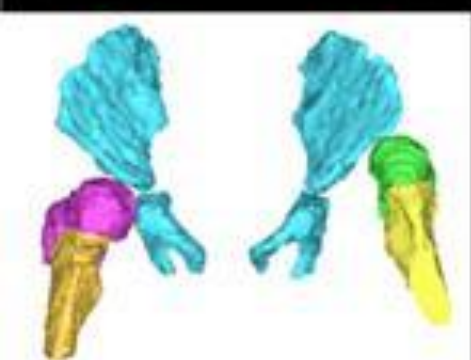


# 見えない軟骨を映し出す



2D-3D  
Registration



Overlay



AI-Based Contour Learning



整形外科 岡久仁洋

# Development of an articular cartilage imaging program

- Articular cartilage imaging on plain X-rays using MRI -

## 関節軟骨イメージングプログラムの開発

- MRIを用いた単純X線への関節軟骨イメージング -

Orthopedic Biomaterial Science, Graduated School of medicine,  
University of Osaka

Associate Proposer Kunihiro Oka

大阪大学大学院医学系研究科運動器バイオマテリアル学  
准教授・岡 久仁洋

## Backgrounds (1) Imaging Articular Cartilage on Plain Radiographs Using MRI

**Background:** Evaluation of articular cartilage is essential for the diagnosis and treatment of musculoskeletal disorders. While MRI is the only modality capable of assessing articular cartilage, it has limitations such as lengthy imaging times, the need for sedation in pediatric patients, and limited availability of equipment. Therefore, a technique that can readily visualize cartilage is sought.

**Challenge:** Lack of imaging tests that can easily evaluate articular cartilage

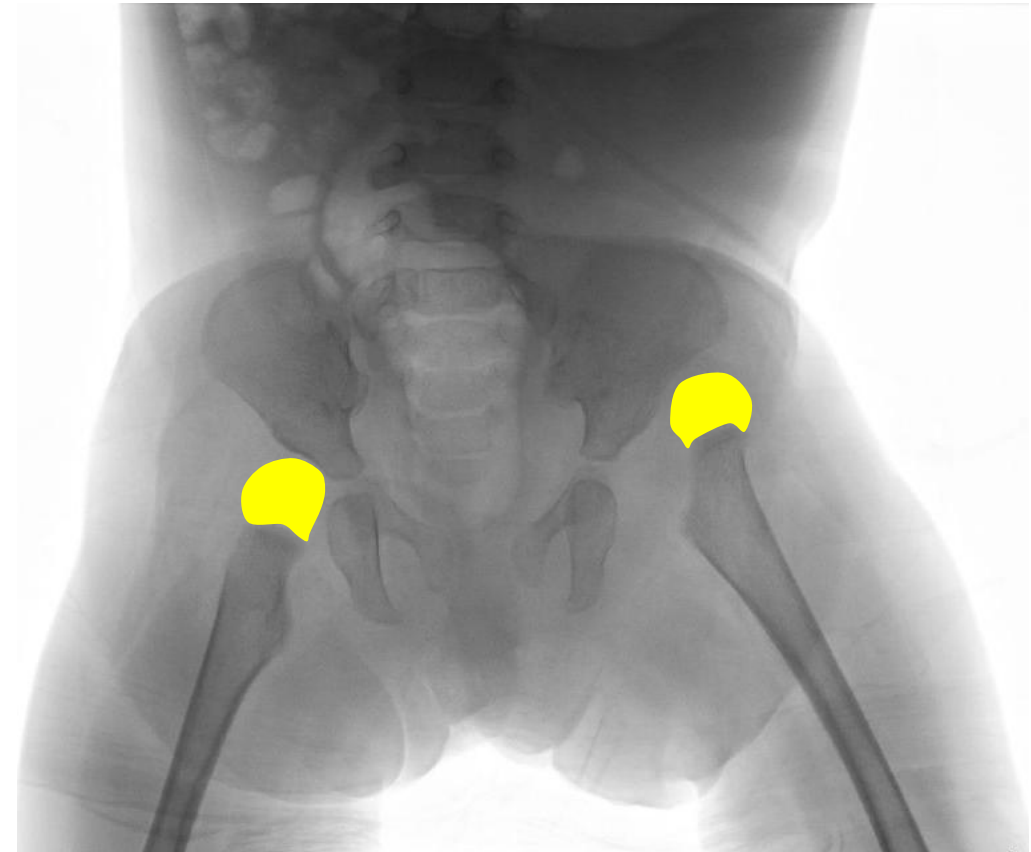
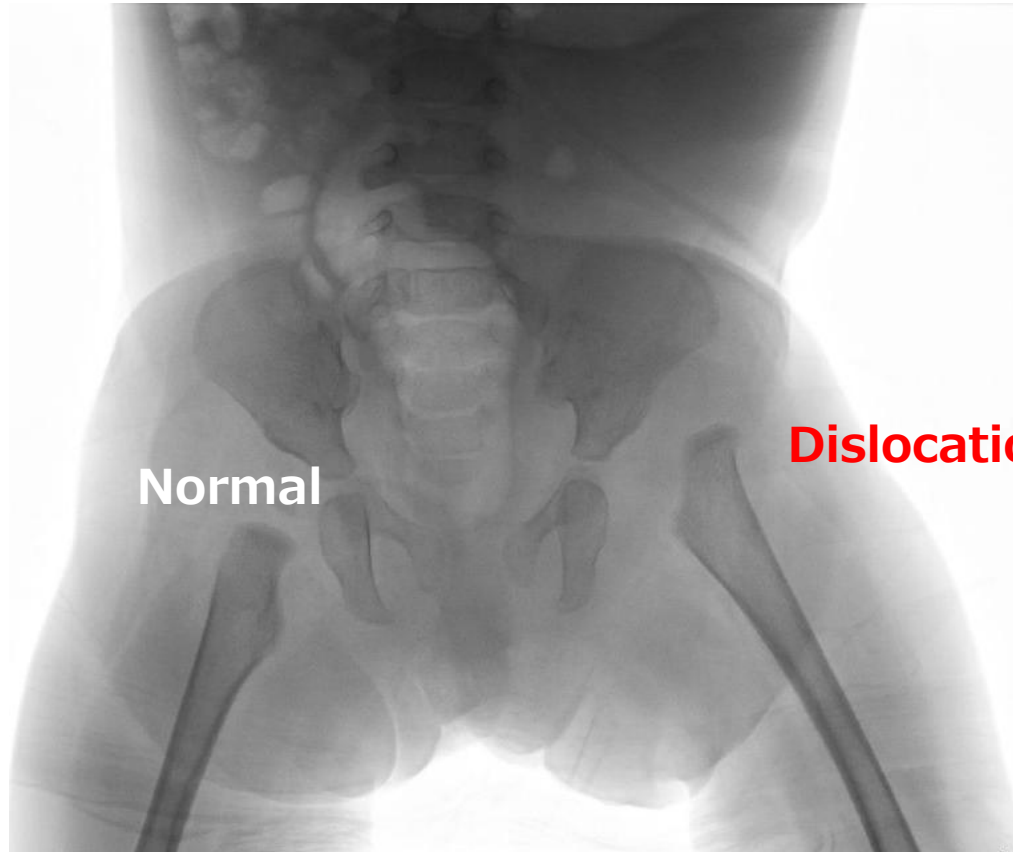
**Developed Technology**  
→ Solving existing challenges

