



**Narodowy  
Instytut  
Onkologii**

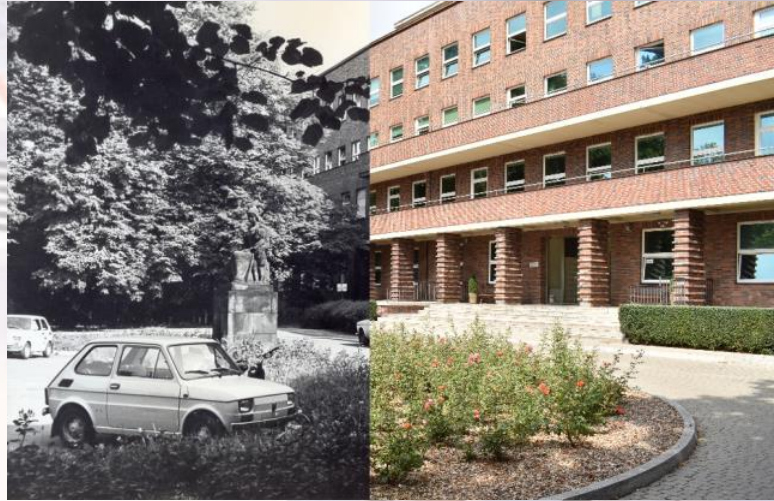
im. Marii Skłodowskiej-Curie  
Państwowy Instytut Badawczy  
Oddział w Gliwicach

# Zastosowanie systemu AlignRT w pozycjonowaniu chorych z wykorzystaniem masek termoplastycznych typu open face

**Dawid Bodusz**  
2023

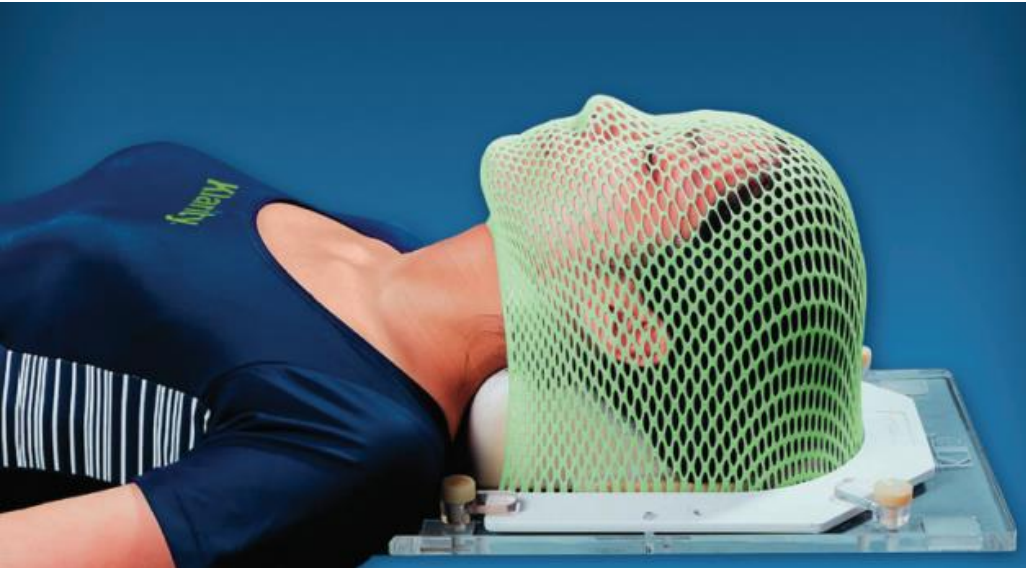








## Porównanie pozycjonowania AlignRT+open face vs standardowa maska H&N



- 42 pts – maska standardowa
- 748 frakcje

- 60 pts – open face
- 232 frakcje

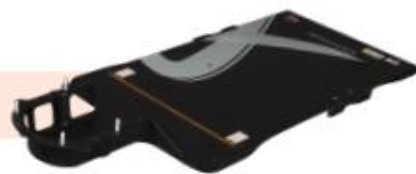


## Charakterystyka maski typu open face

### RT-4600-01

#### Encompass SRS Standalone Device

Device Length 1358 mm  
Handling Weight 5.5 kg (12 lb)  
Weight Limit 249 kg (550 lb), Uniformly Distributed Load at maximum cantilever position indicated on device.



### RT-4600KV-01

#### kVue™ Encompass SRS Insert

Device Length 1311 mm  
Handling Weight 4.5 kg (10 lb)  
Weight Limit 249 kg (550 lb), Uniformly Distributed Load at maximum cantilever position indicated on device.



### RT-4600-01-MRI

#### Encompass SRS MR Standalone Device

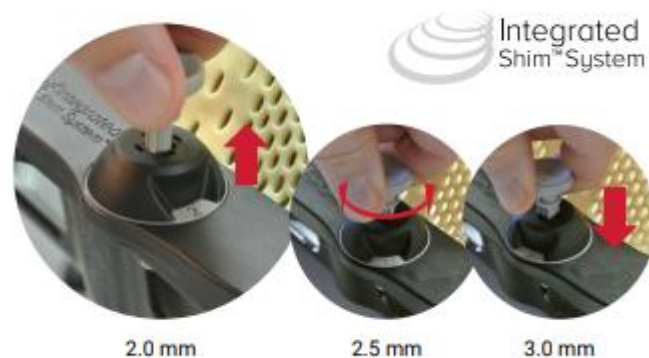
Device Length 1358 mm  
Handling Weight 5.5 kg (12 lb)  
Weight Limit 249 kg (550 lb), Uniformly Distributed Load at maximum cantilever position indicated on device.



### RT-4600-02

#### Encompass SRS Standalone Device

Device Length 1358 mm  
Handling Weight 5 kg (11 lb)  
Weight Limit 249 kg (550 lb), Uniformly Distributed Load at maximum cantilever position indicated on device.



## Charakterystyka maski typu open face

### Features & Benefits

- Immobilization for treatment of multiple lesions with a single isocenter
- High precision immobilization with submillimetric accuracy for stereotactic radiosurgery, including trigeminal neuralgia
- Integrated Shim™ System optimizes workflow efficiencies
- Open View™ Thermoplastic can reduce patient anxiety and allows for intra-fraction positioning verification utilizing optical tracking systems
- Submillimetric immobilization with or without optional IntegraBite™



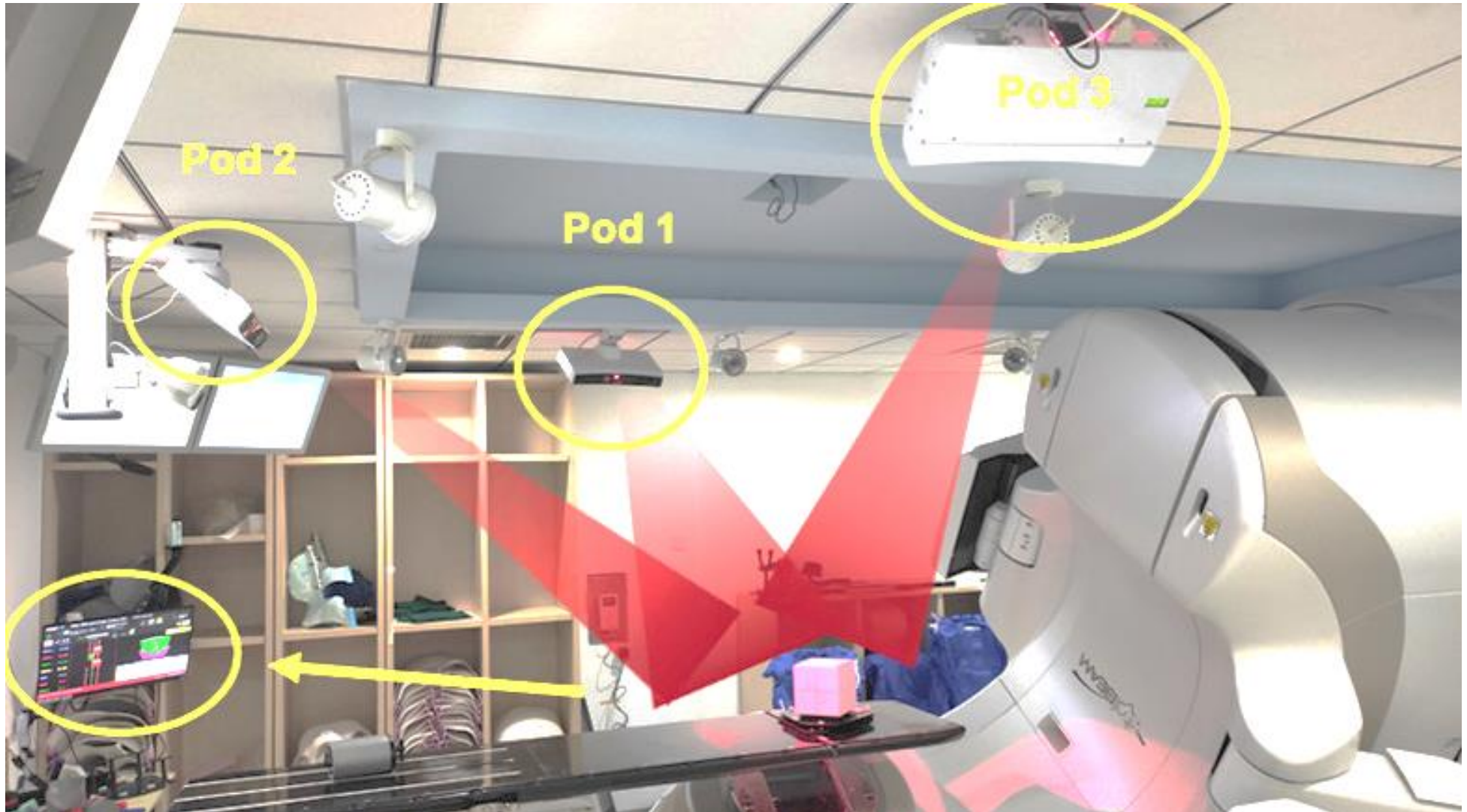
Image used is courtesy from Varian, a Siemens Healthineers company

