

# Efficacy of functional alignment using robotic-arm assisted total knee arthroplasty



Masashi Tamaki 1) Yuki Yamauchi 2) Seishiro Higa 2) Tomoyuki Shimakawa 2) Yuki Isobe 2)  
Kenji Hara 2) Teruya Ishibashi 3) Shoji Konda 4) Tetsuya Tomita 5)

- 1) Dept. of Orthopedics, Osaka University Graduate School of Medicine
- 2) Dept. of Orthopedics, Yaesekai Doujin Hospital
- 3) Div. of Orthopedic Biomaterial Science, Osaka University Graduate School of Medicine
- 4) Dept. of Health and Sport Sciences, Osaka University Graduate School of Medicine
- 5) Graduate School of Health Sciences, Morinomiya University of Medical Sciences



# Objective

- We examined the efficacy of functional alignment using Mako robotic-arm system (Stryker) operated at our institution.
- Our hypothesis was that the functional alignment would reproducibly achieve the target joint gaps in flexion and extension.

# Patients and Methods

- 59cases、 81knees (bilateral 22cases)
- Male : Female = 12 : 47
- Mean age @ TKA  $76.3 \pm 6.5$  y.o.
- Medial type OA of knee
- Triathlon CR Cementless
- Cementless fixation
- **The osteotomy thickness and angle were adjusted to achieve a medial joint gap of at least 18 mm. (Functional alignment)**



# Assesment

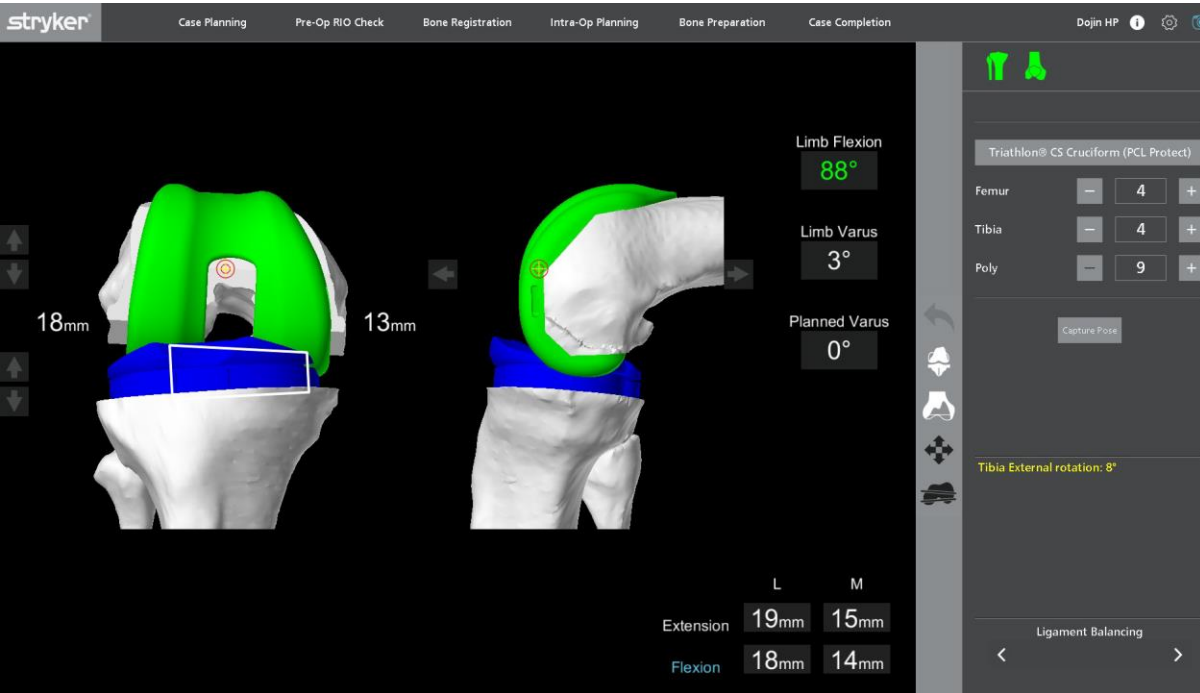
- The final alignment and the joint gaps before and after osteotomy
- The effect of adjusting the osteotomy thickness and angle by functional alignment
- Multiple regression analysis was performed. The significance level was less than 5%.

# Assessment before osteotomy

	Min flex (° )	Max flex (° )
Range of Motion	8.1 ± 5.6	127.2 ± 8.6
	extension (° )	flexion (° )
Varus Angle	10.0 ± 4.7	5.2 ± 4.2