	Plain X-ray	CT	MRI	Technology under development
Access	◎	○	×	◎
Cost	◎	△	×	◎
Inspection time	◎	○	×	◎
<b>Cartilage</b>	×	×	○	◎
Exposure	○	×	◎	◎

## Backgrounds (2) Imaging of articular cartilage on plain radiographs using MRI

Simple X-rays fail to show the articular cartilage portion, leading to missed diagnoses or diagnostic errors

Simple X-ray of Left Congenital Hip Dislocation Anatomically inferred cartilage area



## Seed Overview & Targeted Goal

### Targeted Disease:

Pediatric Joint Disorders (Congenital Hip Dislocation, Traumatic Disorders such as Fractures, etc.)

### Research Objective:

Develop a cartilage image generation program to enabling rapid and simple acquisition of high-precision cartilage images

### **Development Items:**

### Development Items:

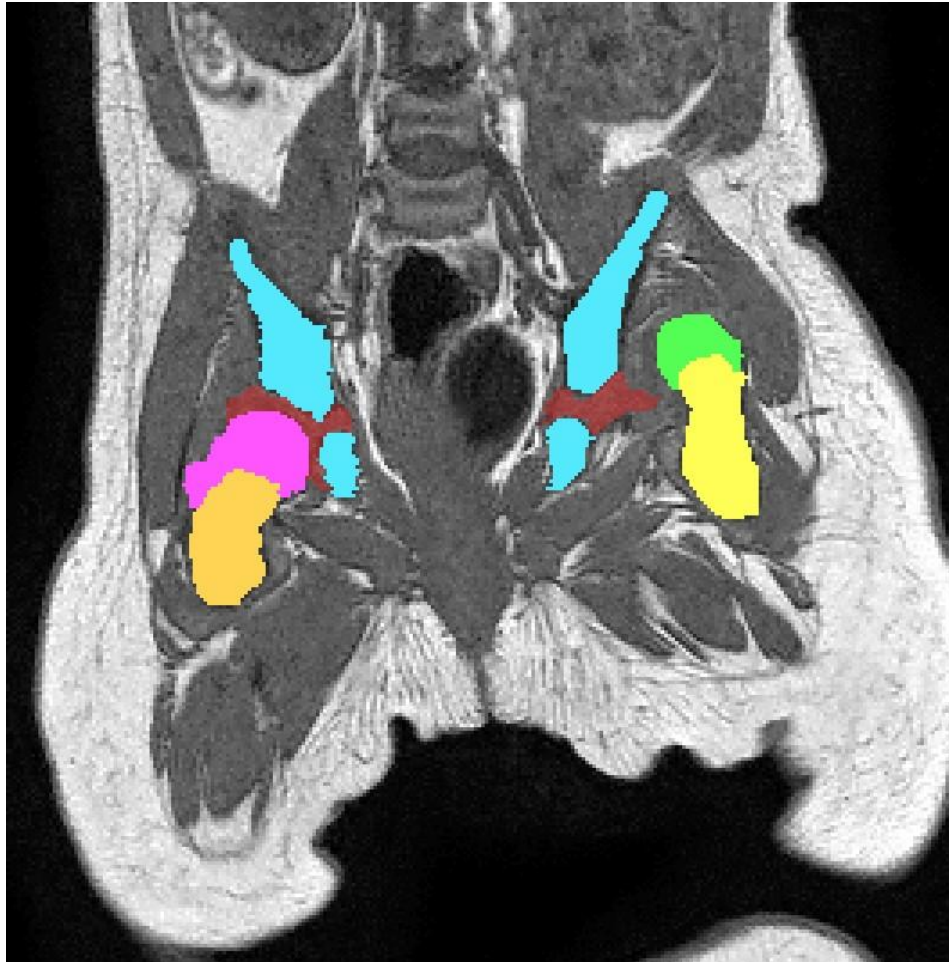
- (1) **Technology to render cartilage on plain X-ray images** by learning bone-cartilage images from MRI and their corresponding plain X-ray images
- (2) Technology to depict the unossified articular cartilage region in pediatric patients by learning from adult plain radiographs

