arXiv:2509.25748v2 [cs.CV] 1 Oct 2025

Dolphin v1.0 Technical Report

Dolphin AI

https://chat.dolphin-ai.cn/

Abstract

Ultrasound is vital in modern medicine but faces challenges like operator dependence, image noise, and dynamic real-time scanning, which hinder effective AI integration. Though large multimodal models excel in other medical imaging areas, they struggle with ultrasound's unique complexities. To bridge this gap, we introduce Dolphin v1.0 (V1) and its reasoning-augmented version, Dolphin R1—the first large-scale multimodal ultrasound foundation models designed to unify diverse clinical tasks within a single vision-language framework. To tackle the variability, noise, and operator dependence inherent in ultrasound imaging, we curated a groundbreaking multimodal dataset at the 2-million-scale, integrating textbook knowledge, public ultrasound data, synthetic knowledge-distilled samples, and general multimodal corpora. This comprehensive dataset ensures the models achieve robust perception, strong generalization, and broad clinical adaptability across medical domains.

The Dolphin series adopts a progressive three-stage training strategy that combines domain-specialized pretraining, instruction-driven alignment, and reinforcement-based refinement. The baseline Dolphin v1.0 establishes reliable performance in classification, detection, regression, and report generation, offering a strong general-purpose model for clinical ultrasound analysis. Building upon this foundation, Dolphin R1 leverages reinforcement learning with verifiable ultrasound-specific reward signals, thereby enabling deeper diagnostic inference, enhanced reasoning transparency, and more interpretable decision pathways.

To systematically evaluate performance,We adopt U2-Bench for evaluation eight representative ultrasound tasks, ranging from lesion localization and organ detection to clinical value estimation and structured report generation. Experimental results demonstrate that Dolphin R1 achieves a U2-score of 0.5835—more than twice the score of the second-best model (0.2968)—establishing a new state of the art in multimodal ultrasound understanding. Meanwhile, Dolphin v1.0 also delivers competitive performance, validating the effectiveness of the unified training framework. Further comparison between standard mode (V1) and deep reasoning mode (R1) reveals that reasoning-enhanced training significantly boosts diagnostic accuracy, consistency, and interpretability. These findings underscore the importance of integrating reasoning into foundation models for high-stakes medical domains, providing a scalable paradigm for future developments in intelligent ultrasound analysis.

1 Introduction

Ultrasound (US) is one of the most widely utilized imaging modalities in clinical practice, playing a critical role in obstetrics, cardiology, emergency medicine, and resource-limited settings due to its real-time imaging capability, portability, and cost-effectiveness(Hewson &Bedforth (2023)). However, despite its broad applicability, ultrasound interpretation remains highly challenging compared to other medical imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). These modalities provide high spatial resolution, standardized anatomical views, and consistent image quality, whereas ultrasound is inherently operator-dependent, susceptible to imaging artifacts, and exhibits significant variability in acquisition quality(Sharma et al. (2021)).

Currently, multimodal large models have emerged as a powerful paradigm in artificial intelligence research(OpenAI (2023), Bai et al. (2025), Lin et al. (2023), Wu et al. (2024)), demonstrating remarkable capabilities in processing and integrating information across diverse modalities such as text, images, audio, and video. Currently, Multimodal large models have demonstrated significant potential in the medical field, offering advanced capabilities for integrating and analyzing diverse data types, including medical images (MRI,CT,PET; Lee et al. (2024); Volkov et al. (2025); Shui et al. (2025)), electronic health records(AlSaad et al. (2024)), genomic data(Fallahpour et al. (2025)), and clinical notes(Han et al. (2024)). While these models have achieved remarkable success in processing static, high-resolution medical images and structured clinical data, their application to ultrasound imaging presents unique challenges that remain largely unaddressed.

The translation of multimodal approaches to ultrasound is hindered by several critical limitations. First, unlike the standardized acquisition protocols for CT or MRI, ultrasound examinations are highly operator-dependent, resulting in significant variability in image quality and anatomical views (Stasi &Ruoti (2015)). Second, the dynamic nature of ultrasound video sequences - often containing crucial temporal information about tissue motion and blood flow - is fundamentally different from the static images that current multimodal models typically process (Szabo (2013)). Third, the characteristic speckle noise and lower signal-to-noise ratio of ultrasound images compared to other modalities create additional challenges for feature extraction and interpretation (Loizou &Pattichis (2022)). Furthermore, existing multimodal models struggle with the sparse and often subjective nature of ultrasound reports, which typically lack the detailed anatomical descriptions found in radiology reports for other imaging modalities(Wang et al. (2024)). Given the aforementioned challenges, developing large multimodal models specifically tailored for ultrasound imaging has become an urgent necessity. In recent years, several studies have attempted to apply ultrasound images in the research of large-scale multimodal models. The EchoCLIP model proposed by Christensen et al. (2024) learns the correspondence between cardiac ultrasound images and expert-annotated cardiac case reports, thereby achieving an understanding of cardiac-related semantic information. Subsequently, Guo et al. (2024) proposed LLaVA-Ultra, which integrates the CLIP and SAM encoders and constructs a general-purpose large model for the ultrasound domain through domain-specific fine-tuning. It has outperformed LLaVA-Med(Li et al. (2023)) on benchmark tests across various general medical tasks.