## Porównanie pozycjonowania AlignRT+open face vs standardowa maska H&N

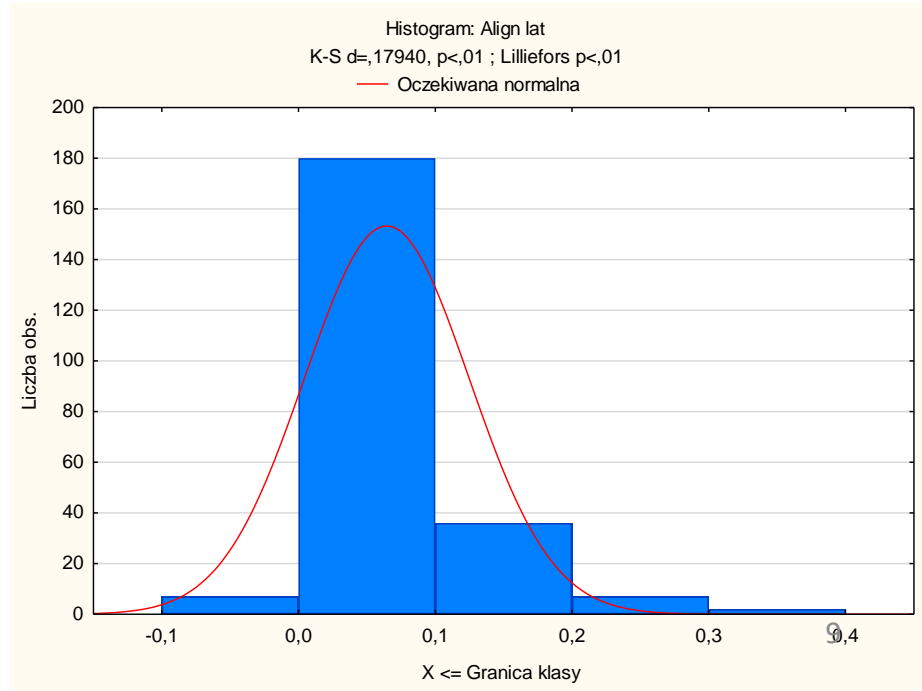
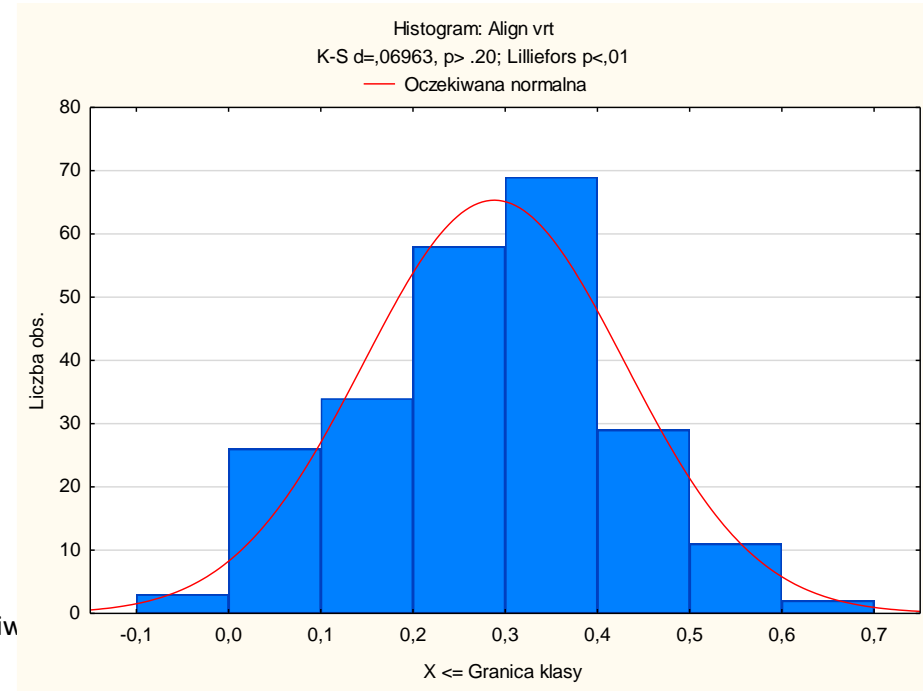
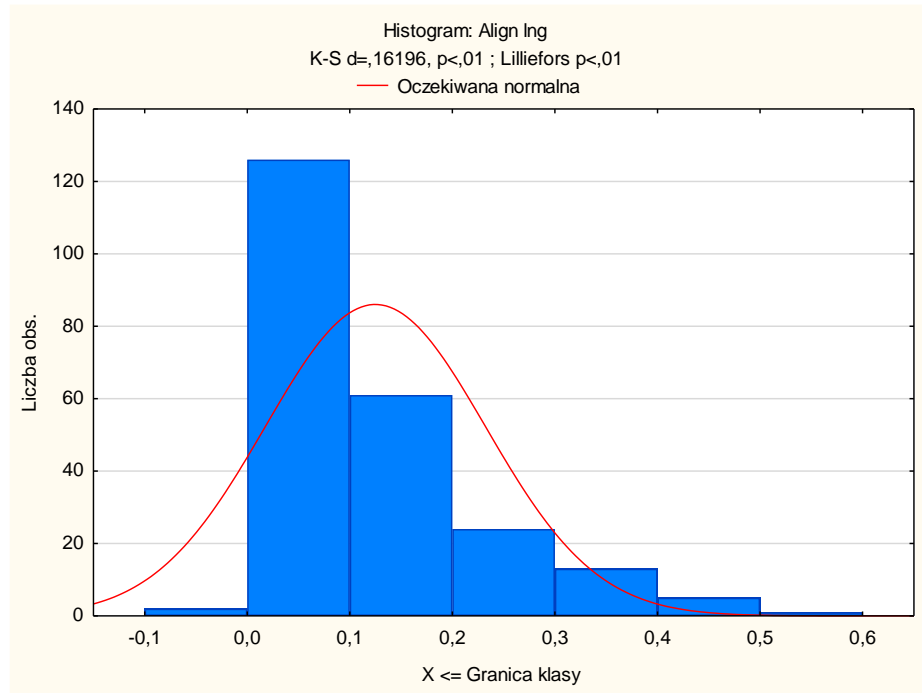
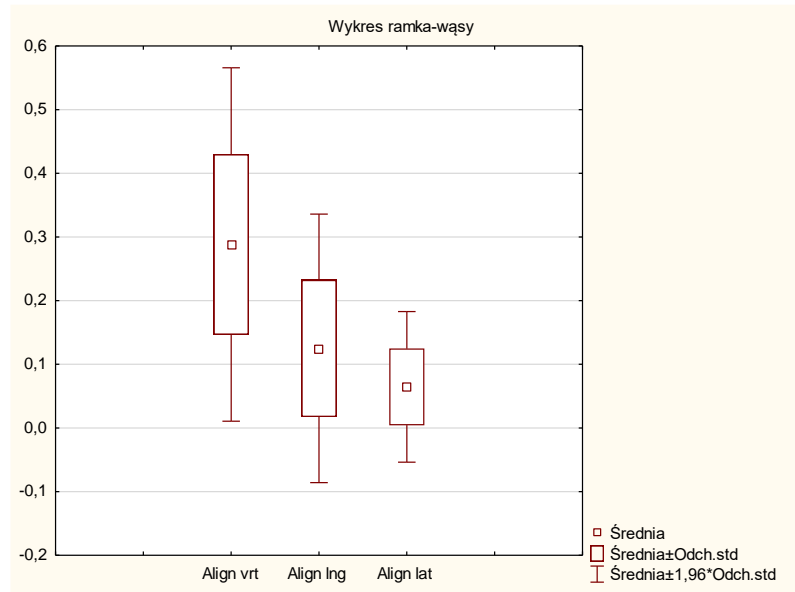
Procedura pozycjonowania AlignRT+open face	Procedura pozycjonowania maska standardowa
Ułożenie na stole terapeutycznym z wykorzystaniem SGRT	Ułożenie na stole terapeutycznym z wykorzystaniem laserów
Wykonanie obrazowania	Wykonanie obrazowania
Akceptacja i RT	Akceptacja i RT lub repozycjonowanie
Monitoring w trakcie RT	

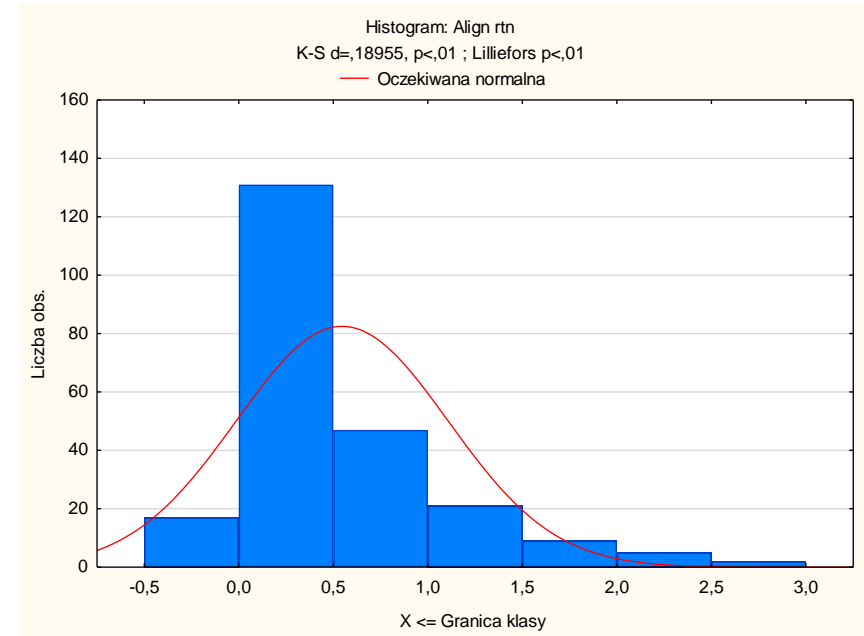
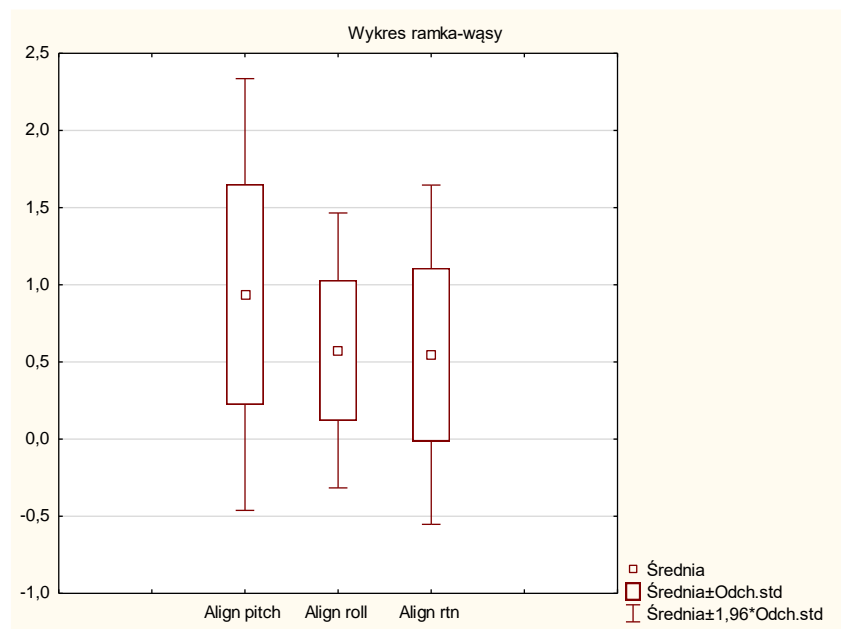
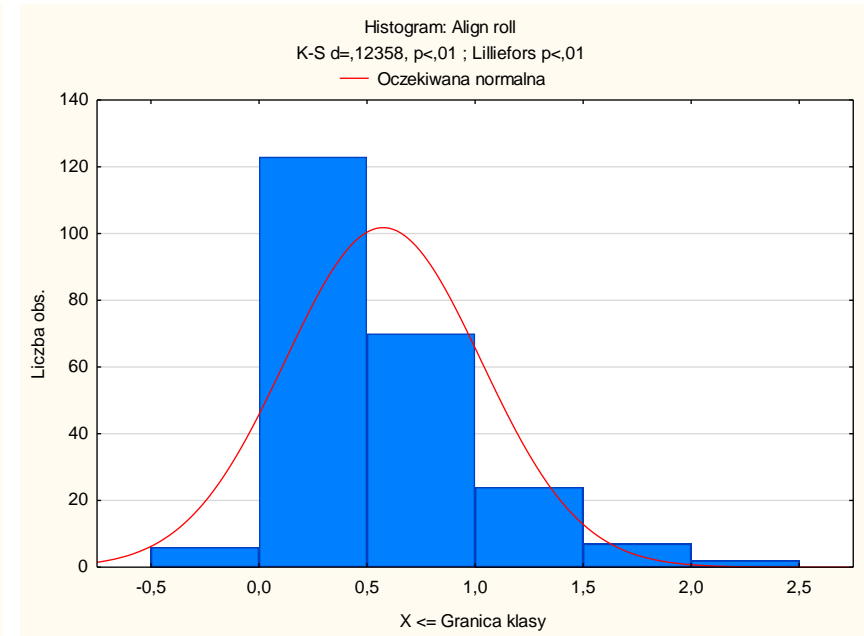
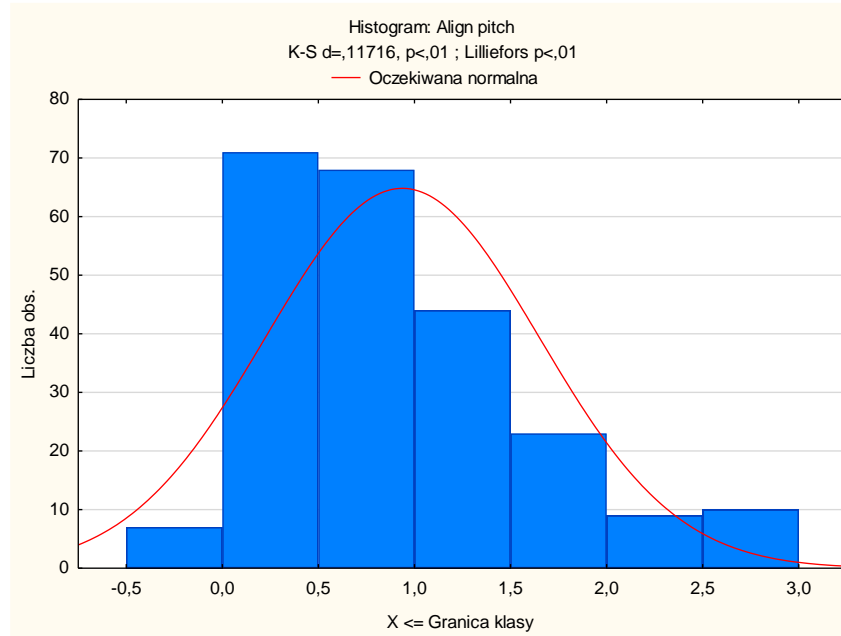