### Outcome: **Application of cartilage visualization technology to the following**

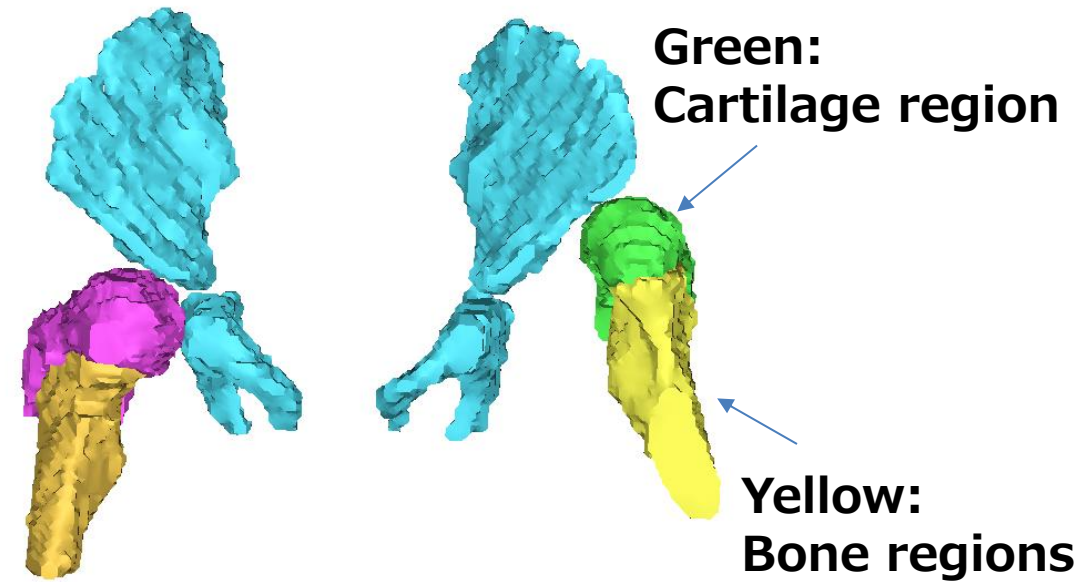
- ❑ **Integration into medical imaging systems** at healthcare institutions
- ❑ **Integration into image conversion systems using only image information, such as web services**
- ❑ **Inexpensive and simple image information tools available for use by screening facilities and municipal health departments**  
(Expansion into non-insurance medical device services)

## Key Data (1) Fusion of MRI Data and Plain X-ray Images

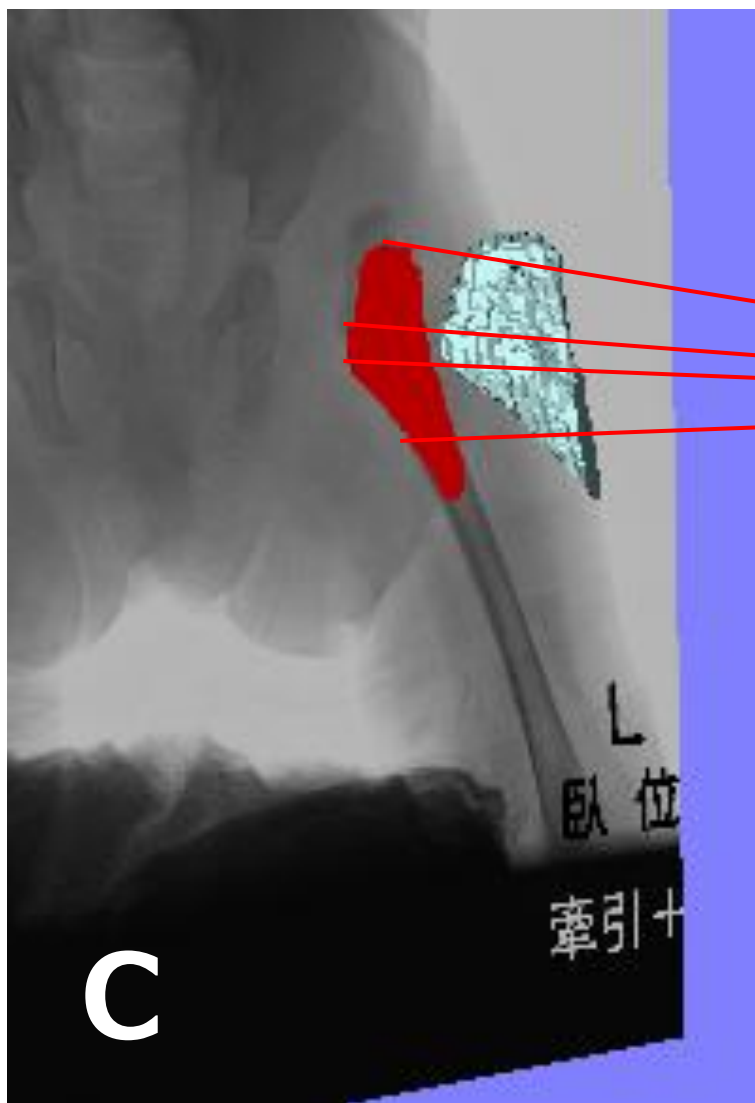
Extraction of Bone and Cartilage Regions via MRI



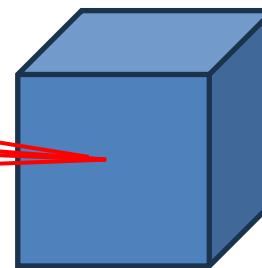
## 3D Bone and Cartilage Modeling



## Key Data (2) Fusion of MRI Data and Plain X-ray Images



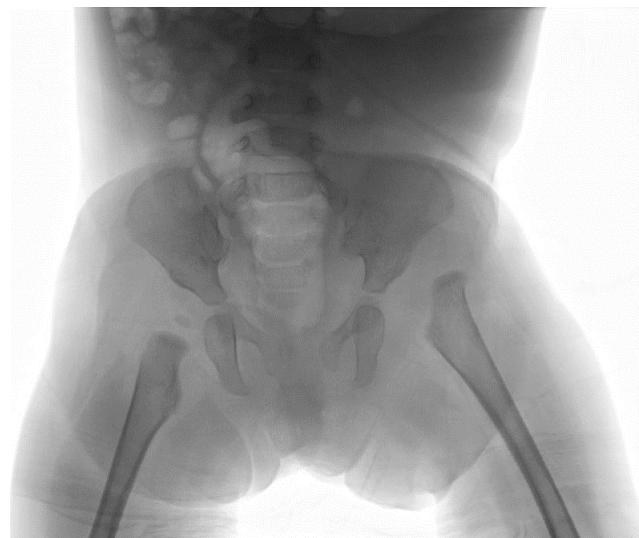
### Source



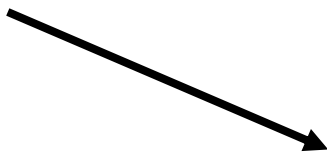
Estimation of the optimal spatial position and orientation of 3D data so that the contours of the 3D data match the contours of the 2D data

