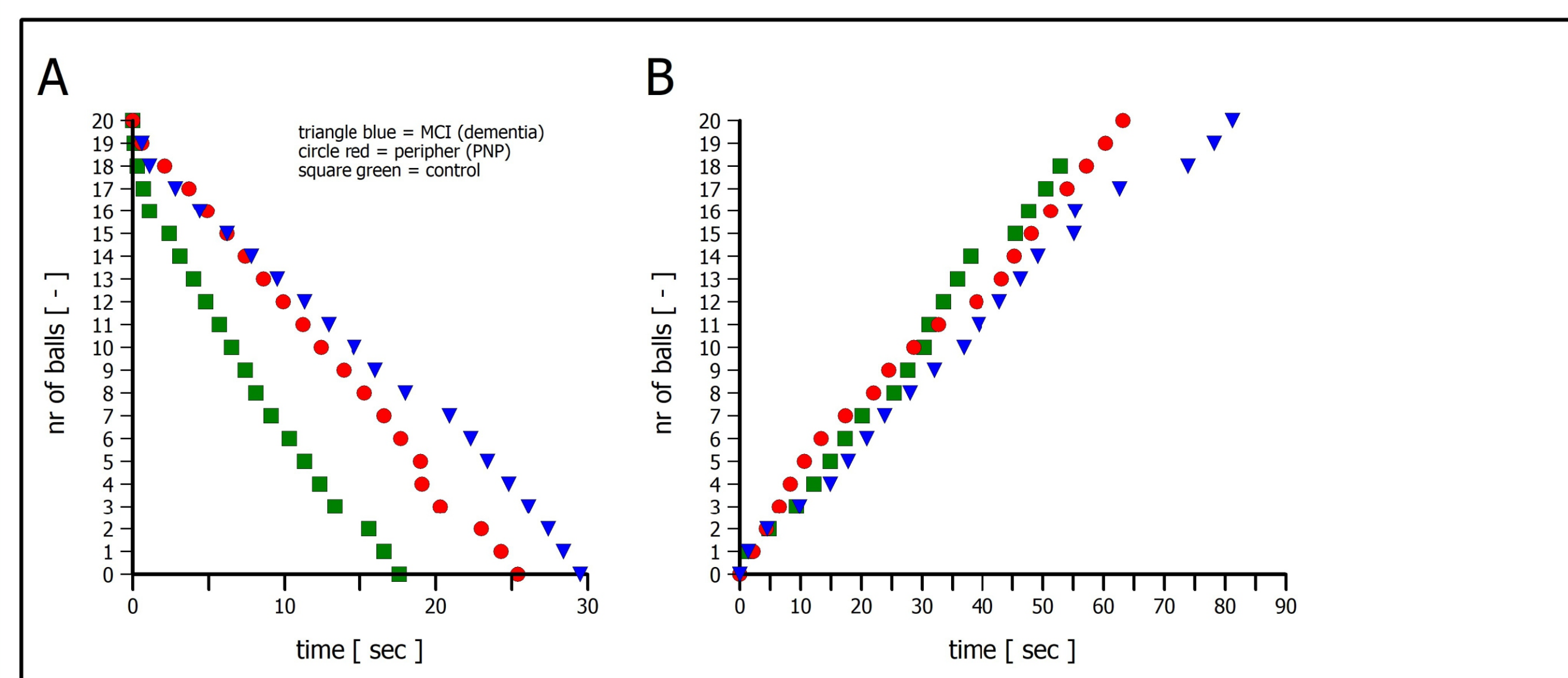
geriatric syndrome
- falls 1

Fig. 4: 20 ball examples control vs peripher vs central impairment
A: remove 20 balls
B: put 20 balls
green squares: control, read dots: peripher, blue triangles: central