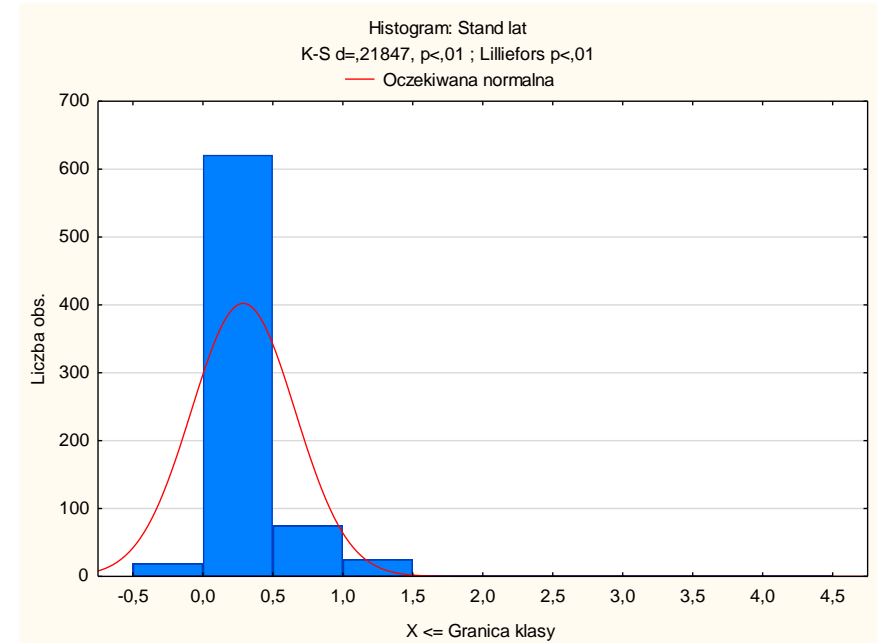
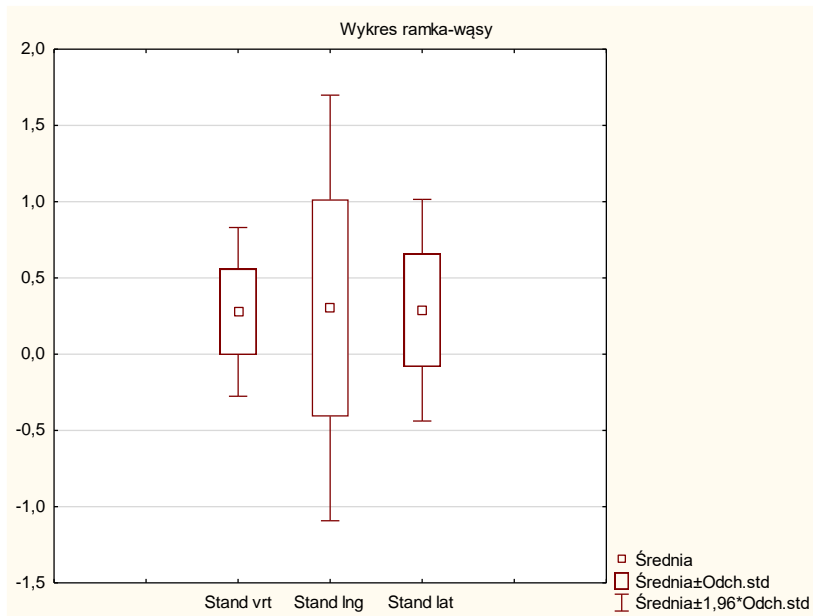
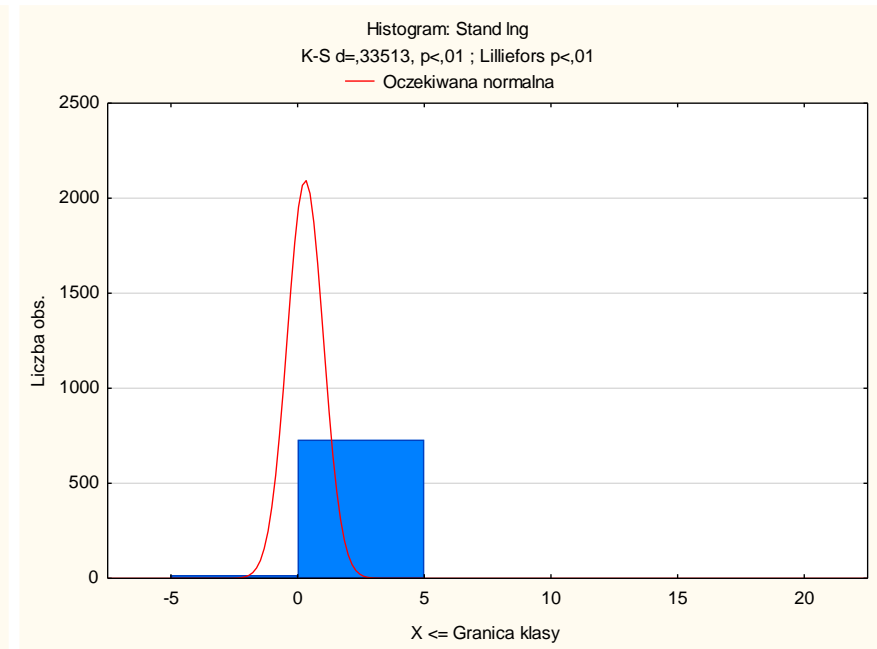
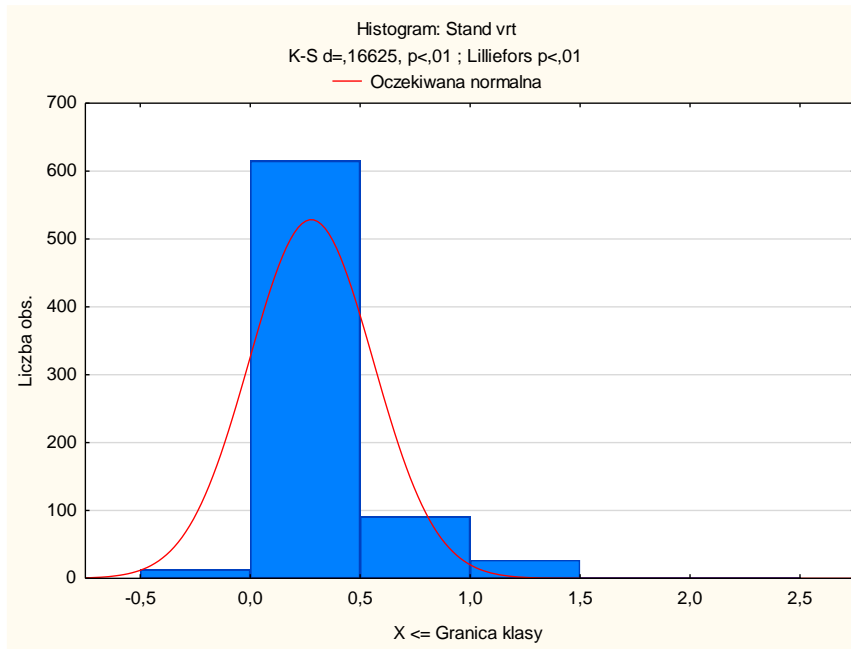
Porównanie pozycjonowania AlignRT+open face vs standardowa maska H&N