**2D-3D Registration Program  
Developed**

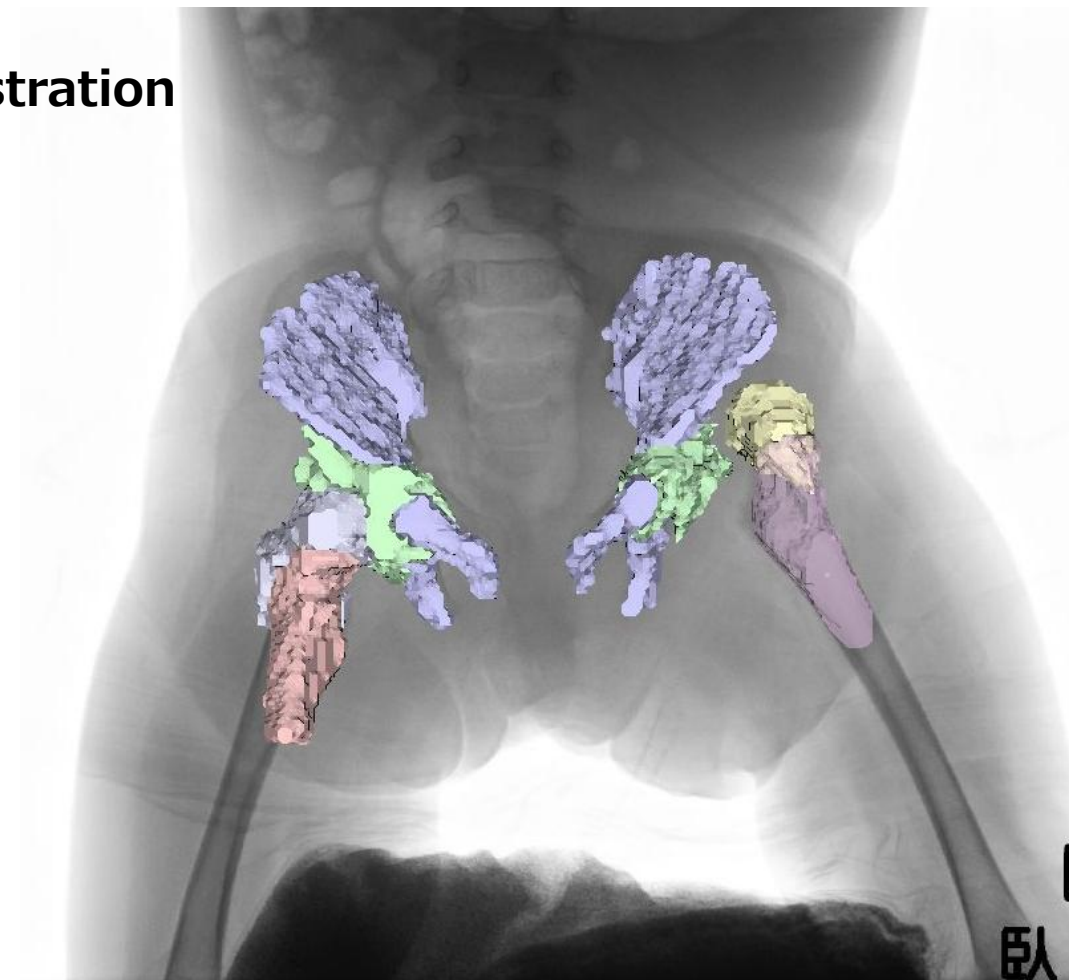
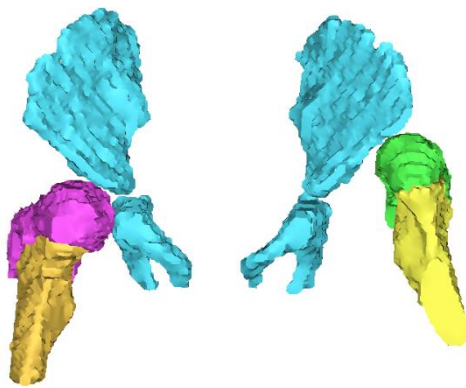
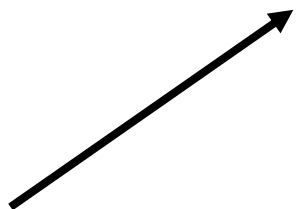
# Key Data (3) Fusion of MRI Data and Plain X-ray Images



2D-3D Registration



Overlay



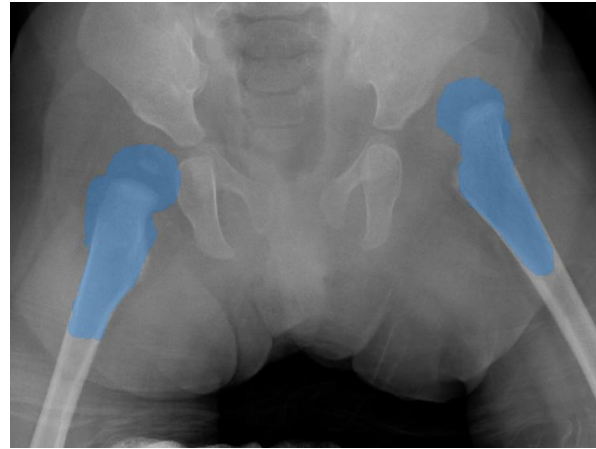
AI-Based Contour Learning

## Key Data (4) Cartilage Region Display

### Training Dataset



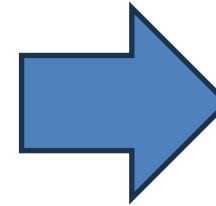
Plain X-ray Image



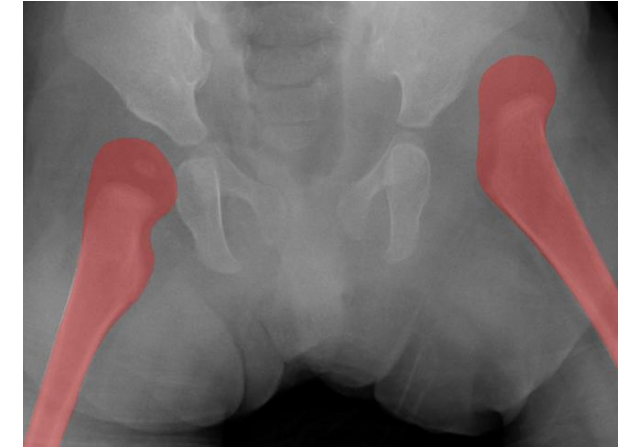
X-ray image with  
projected MRI  
osteochondral model  
(blue)