Tab. 2: Comparison of Assessments

Dimension	Assessment		all	control	peripher	central		all	control	peripher	central		all	control	peripher	central
							right side					left side				
		Sex	mean n	mean n	mean	mean		mean n	mean n	mean n	mean n		mean n	mean n	mean n	mean n
ADL	Barthel index [..]	m	62,50 10	55,00 4	77,50 2	58,75 8										
	Barthel index [..]	f	62,00 10	65,00 4		70,00 2										
Mobility	DEHMI [..]	m	54,64 11	36,00 1	53,00 2	57,38 8										
	DEHMI [..]	f	47,60 10	43,25 4	49,25 4	52,00 2										
	Timed up and go [sec]	m	20,80 10	18,00 1	12,00 2	23,71 7										
	Timed up and go [sec]	f	30,00 9	37,00 3		22,50 2										
	fist closing power [N*10]	m						27,12 6	25,00 1	28,50 2	27,00 3		24,83 6	24,00 1	36,00 2	21,67 3
	fist closing power [N*10]	f						18,25 8	24,67 3	15,33 3	13,00 2		18,86 7	22,33 3	15,00 3	20,00 1
Cognition	Minimental test [..]	m	26,10 4	27,00 1	27,50 2	24,00 1										
	Minimental test [..]	f	27,30 10	27,75 4	27,00 4											
	DEMTECT [..]	m	20,80 10	20,00 3		13,50 4										
	Clock completion test [..]	m	2,40 10	2,50 4	2,50 4	2,67 3										
	Clock completion test [..]	f	2,40 10	2,50 4	2,50 4	2,00 2										
Fine motor skills	20-cents-test [sec]	m						36,00 1	43,50 2	51,88 8			38,00 1	45,00 2	49,67 4
	20-cents-test [sec]	f						26,25 4	25,25 4				26,25 4	29,67 3		
	20-balls-test remove [sec]	m						42,30 10	28,50 1	36,00 3	51,88 8		38,90 10	28,00 1	32,00 2	42,43 7
	20-balls-test remove [sec]	f						28,13 7	20,95 2	36,00 3	23,50 2		24,09 7	24,67 3	25,50 2	
	20-balls-test put [sec]	m						65,72 8	70,00 1	82,00 3	65,50 2		79,89 9	84,00 2	77,00 6	
	20-balls-test put [sec]	f						63,77 7	55,67 3	65,80 2	65,50 2		62,86 7	58,50 4	62,50 2	81,00 1
Mood	Geriatric depression sc. [..]	m	3,80 5	5,00 1	8,00 2	3,50 2										
	Geriatric depression sc. [..]	f	2,00 8	1,50 4	2,75 4	4,50 2										
Age	age [years]	m=f		76,40 5	82,33 6	70,60 10										
	age [years]	m	83,20 2	62,50 2												
	age [years]	f	77,78 4	82,25 4	81,50 2											

DEHMI = de Morton Mobility Index
m=male, f = female, .. = points
control group
peripher = patients with peripheral lesions
central = patients with lesion in central nervous system

20 ball put = 20 balls put on the table
20 ball remove= 20 ball remove from the table

5. Conclusion

It is possible to develop digital devices for geriatric assessments.
In this case we developed an assessment for fine motor skills.

Many obstacles must be survived

There must be considered technical realisation precision, reproducibility and medical devices act and aspects of security and CE-mark. Furthermore the feasibility on a ward and acceptance by the operating stuff must be checked.

Man kann digitale Assessments entwickeln, was hier am 20 Kugeltest (engl. 20-balls-test) gezeigt wird.
Berücksichtigt werden müssen die technische Realisation mit Genauigkeit, Reproduzierbarkeit, das Medizinproduktegesetz mit Aspekten der Sicherheit und Klärung zur CE-Kennzeichnung.
Zu berücksichtigen sind auch die Durchführbarkeit auf der Station mit Akzeptanz durch das bedienende Personal.
Die Feinmotorikleistung ist besser bei Frauen, in der dominanten Hand, vermindert bei Läsionen der Hand und seiner Muskeln, der ansteuernden Nerven (periphere Gruppe) und bei ZNS-Läsionen (z.B. nach Schlaganfall) oder bei kognitiven Defiziten (Demenzen).
Durch die digitale Realisation erhält man genauere und umfangreichere Information über die Performance der Feinmotorik.

6. Literature

(1) Krupp et al. (2015): Timed up and go test for fingers in the form of the 20 cents test. Psychometric criteria of a simple performance test of fine motor skills. Zeitschrift für Gerontologie und Geriatrie 48 121-127
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