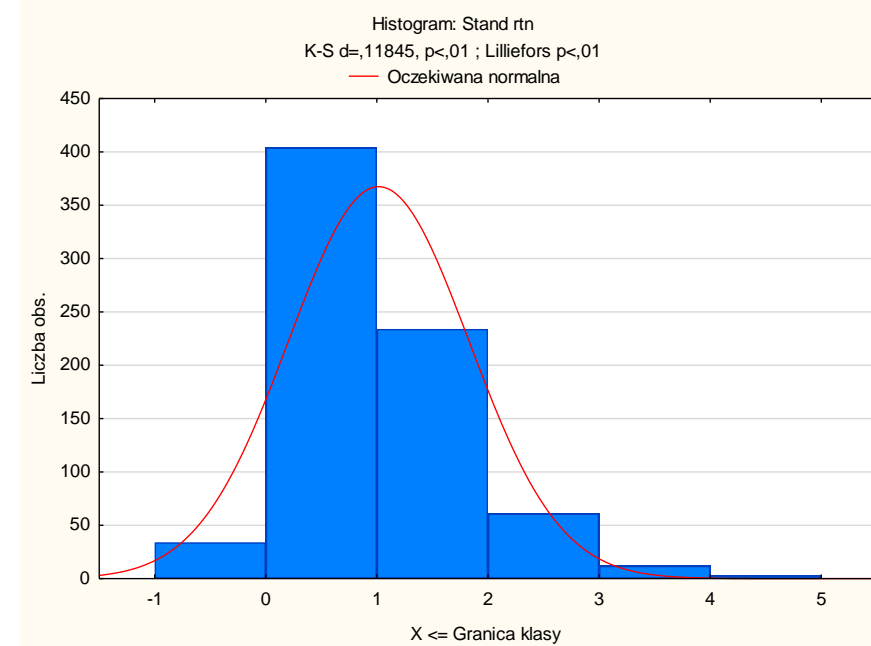
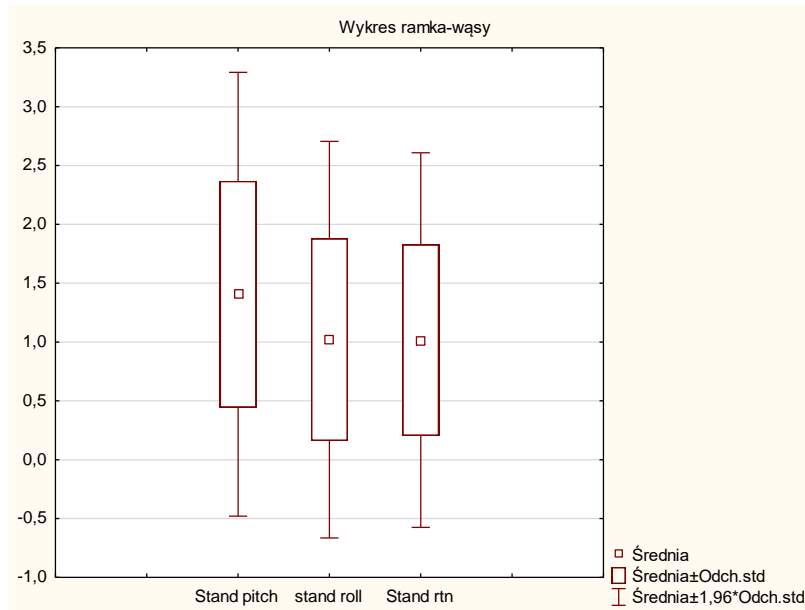
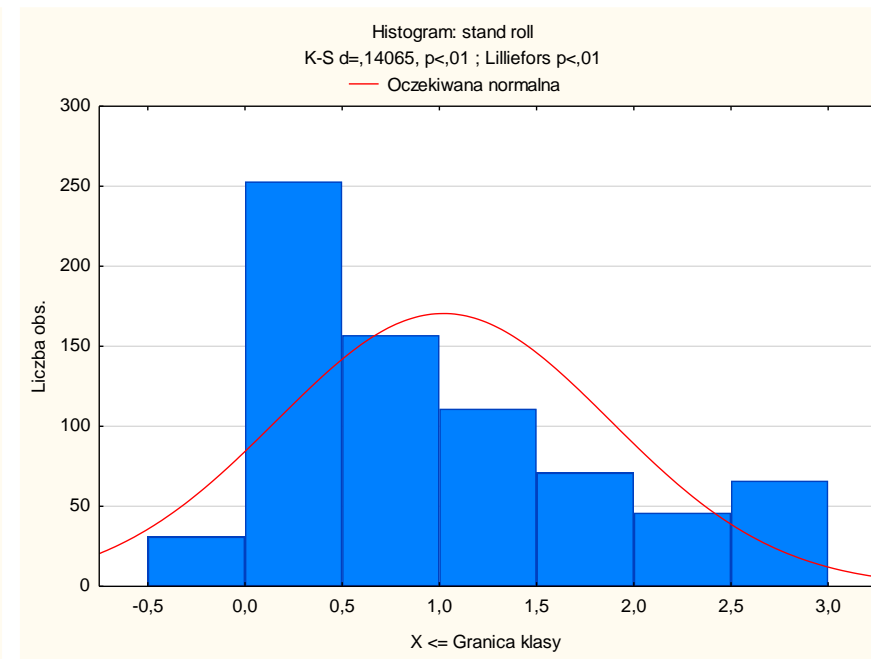
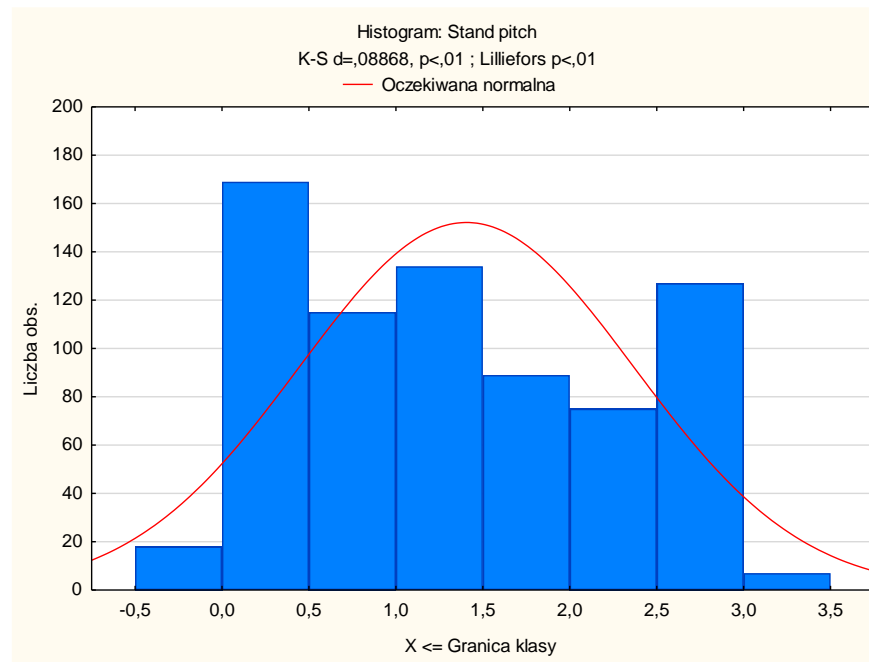


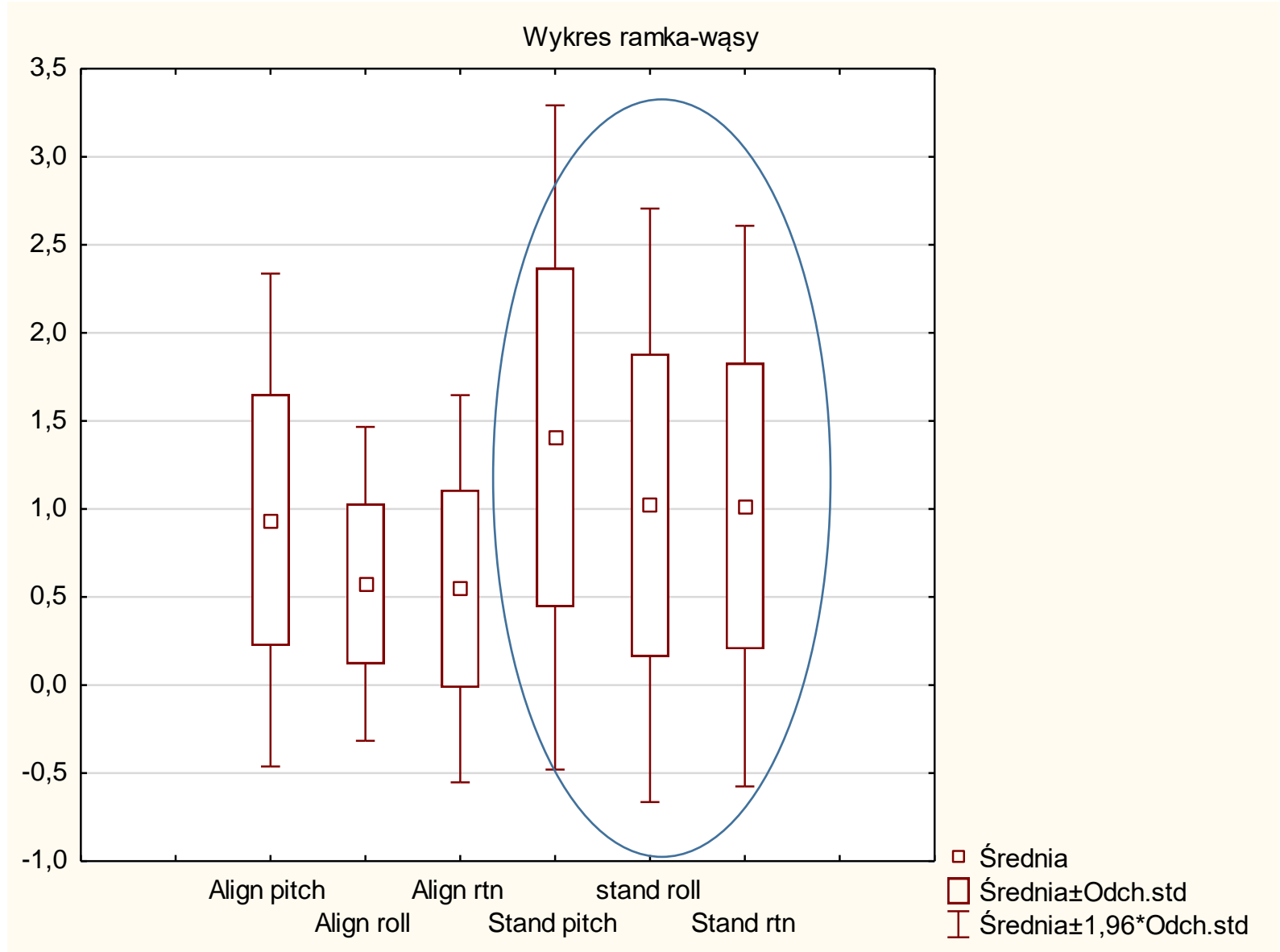












Wykres ramka-wąsy

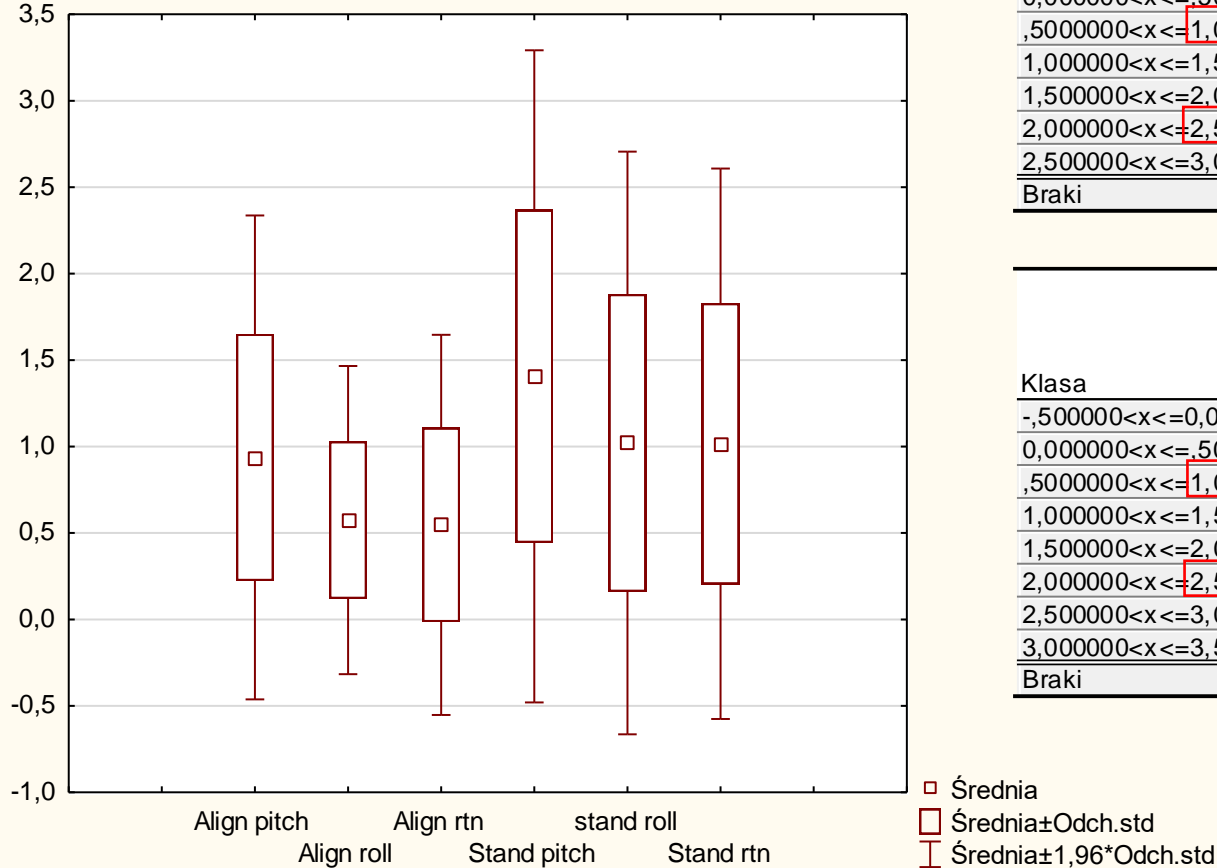


Tabela liczości: Align pitch (statystyka open face)  
K-S d=,11716, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	7	7	3,0172	3,0172	0,93583	0,9358
0,000000<x<=,50000000	71	78	30,6034	33,6207	9,49198	10,4278
,5000000<x<=1,0000000	68	146	29,3103	62,9310	9,09091	19,5187
1,000000<x<=1,500000	44	190	18,9655	81,8966	5,88235	25,4011
1,500000<x<=2,000000	23	213	9,9138	91,8103	3,07487	28,4759
2,000000<x<=2,500000	9	222	3,8793	95,6897	1,20321	29,6791
2,500000<x<=3,000000	10	232	4,3103	100,0000	1,33690	31,0160
Braki	516	748	222,4138		68,98396	100,0000