### Cross-validation

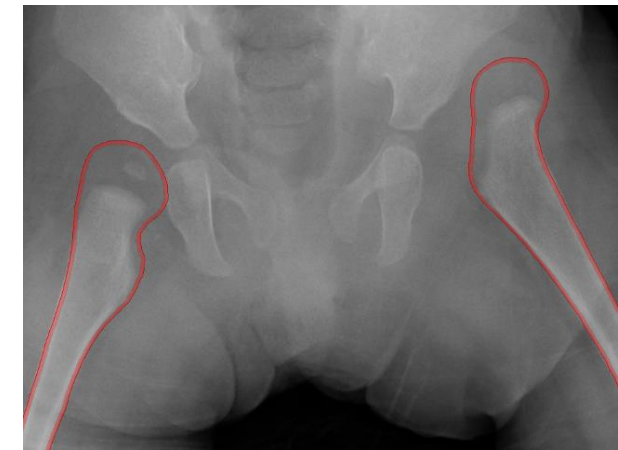
Training: Validation: Test 8:1:1



### AI-generated osteochondral region image

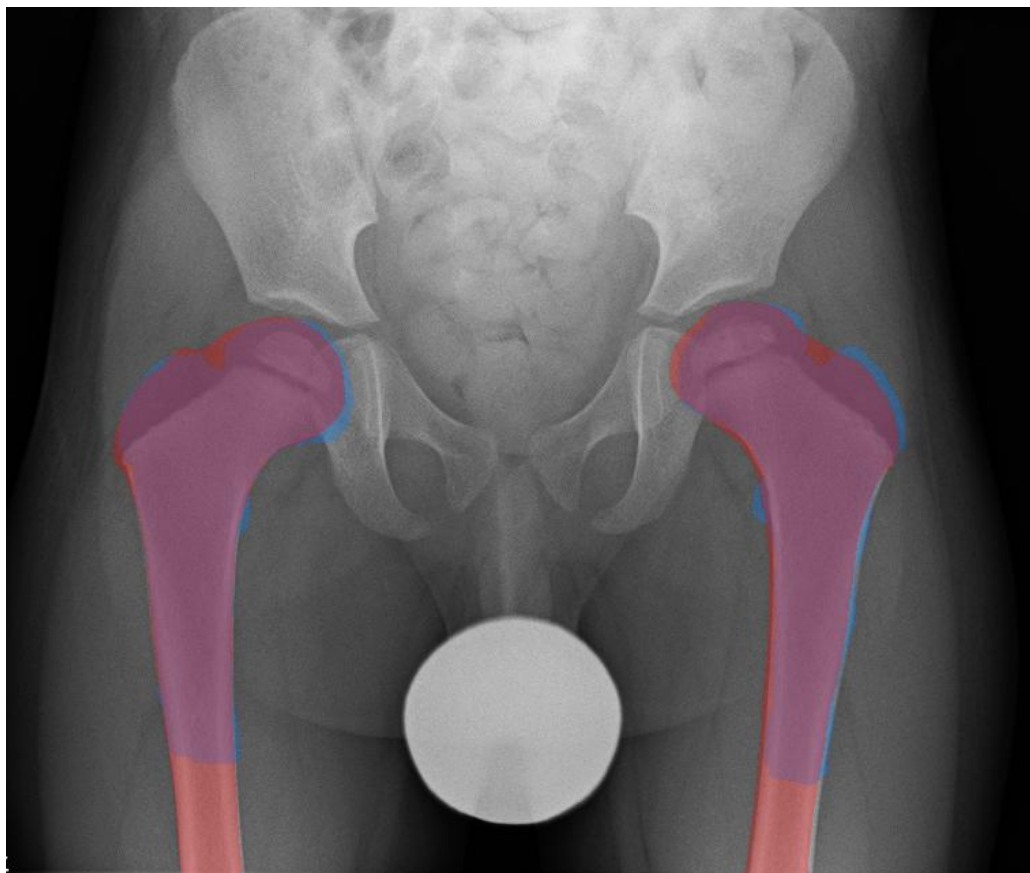


Osteochondral region (red)



Osteochondral contour (red)

## Key Data (5) Accuracy of Cartilage Re Accuracy Verification



Reference  
Region

Estimated  
Results

$$F_1 = 2 \cdot \frac{\text{適合率} \cdot \text{再現率}}{\text{適合率} + \text{再現率}}$$

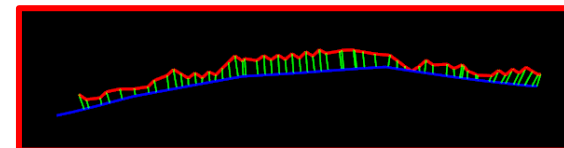
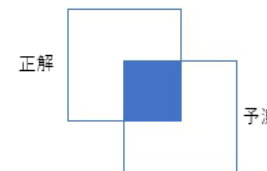
**0.90 ± 0.10**