N=81

# The joint gap was measured in valgus stress at 0 degrees of extension and 90 degrees of flexion



## Valgus stress

ストレス有 [外反ストレス]	
外側(内反ストレス時)	内側
19(19)	15
18(19)	14

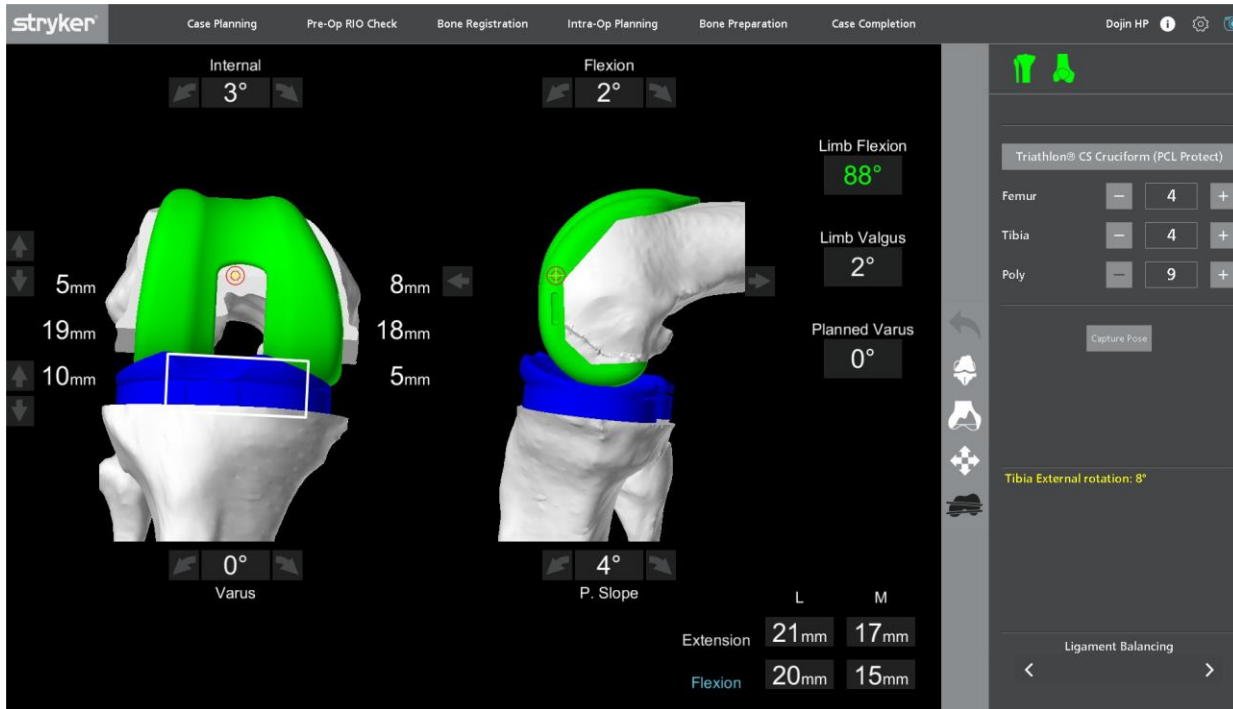


# Medial joint gap at valgus stress before osteotomy

	Medial(mm)	Lateral(mm)
Extension	<u>17.0 ± 2.6</u>	19.1 ± 2.4
Flexion	<u>16.3 ± 3.1</u>	18.3 ± 2.2

N=81

# The joint gap was measured in valgus stress at 0 degrees of extension and 90 degrees of flexion



ストレス有 [外反ストレス]	
外側(内反ストレス時)	内側
19(19)	15
18(19)	14



ストレス有 [外反ストレス]	
外側(内反ストレス時)	内側
19(24)	19
19(26)	18



# Assessment after osteotomy

	Min Flexion	Max Flexion
Range of Motion	$2.3 \pm 3.4$	$129.8 \pm 6.1$
	Extension	Flexion
Varus Angle	$3.3 \pm 2.8$	$2.4 \pm 2.8$

N=81



# Medial joint gap at valgus stress after osteotomy

	Medial(mm)	Lateral(mm)
Extension	<u>18.8 ± 1.2</u>	18.3 ± 1.7
Flexion	<u>18.9 ± 1.2</u>	18.1 ± 1.4

N=81

The effect of adjusting the osteotomy by functional alignment were examined using multiple regression analysis.

$$\begin{aligned} \text{Medial Gap in flexion} = & \underline{3.4} * \underline{\text{Femoral size down (3mm)}} \\ & + \underline{1.3} * \underline{\text{posterior slope of tibia}} + \underline{0.9} * \underline{\text{proximal thickness of tibia}} \\ & + \underline{0.8} * \underline{\text{femoral external rotation}} + 1.4 \end{aligned}$$

$$\begin{aligned} \text{Medial Gap in flexion} = & \underline{3.4} * \underline{\text{Femoral size down (3mm)}} \\ & + \underline{1.3} * \underline{\text{posterior slope of tibia}} + \underline{0.9} * \underline{\text{proximal thickness of tibia}} \\ & + \underline{0.8} * \underline{\text{femoral external rotation}} + 1.4 \end{aligned}$$

(Multiple regression analysis R<sup>2</sup>=0.55 P<0.0001)

# Discussion

- Robotic arm assisted TKA is becoming popular worldwide for its ability to perform accurate osteotomy and gap balancing safely and reproducibly.

BJO2020,JOA2018,BJJ2018,Knee surg2017,2019,2020

- We could also reproducibly achieve the target joint gaps in flexion and extension using functional alignment.

	Medial(mm)	Lateral(mm)
Extension	<u>18.8±1.2</u>	18.3±1.7
Flexion	<u>18.9±1.2</u>	18.1±1.4

# Significant effective factors for osteotomy adjustment

- Medial Gap in flexion =  $3.4 * \text{Femoral size down (3mm)}$  +  $1.3 * \text{posterior slope of tibia}$  +  $0.9 * \text{proximal thickness of tibia}$  +  $0.8 * \text{femoral external rotation}$  + 1.4
- Medial Gap in flexion =  $3.4 * \text{Femoral size down (3mm)}$  +  $1.3 * \text{posterior slope of tibia}$  +  $0.9 * \text{proximal thickness of tibia}$  +  $0.8 * \text{femoral external rotation}$  + 1.4



- We have learned some knowledge about joint gap adjustment that is useful not only for robotic arm assisted TKA but also for conventional TKA.



# Summary

- Functional alignment using robotics would reproducibly achieve the target joint gaps in extension and flexion.