Tabela liczości: Stand pitch (statystyka open face)  
K-S d=,08868, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	18	18	2,45232	2,4523	2,40642	2,4064
0,000000<x<=,50000000	169	187	23,02452	25,4768	22,59358	25,0000
,5000000<x<=1,0000000	115	302	15,66757	41,1444	15,37433	40,3743
1,000000<x<=1,500000	134	436	18,25613	59,4005	17,91444	58,2888
1,500000<x<=2,000000	89	525	12,12534	71,5259	11,89840	70,1872
2,000000<x<=2,500000	75	600	10,21798	81,7439	10,02674	80,2139
2,500000<x<=3,000000	127	727	17,30245	99,0463	16,97861	97,1925
3,000000<x<=3,500000	7	734	0,95368	100,0000	0,93583	98,1283
Braki	14	748	1,90736		1,87166	100,0000



Wykres ramka-wąsy

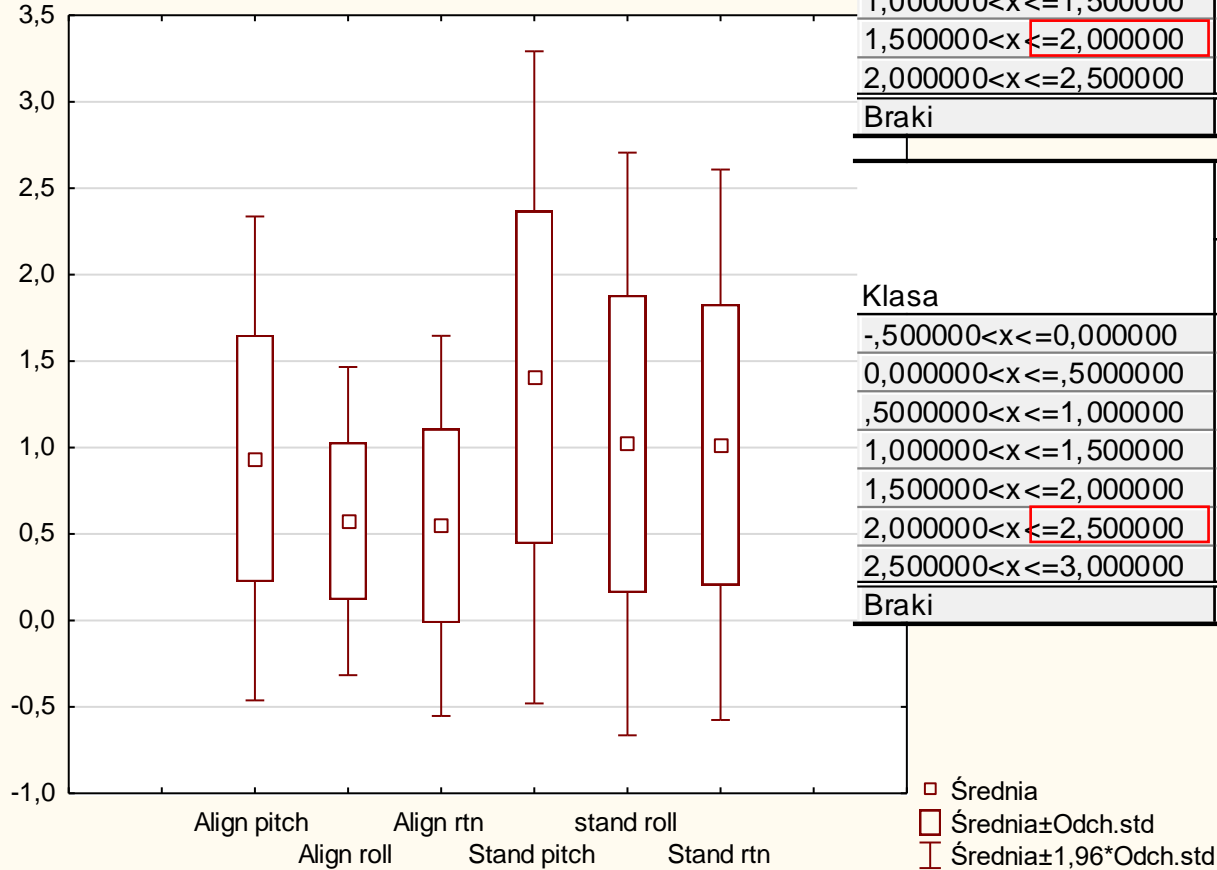


Tabela licznosci: Align roll (statystyka open face)  
K-S d=,12358, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	6	6	2,5862	2,5862	0,80214	0,8021
0,000000<x<=,5000000	123	129	53,0172	55,6034	16,44385	17,2460
,5000000<x<=1,000000	70	199	30,1724	85,7759	9,35829	26,6043
1,000000<x<=1,500000	24	223	10,3448	96,1207	3,20856	29,8128
1,500000<x<=2,000000	7	230	3,0172	99,1379	0,93583	30,7487
2,000000<x<=2,500000	2	232	0,8621	100,0000	0,26738	31,0160
Braki	516	748	222,4138		68,98396	100,0000

Tabela licznosci: stand roll (statystyka open face)  
K-S d=,14065, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	31	31	4,21769	4,2177	4,14439	4,1444
0,000000<x<=,5000000	253	284	34,42177	38,6395	33,82353	37,9679
,5000000<x<=1,000000	157	441	21,36054	60,0000	20,98930	58,9572
1,000000<x<=1,500000	111	552	15,10204	75,1020	14,83957	73,7968
1,500000<x<=2,000000	71	623	9,65986	84,7619	9,49198	83,2888
2,000000<x<=2,500000	46	669	6,25850	91,0204	6,14973	89,4385
2,500000<x<=3,000000	66	735	8,97959	100,0000	8,82353	98,2620
Braki	13	748	1,76871		1,73797	100,0000

Wykres ramka-wąsy

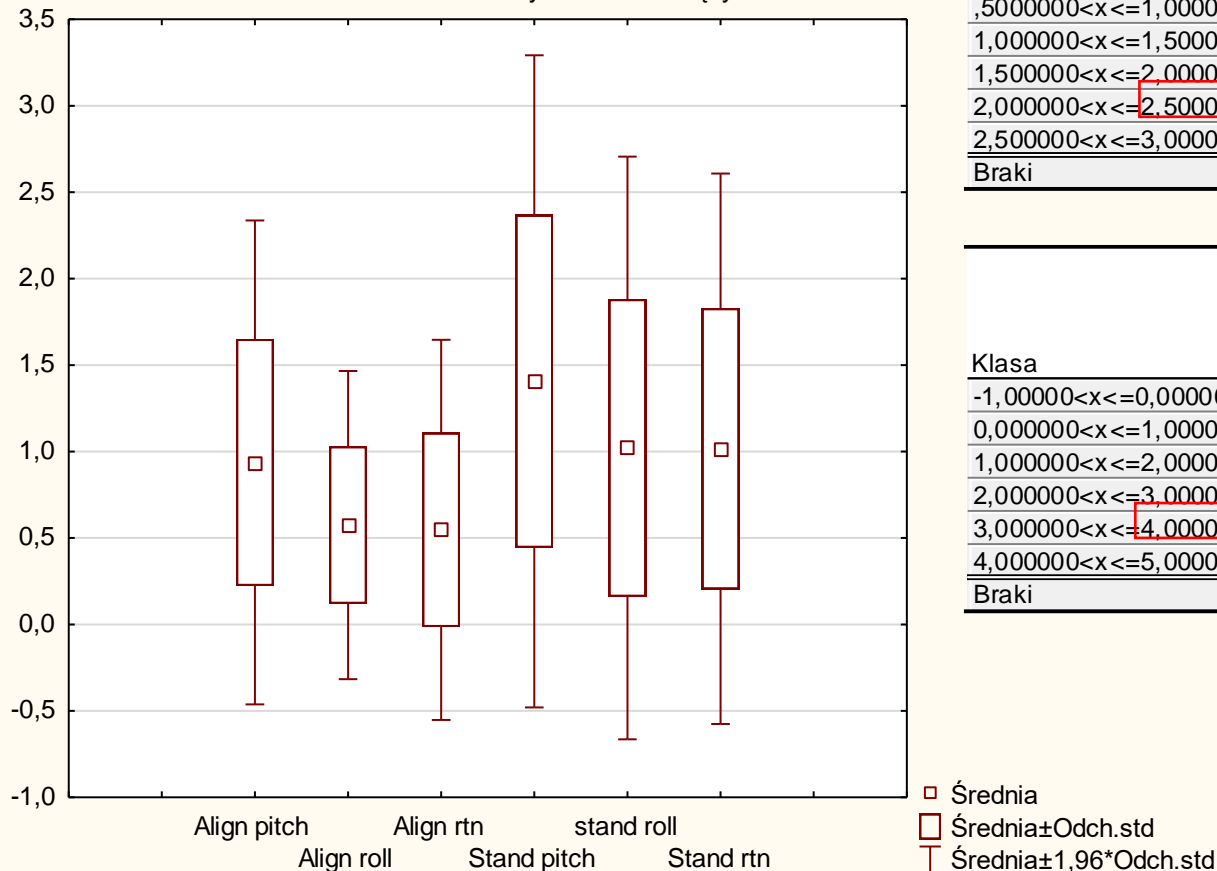


Tabela licznosci: Align rtn (statystyka open face)