$$IoU = \frac{A \cap B}{A \cup B}$$

**0.83 ± 0.12**

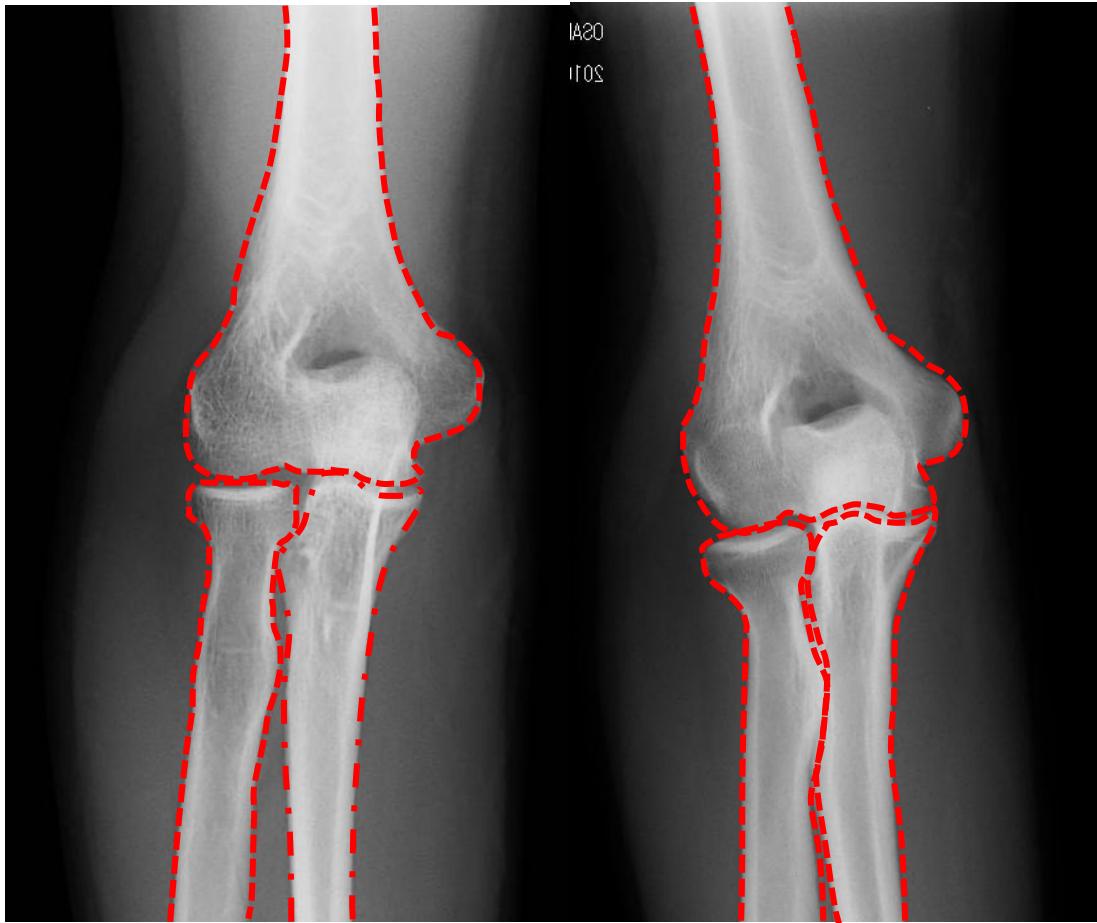
Mean Absolute Distance (MAD)

**1.33 ± 1.21mm**



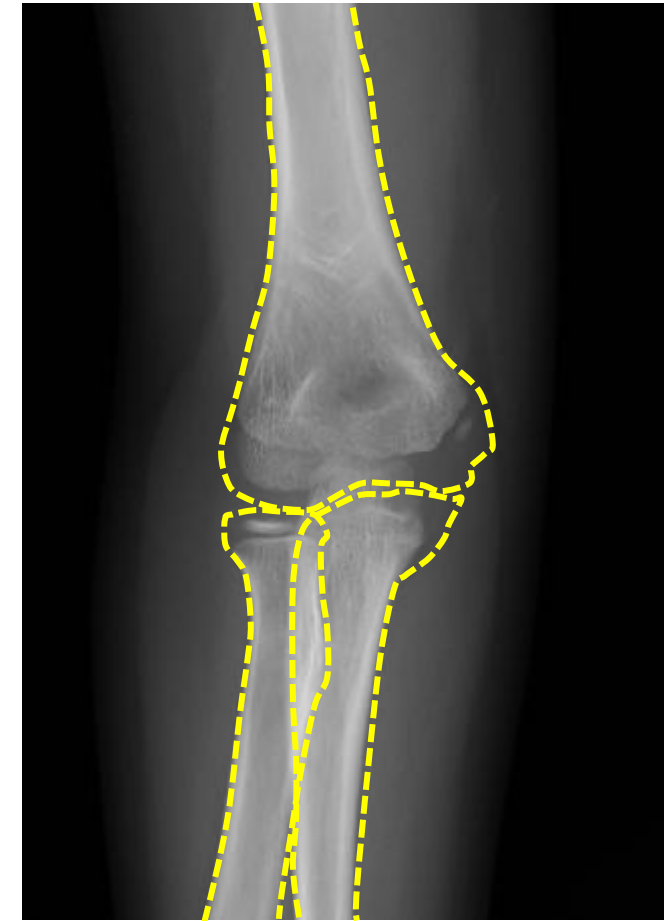
## Key Data (6) Imaging of pediatric articular cartilage regions from adult X-rays