K-S d=,18955, p<,01 ; Lilliefors p<,01

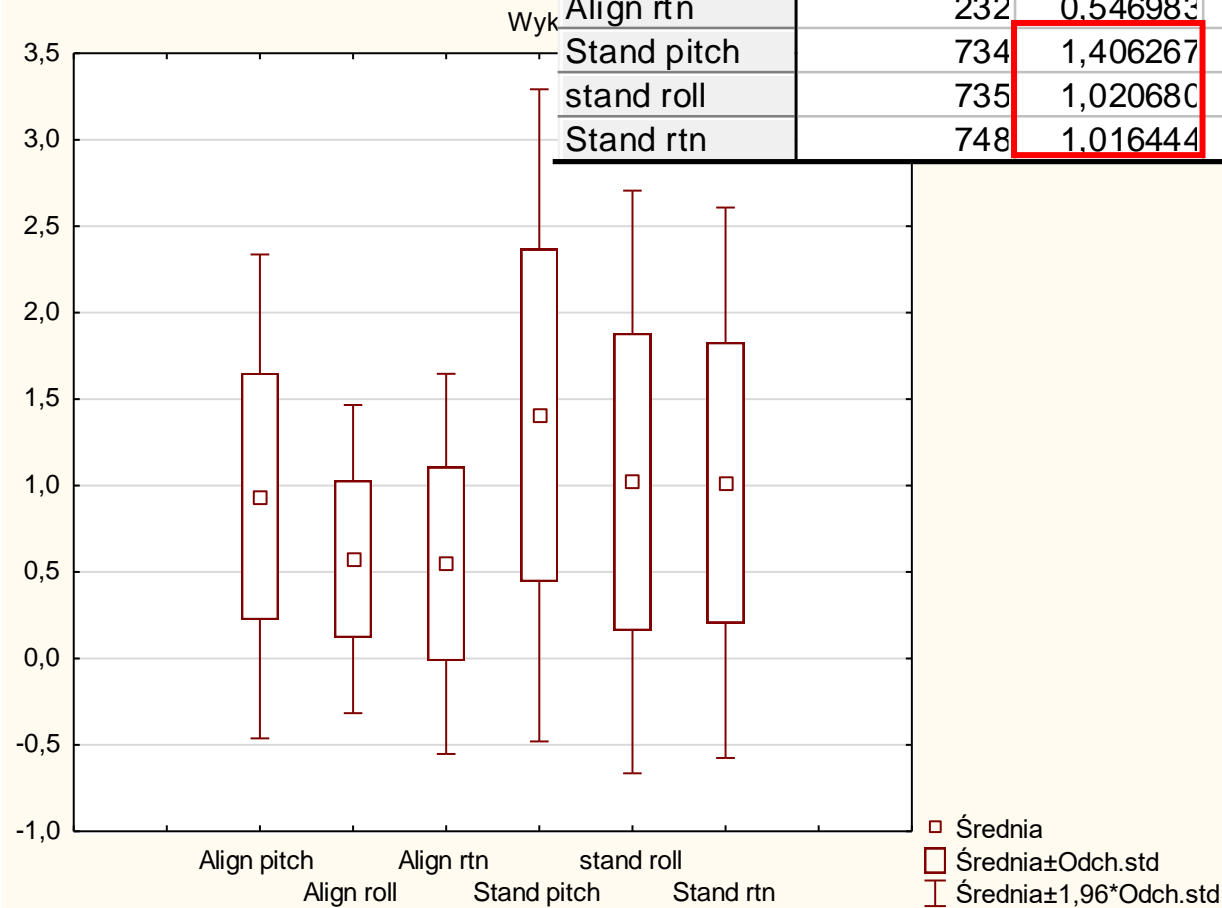
Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	17	17	7,3276	7,3276	2,27273	2,2727
0,000000<x<=,5000000	131	148	56,4655	63,7931	17,51337	19,7861
,5000000<x<=1,000000	47	195	20,2586	84,0517	6,28342	26,0695
1,000000<x<=1,500000	21	216	9,0517	93,1034	2,80749	28,8770
1,500000<x<=2,000000	9	225	3,8793	96,9828	1,20321	30,0802
2,000000<x<=2,500000	5	230	2,1552	99,1379	0,66845	30,7487
2,500000<x<=3,000000	2	232	0,8621	100,0000	0,26738	31,0160
Braki	516	748	222,4138		68,98396	100,0000

Tabela licznosci: Stand rtn (statystyka open face)

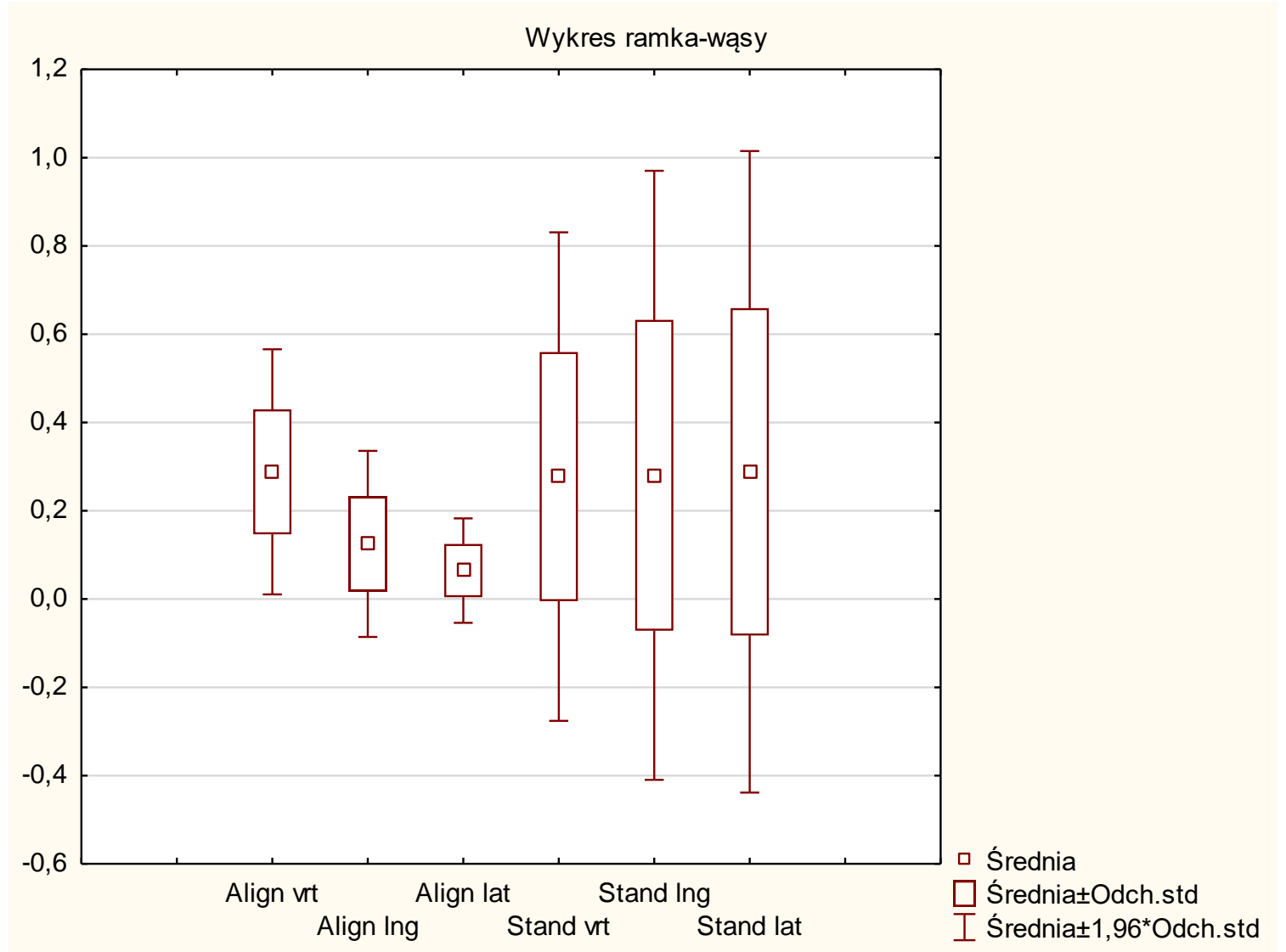
K-S d=,11845, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-1,000000<x<=0,000000	34	34	4,54545	4,5455	4,54545	4,5455
0,000000<x<=1,000000	404	438	54,01070	58,5561	54,01070	58,5561
1,000000<x<=2,000000	234	672	31,28342	89,8396	31,28342	89,8396
2,000000<x<=3,000000	61	733	8,15508	97,9947	8,15508	97,9947
3,000000<x<=4,000000	12	745	1,60428	99,5989	1,60428	99,5989
4,000000<x<=5,000000	3	748	0,40107	100,0000	0,40107	100,0000
Braki	0	748	0,00000		0,00000	100,0000

Zmienna	Statystyki opisowe (statystyka open face)							
	Nważnych	Średnia	Mediana	Moda	Liczność Mody	Minimum	Maksimum	Odch.std
Align pitch	232	0,937069	0,800000	0,100000	22	0,00	3,000000	0,713874
Align roll	232	0,574569	0,500000	0,100000	36	0,00	2,500000	0,454701
Align rtn	232	0,546983	0,400000	0,100000	38	0,00	2,900000	0,560990
Stand pitch	734	1,406267	1,300000	3,000000	66	0,00	3,300000	0,962256
stand roll	735	1,020680	0,800000	0,100000	69	0,00	3,000000	0,859793
Stand rtn	748	1,016444	0,800000	0,300000	56	0,00	5,000000	0,812130







Wykres ramka-wąsy

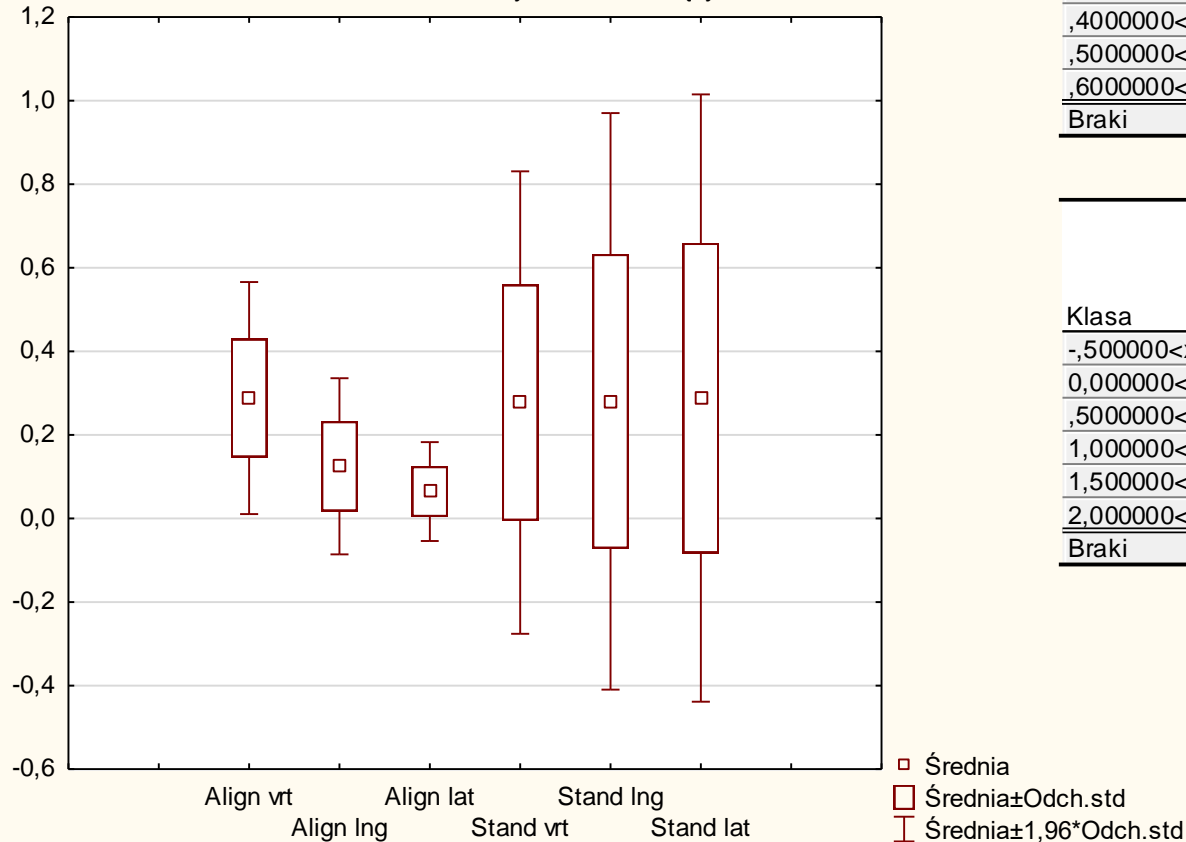


Tabela liczności: Align vrt (statystyka open face)						
K-S d=,06963, p> .20; Lilliefors p<,01						
Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,100000<x<=,214E-14	3	3	1,2931	1,2931	0,40107	0,4011
,214E-14<x<=,1000000	26	29	11,2069	12,5000	3,47594	3,8770
,1000000<x<=,2000000	34	63	14,6552	27,1552	4,54545	8,4225
,2000000<x<=,3000000	58	121	25,0000	52,1552	7,75401	16,1765
,3000000<x<=,4000000	69	190	29,7414	81,8966	9,22460	25,4011
,4000000<x<=,5000000	29	219	12,5000	94,3966	3,87701	29,2781
,5000000<x<=,6000000	11	230	4,7414	99,1379	1,47059	30,7487
,6000000<x<=,7000000	2	232	0,8621	100,0000	0,26738	31,0160
Braki	516	748	222,4138		68,98396	100,0000

Tabela liczności: Stand vrt (statystyka open face)						
K-S d=,16625, p<,01 ; Lilliefors p<,01						
Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	13	13	1,73797	1,7380	1,73797	1,7380
0,000000<x<=,5000000	615	628	82,21925	83,9572	82,21925	83,9572
,5000000<x<=1,000000	91	719	12,16578	96,1230	12,16578	96,1230
1,000000<x<=1,500000	27	746	3,60963	99,7326	3,60963	99,7326
1,500000<x<=2,000000	1	747	0,13369	99,8663	0,13369	99,8663
2,000000<x<=2,500000	1	748	0,13369	100,0000	0,13369	100,0000
Braki	0	748	0,00000		0,00000	100,0000

Wykres ramka-wąsy

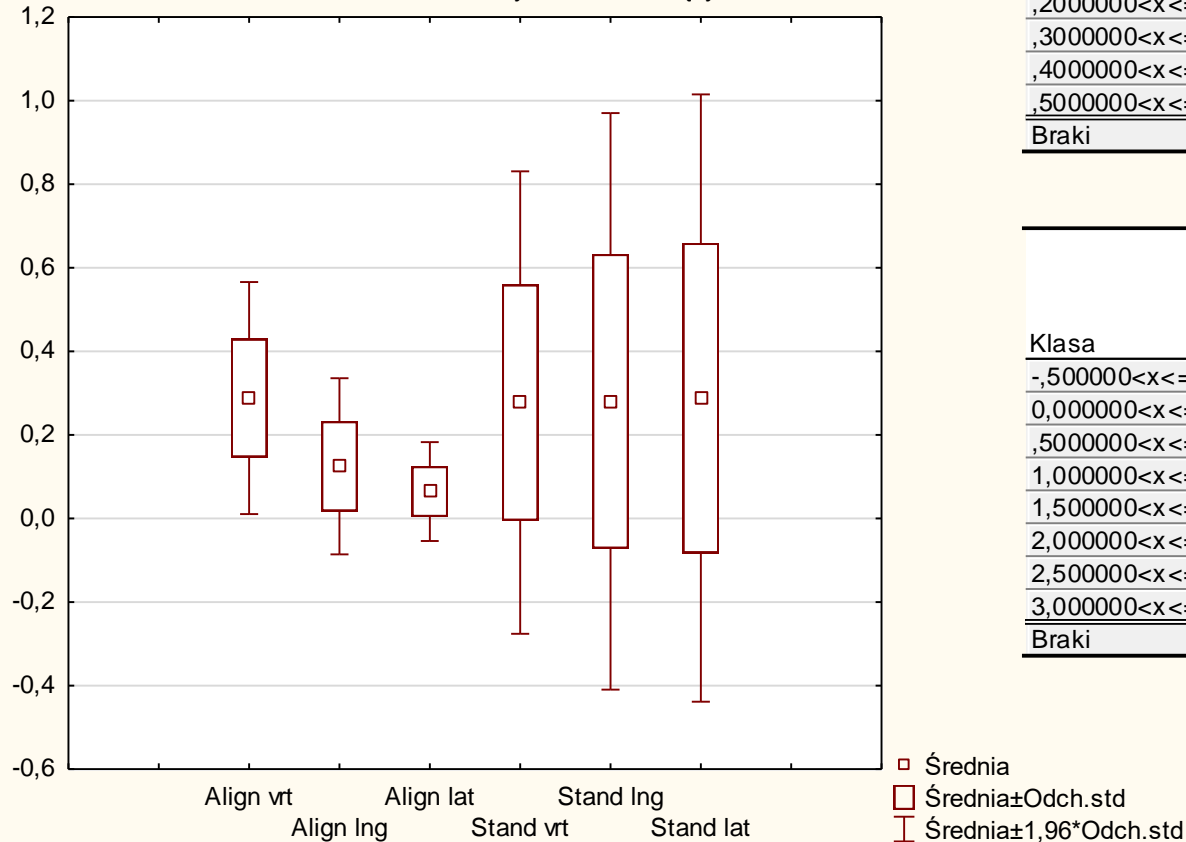


Tabela liczności: Align lng (statystyka open face)

K-S d=,16196, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,100000<x<=,214E-14	2	2	0,8621	0,8621	0,26738	0,2674
,214E-14<x<=,1000000	126	128	54,3103	55,1724	16,84492	17,1123
,1000000<x<=,2000000	61	189	26,2931	81,4655	8,15508	25,2674
,2000000<x<=,3000000	24	213	10,3448	91,8103	3,20856	28,4759
,3000000<x<=,4000000	13	226	5,6034	97,4138	1,73797	30,2139
,4000000<x<=,5000000	5	231	2,1552	99,5690	0,66845	30,8824
,5000000<x<=,6000000	1	232	0,4310	100,0000	0,13369	31,0160
Braki	516	748	222,4138		68,98396	100,0000

Tabela liczności: Stand lng (statystyka open face)

K-S d=,21286, p<,01 ; Lilliefors p<,01

Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	17	17	2,27273	2,2727	2,27273	2,2727
0,000000<x<=,5000000	632	649	84,49198	86,7647	84,49198	86,7647
,5000000<x<=1,000000	64	713	8,55615	95,3209	8,55615	95,3209
1,000000<x<=1,500000	9	722	1,20321	96,5241	1,20321	96,5241
1,500000<x<=2,000000	25	747	3,34225	99,8663	3,34225	99,8663
2,000000<x<=2,500000	0	747	0,00000	99,8663	0,00000	99,8663
2,500000<x<=3,000000	0	747	0,00000	99,8663	0,00000	99,8663
3,000000<x<=3,500000	1	748	0,13369	100,0000	0,13369	100,0000
Braki	0	748	0,00000		0,00000	100,0000

Wykres ramka-wąsy

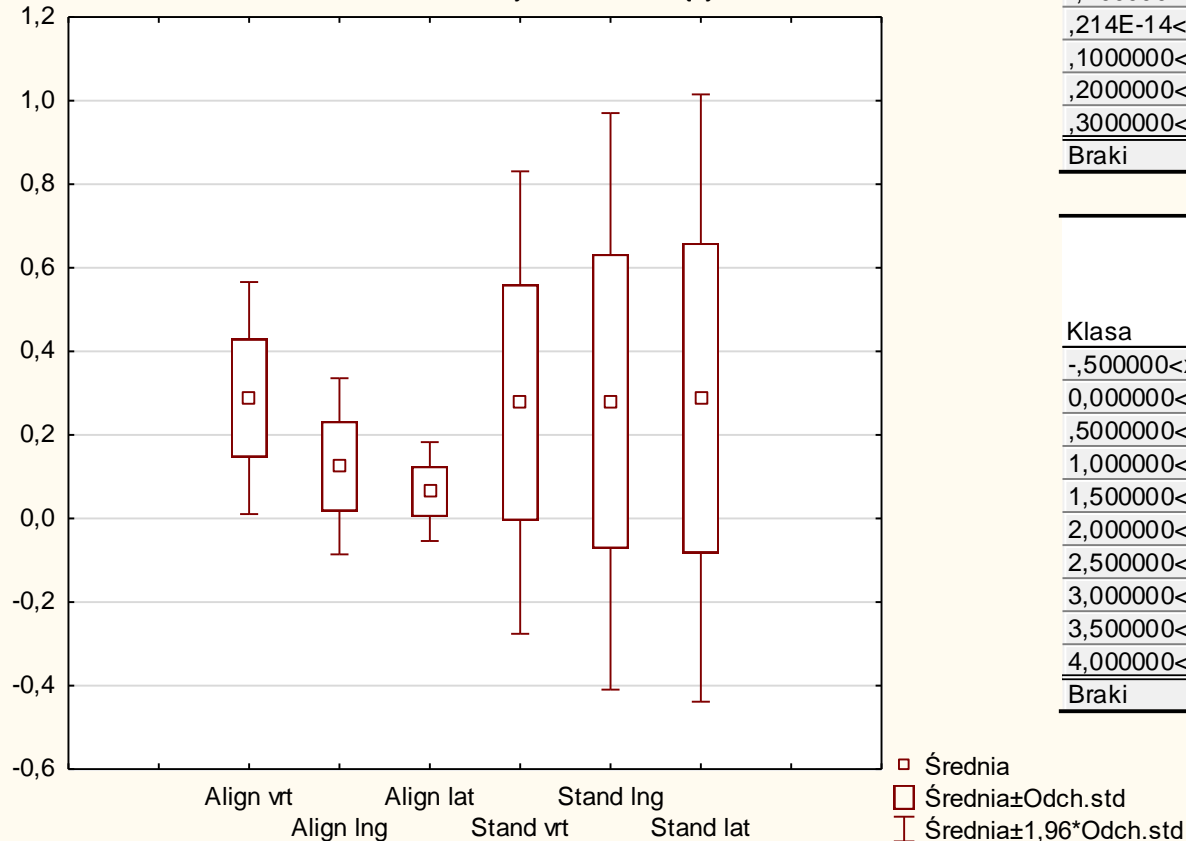
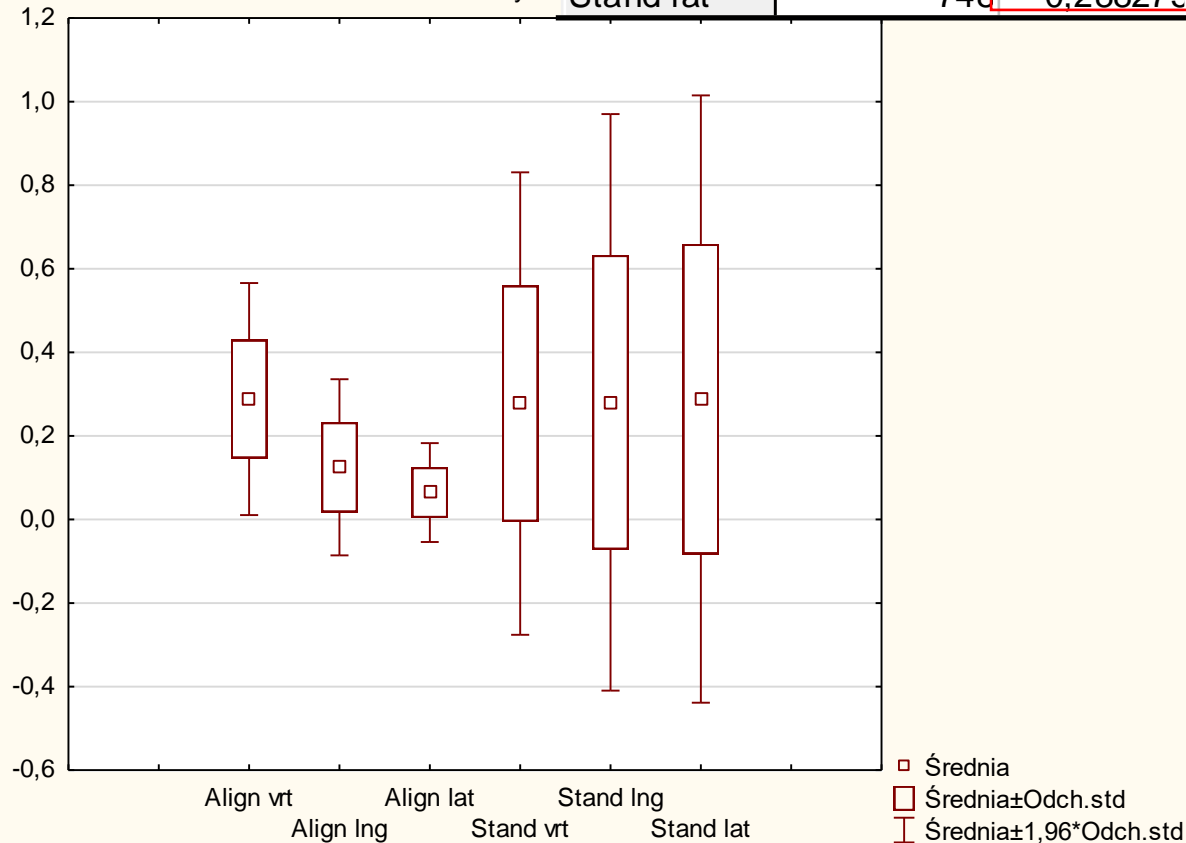