**Adult elbow joint**



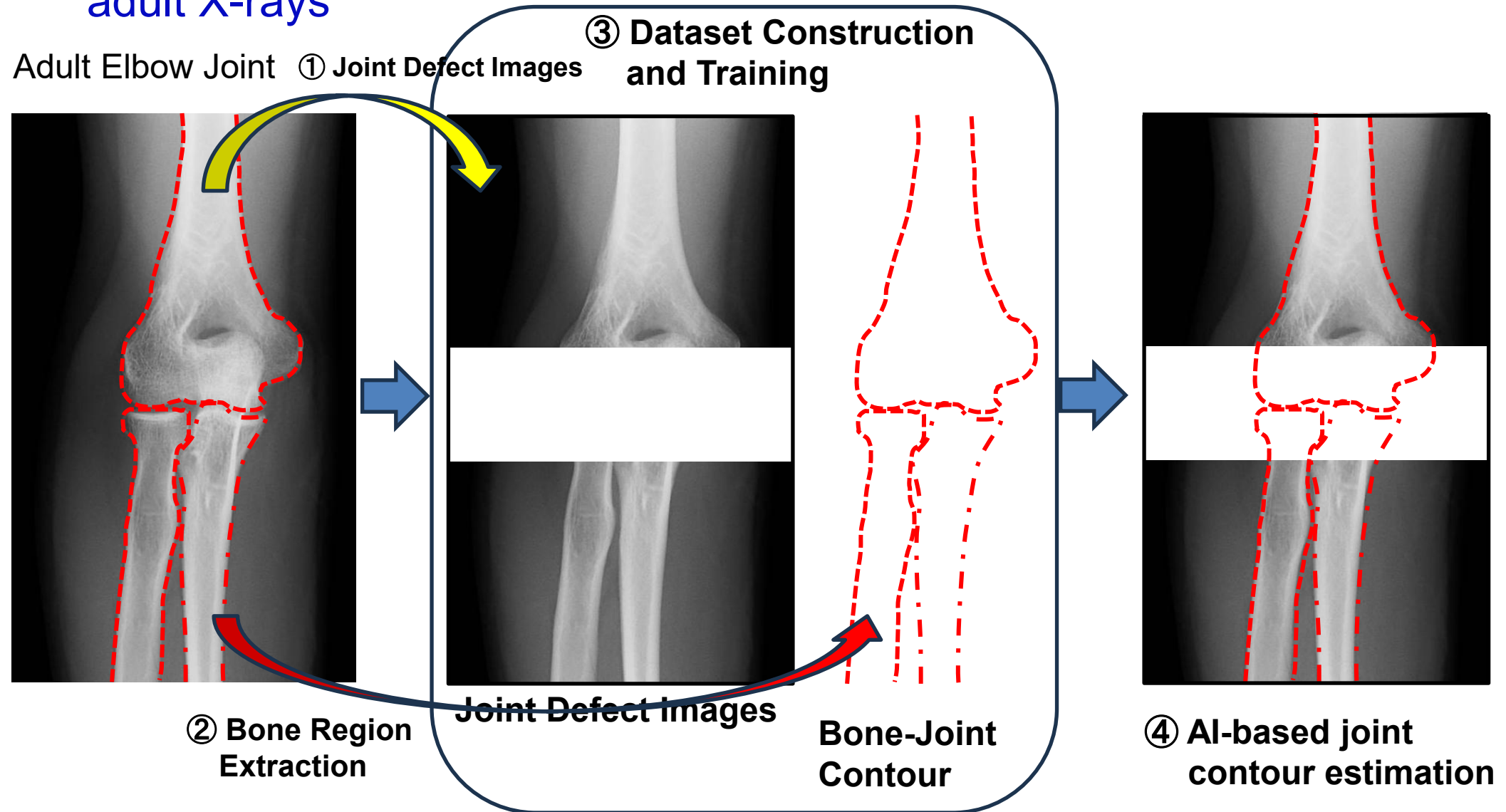
**Outline of Adult Bone Joints;  
Outline extraction is generally possible with X-rays**

**Pediatric elbow joint**



**Outline of pediatric bone joints;  
Joint areas must be estimated  
due to thick articular cartilage**

## Key Data (7) Imaging of pediatric articular cartilage regions from adult X-rays

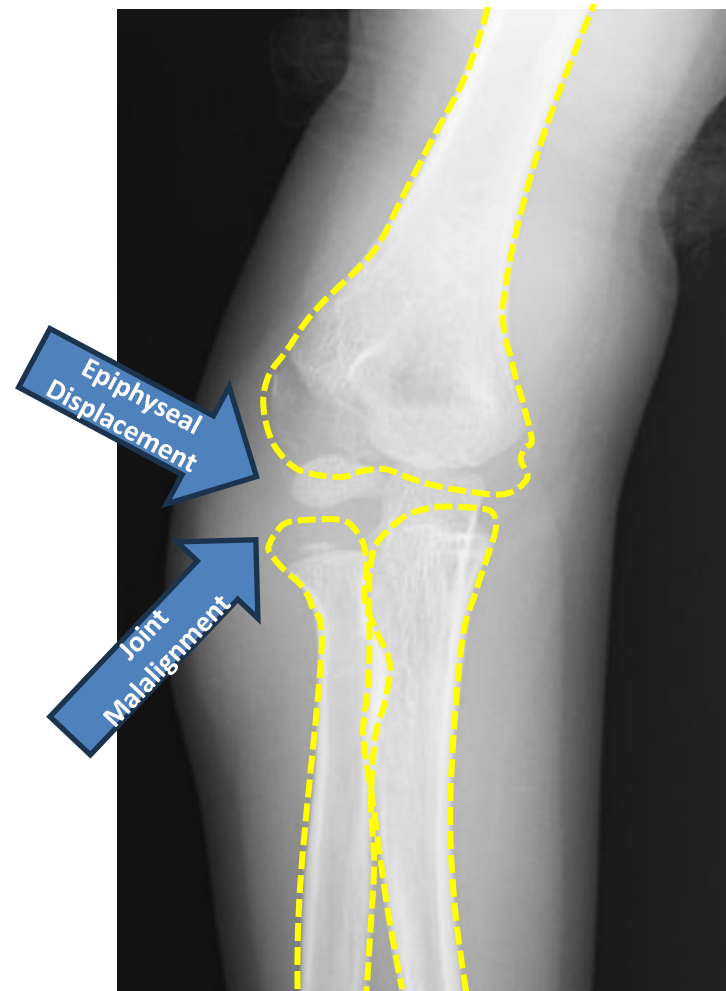


## Key Data (8) Imaging of pediatric articular cartilage regions from adult X-rays

**Fractures of the Pediatric Elbow Joint**



**AI-based contour extraction (prediction)**



Improved diagnostic accuracy for cartilage fractures

## Key Data (9) Imaging of pediatric articular cartilage regions from adult X-rays



**Annotation completed for 1,116 data points (186 cases × 3 images × 2)**



**AI training scheduled to begin in December 2025 (InterLab Co., Ltd.\*)**

\*: Outsourced AI program development provider

**Advantage: There is no imaging test that conveniently displays cartilage, and there are no competing technologies.**

- **Convenient evaluation of articular cartilage (using widely available plain radiography)**
- **No hardware required due to software-based program**
- **Improved treatment outcomes**
- **Reduced patient burden (no MRI sedation required)**
- **Reduction in healthcare costs**

# Exit Strategy

## Customer

① Neonatal and Infant Checkups: Palpation Only

↓ (Suspected)

② General orthopedic consultation: Plain X-ray

↓ (Suspicion present)

③ Pediatric Orthopedic Specialist Facility:  
Plain X-ray, Ultrasound, MRI

## Positioning of this Product

②③ Utilization

## Pharmaceutical Strategy

Aiming for regulatory approval as a program that provides cartilage region image information on plain hip X-ray images by demonstrating high image reconstruction performance

## Commercialization

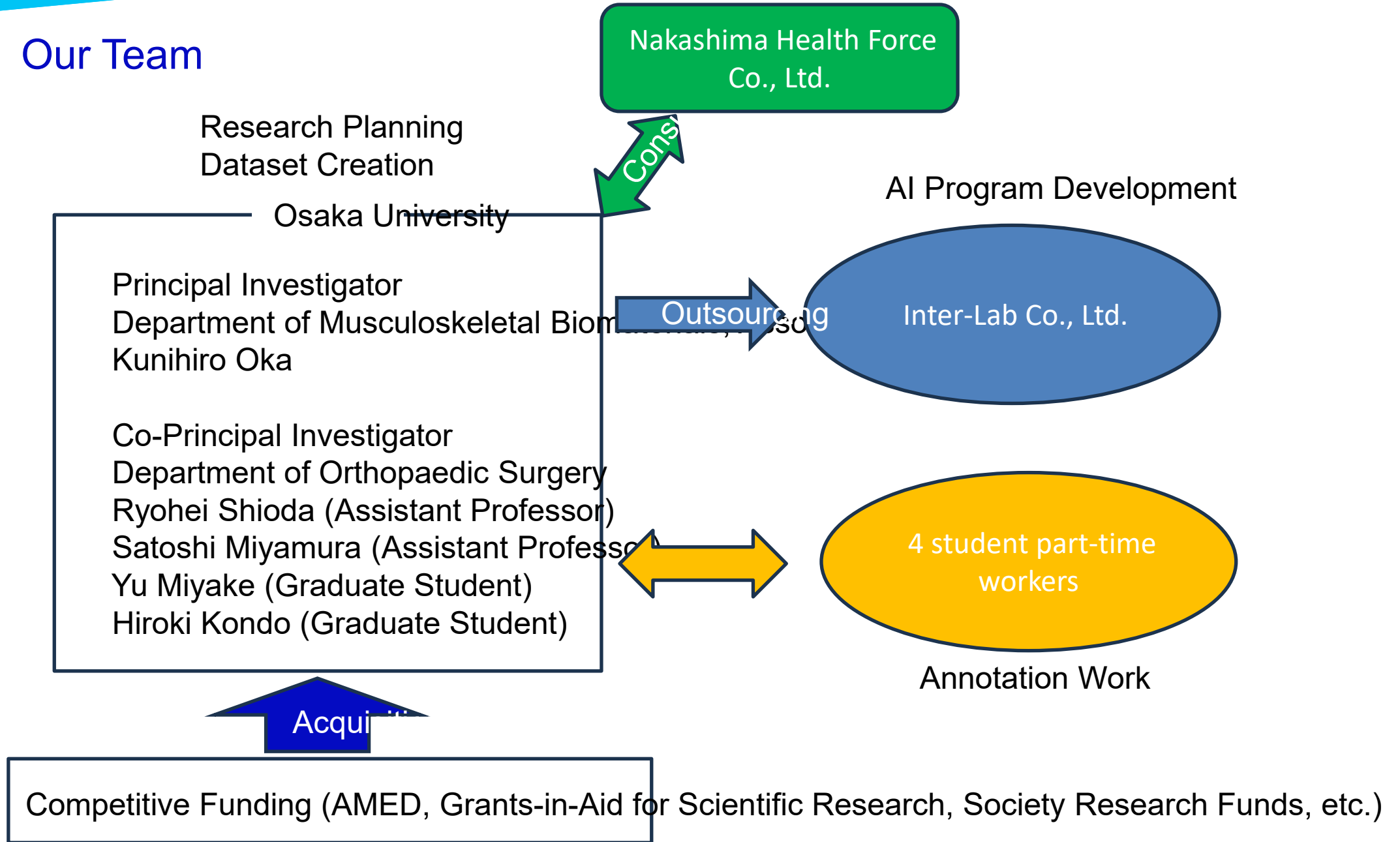
- ❑ Integration into medical imaging systems at healthcare institutions
- ❑ Integration into image conversion systems that utilize only image information via **web services, etc.**
- ❑ Generate revenue not through insurance-covered medical treatment as a medical device, but by widely disseminating it as **an inexpensive and simple tool to screening facilities and municipal health departments**

# Time Schedule; Roadmap

☑ : Achieved

Forecast Year	2024				2025				2026				2027			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	<b>Seeds A Grant Period</b>															
<b>Cartilage Imaging</b>																
2D-3D Registration Program		☑														
Congenital Hip Dislocation Imaging			☑													
Patent Application (MRI-Based Imaging)		☑														
TPP Consultation			☑													
PCT Application					☑											
Cartilage Imaging for Joint Diseases																
Imaging of Immature Cartilage in Pediatric Joints																
CT Cartilage Imaging																
Patent Application (Pediatric Cartilage/CT Cartilage)				☑												
PCT Application																☑
PMDA Consultation																
Software Application Development																
Pharmaceutical Strategy and Medical Device Approval																
Market Launch																

# Our Team



## Proposed Partnership Scheme;

### **Collaboration as a Joint Development Company**

#### **Our Team;**

- Development of Imaging Technology Using Competitive Funding
- Acquisition of New Competitive Funding (in Collaboration with Partner Companies)
- Accuracy Verification
- Clinical Trials

#### **Partner company;**

- Business model proposal
- Productization
- Collaboration with major companies handling medical images
- Service provision