Tabela licznosci: Align lat (statystyka open face)						
K-S d=,17940, p<,01 ; Lilliefors p<,01						
Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,100000<x<=,214E-14	7	7	3,0172	3,0172	0,93583	0,9358
,214E-14<x<=,1000000	180	187	77,5862	80,6034	24,06417	25,0000
,1000000<x<=,2000000	36	223	15,5172	96,1207	4,81283	29,8128
,2000000<x<=,3000000	7	230	3,0172	99,1379	0,93583	30,7487
,3000000<x<=,4000000	2	232	0,8621	100,0000	0,26738	31,0160
Braki	516	748	222,4138		68,9839€	100,0000

Tabela licznosci: Stand lat (statystyka open face)						
K-S d=,21847, p<,01 ; Lilliefors p<,01						
Klasa	Liczba	Skumulow. Liczba	Procent Ważnych	Skumul. % Ważnych	% ogółu Przypadki	Skumulow. % Ogółu
-,500000<x<=0,000000	19	19	2,54011	2,5401	2,54011	2,5401
0,000000<x<=,5000000	621	640	83,02139	85,5615	83,02139	85,5615
,5000000<x<=1,000000	75	715	10,02674	95,5882	10,02674	95,5882
1,000000<x<=1,500000	25	740	3,34225	98,9305	3,34225	98,9305
1,500000<x<=2,000000	1	741	0,13369	99,0642	0,13369	99,0642
2,000000<x<=2,500000	2	743	0,26738	99,3316	0,26738	99,3316
2,500000<x<=3,000000	2	745	0,26738	99,5989	0,26738	99,5989
3,000000<x<=3,500000	1	746	0,13369	99,7326	0,13369	99,7326
3,500000<x<=4,000000	1	747	0,13369	99,8663	0,13369	99,8663
4,000000<x<=4,500000	1	748	0,13369	100,0000	0,13369	100,0000
Braki	0	748	0,00000		0,00000	100,0000

Zmienna	Statystyki opisowe (statystyka open face)							
	Nważnych	Średnia	Mediana	Moda	Liczność Mody	Minimum	Maksimum	Odch.std
Align vrt	232	0,288233	0,300000	0,380000	15	0,00	0,640000	0,141656
Align lng	232	0,124957	0,085000	0,050000	23	0,00	0,600000	0,107599
Align lat	232	0,064526	0,050000	Wielokr.	29	0,00	0,370000	0,060379
Stand vrt	748	0,277500	0,180000	0,080000	29	0,00	2,330000	0,282325
Stand lng	748	0,280428	0,170000	0,100000	32	0,00	3,020000	0,352051
Stand lat	748	0,288275	0,190000	Wielokr.	25	0,00	4,130000	0,370837

Wykre





Grupa 1 wz. Grupy 2	Testy dla prób niezależnych (statystyka open face) Uwaga: Zmienne traktowane są jako niezależne próby.													
	Średnia Grupa 1	Średnia Grupa 2	t	df	p	Nważnych Grupa 1	Nważnych Grupa 2	Odch.std Grupa 1	Odch.std Grupa 2	iloraz F Wariancje	p Wariancje	Levene'a F(1,df)	df Levene'a	p Levene'a
Align pitch vs. Stand pitch	0,937069	1,406267	-6,8537	964	0,000000	232	734	0,713874	0,962256	1,816930	0,000000	48,6038	964	0,000000
Align roll vs. stand roll	0,574569	1,020680	-7,5739	965	0,000000	232	735	0,454701	0,859793	3,575496	0,000000	104,5434	965	0,000000
Align rtn vs. Stand rtn	0,546983	1,016444	-8,2163	978	0,000000	232	748	0,560990	0,812130	2,095759	0,000000	42,5171	978	0,000000

Grupa 1 wz. Grupy 2	Testy dla prób niezależnych (statystyka open face) Uwaga: Zmienne traktowane są jako niezależne próby.													
	Średnia Grupa 1	Średnia Grupa 2	t	df	p	Nważnych Grupa 1	Nważnych Grupa 2	Odch.std Grupa 1	Odch.std Grupa 2	iloraz F Wariancje	p Wariancje	Levene'a F(1,df)	df Levene'a	p Levene'a
Align vrt vs. Stand vrt	0,288233	0,277500	0,5575	978	0,577289	232	748	0,141656	0,282325	3,97216	0,000000	49,2941	978	0,000000
Align lng vs. Stand lng	0,124957	0,280428	-6,6290	978	0,000000	232	748	0,107599	0,352051	10,70527	0,000000	62,9065	978	0,000000
Align lat vs. Stand lat	0,064526	0,288275	-9,1495	978	0,000000	232	748	0,060379	0,370837	37,72163	0,000000	77,4606	978	0,000000

## Initial clinical experience of surface guided stereotactic radiation therapy with open-face mask immobilization for improving setup accuracy: a retrospective study

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**Results:** The absolute values of median (maximal) CBCT couch shifts were 0.4 (1.3) mm in VRT, 0.1 (2.5) mm in LNG, 0.2 (1.6) mm in LAT, 0.1(1.2) degree in YAW, 0.2 (1.4) degree in PITCH and 0.1(1.3) degree in ROLL. The couch shifts and AlignRT RTD values exhibited highly agreement except in VRT and PITCH (p value < 0.01), of which the differences were as small as negligible. We did not find any case of patient repositioning that was due to out-of-tolerance setup errors, i.e., 3 mm and 2 degree. The surface guided setup time ranged from 52 to 174 s, and the mean and median time was 97.72 s and 94 s respectively.

**Conclusions:** The proposed surface guided SRT procedure with open-face mask immobilization is a step forward in improving patient comfort and positioning accuracy in the same process. Minimized initial setup errors and repositioning rate had been achieved with reasonably efficiency for routine clinical practice.

## Intra-fractional motion error during HyperArc stereotactic radiosurgery on patients with brain metastases: Comparison of open and full-face clamshell-style immobilization devices

Shingo Ohira <sup>1 2</sup>, Riho Komiyama <sup>1</sup>, Naoyuki Kanayama <sup>1</sup>, Yoshihiro Ueda <sup>1</sup>, Shoki Inui <sup>1</sup>, Masayoshi Miyazaki <sup>1</sup>, Masahiko Koizumi <sup>2</sup>, Koji Konishi <sup>1</sup>

**Results:** For Encompass, the mean values of IME in the translational setup were 0.1, 0.2, and 0.0 mm in the anterior-posterior, superior-inferior, and left-right directions, respectively, and the mean values of IME about rotational axes were -0.1, 0.0, and 0.0° for the Pitch, Roll, and Yaw rotations, respectively. For DSPS, the mean values of IME in the translational setup were 0.2, 0.2, and 0.0 mm in the anterior-posterior, superior-inferior, and left-right directions, respectively, and the mean values of IME about rotational axes were -0.1, -0.1, and 0.0° for the Pitch, Roll, and Yaw rotations, respectively. No statistically significant difference was observed between the IME of the two immobilization systems except in the anterior-posterior direction ( $p = 0.02$ ). Moreover, no statistically significant correlation was observed between three-dimensional IME and treatment time. The margin compensation for IME was less than 1 mm for both immobilization devices.

**Conclusions:** The IME during STI using open- and full-face clamshell-style immobilization devices is approximately equal considering the adequate accuracy in patient positioning.

## Assessment of intra-fraction motion during automated linac-based SRS treatment delivery with an open face mask system

Mariluz De Ornelas <sup>1</sup>, Tejan Diwanji <sup>2</sup>, Irene Monterroso <sup>2</sup>, Elizabeth Bossart <sup>2</sup>, Raphael Yechieli <sup>2</sup>, Nesrin Dogan <sup>2</sup>, Eric A Mellon <sup>2</sup>

**Results:** For 132 fractions with isocenter within a single target, the median shift magnitude was 0.40 mm with a maximum shift of 1.17 mm. A total of 398 targets treated for plans having multiple or single targets that lied outside isocenter, resulted in a median shift magnitude of 0.46 mm, with median translational shifts of 0.20 mm and 0.20° rotational shifts. A 1 mm PTV margin was insufficient in 18% of targets at a distance greater than 6 cm away from isocenter, but sufficient for 96% of targets within 6 cm.

**Conclusions:** The findings of this study support 1 mm PTV expansion due to intra-fraction motion to ensure target coverage for plans with isocenter placement less than 6 cm away from the targets.

## WNIOSKI na podstawie doświadczeń własnych

- AlignRT nie wydłuża czasu pozycjonowania na paracie terapeutycznym
- Użycie masek typu open-face wraz z AlignRT zapewnia wysoką odtwarzalność ułożenia chorego
- Stosowanie AlignRT zapewnia większą precyzję ułożenia w zakresie rotacji wokół osi x,y,z
- Nie zaobserwowano ruchomości w trakcie seansu RT
- Pacjenci nie wymagają repozycjonowania

Zastosowanie masek typu open-face do radioterapii stereotaktycznej w obrębie mózgowia wraz z AlignRT zapewnia wysoką precyzję ułożenia i zmniejsza odsetek przypadków wymagających repozycjonowania chorego na stole terapeutycznym. Ze względu na powyższe oraz komfort chorego, tego typu rozwiązanie wydaje się uzasadnione i praktyczne.