Although multimodal large models have been increasingly explored in the ultrasound domain, existing approaches often lack comprehensive generalization and in-depth medical reasoning capabilities. To address these challenges, we introduce Dolphin V1 and Dolphin R1, the world's first general-purpose multimodal ultrasound large models. Dolphin V1 is a vision-language model capable of jointly understanding ultrasound images, videos, dynamic scanning sequences, and associated clinical text, while Dolphin R1 further enhances the model's reasoning and diagnostic inference capabilities.

To support model development, we curated a large-scale multimodal ultrasound dataset containing over 2 million high-quality samples sourced from medical textbooks, public ultrasound repositories, general multimodal data, and knowledge-distilled synthetic data. This diverse and extensive dataset underpins the models' robustness and clinical adaptability. Additionally, we propose the Dolphin Ultrasound Data Protocol (DUDP), a standardized data interface that unifies and formalizes a wide range of ultrasound tasks, laying the groundwork for future research and development in this domain.

In our work, we first unify a wide range of complex ultrasound tasks by abstracting them into four core task categories: classification, detection, regression, and generation. To effectively train the model, we employ a progressive three-stage training strategy, which simultaneously emphasizes the model's generalization capability and medical understanding. Furthermore, we incorporate large-scale reinforcement learning based on ultrasound data, endowing the model with advanced reasoning abilities for complex diagnostic scenarios.

The experimental results indicate that our model outperforms all compared methods across the eight

diverse ultrasound tasks defined in the U2-Bench benchmark. It achieves superior performance on a wide range of tasks, including disease diagnosis, organ detection, and medical report generation, demonstrating robustness and generalization capability in both low-level perception and high-level reasoning. Notably, our model achieves a U2-Bench score of 0.5835, significantly surpassing the second-best performing model, Gemini-2.5 Pro, which scores 0.2968. This result establishes a new state of the art in ultrasound-based multimodal modeling.

Our key contributions can be summarized as follows:

- We construct a large-scale, multimodal ultrasound dataset comprising over 2 million high-quality samples, covering both supervised fine-tuning (SFT) and reinforcement learning (RL) data.
- We propose a progressive three-stage training framework that effectively enhances the model's generalization capability and medical reasoning.
- Our model achieves state-of-the-art performance on the U2-Bench benchmark, significantly outperforming existing methods across a wide range of ultrasound tasks, demonstrating strong low-level perception and high-level reasoning abilities.

These advancements collectively pave the way for significant progress in ultrasound-based medical AI, fostering more accurate, efficient, and intelligent clinical decision-making.

2 Data Curation

2.1 Post-training data

To enable the model to possess expert-level ultrasound image recognition capabilities, we constructed a large-scale, high-quality ultrasound image dataset. Specifically, our data is primarily sourced from the following four aspects: (1) **Ultrasound textbooks and clinical guidelines** - to enhance the model's fundamental ultrasound recognition capabilities; (2) **Publicly available ultrasound datasets** covering classification, segmentation, detection, measurement, and other tasks - to improve the model's disease diagnostic abilities; (3) **General medical data** - to enhance the model's generalization and conversational capabilities; (4) **Distilled knowledge data** - to strengthen the model's instruction-following and formatted output abilities.

During this process, we also constructed synthetic ultrasound data through the following approaches: (1) **Question templates** – Generated deterministic responses for structured data construction. (2) **VQA data** – Created using GPT-generated plausible options for ultrasound visual question answering. (3) **Knowledge distillation data** – Derived ultrasound datasets through model-based knowledge transfer, following the methodology of Xu et al. Xu et al. (2023a) on Evol-Instruct to iteratively enhance the quality of distilled data.

Our data generation pipeline is meticulously designed to minimize the risk of hallucination and ensure high fidelity in clinical representation. The process begins with a well-defined task framework and template construction, which is followed by an initial review by board-certified physicians to validate the clinical relevance and diagnostic coherence of the proposed structure. Upon achieving expert consensus, synthetic data is generated in accordance with the predefined templates. This synthesized data then undergoes a second round of rigorous evaluation by medical professionals, who provide detailed feedback to guide iterative refinement and correction. Only after substantial alignment with clinical standards is achieved does the data proceed to a final validation stage, where it is independently assessed by physicians for inclusion in the training corpus. In total, this systematic approach incorporates three iterative rounds of cross-validation, ensuring robust clinical plausibility, diagnostic accuracy, and methodological rigor throughout the data creation process.

2.1.1 Ultrasound teaching material data

We collected a large number of classic ultrasound textbooks and industry guidelines, uniformly converted these materials into Markdown format, manually filtered out non-substantive content such as covers, back covers, and margins, and corrected grammatical errors and formulas that were inaccurately converted. Based on these ultrasound textbooks, we constructed the following three datasets: the **Ultrasound Question-Answering Dataset**, the **Ultrasound Caption Dataset**, and the **Ultrasound Image-Text Explanation Dataset**.

Ultrasound Question-Answering Dataset: We segmented the textbook data into chunks and employed GPT to generate contextually appropriate questions for each segment. Through self-distillation, we

Figure 1: Distribution of the Dolphin Ultrasound Large-Scale Dataset

regenerated corresponding answers to ensure strict question-answer consistency.

Ultrasound Caption Dataset: The ultrasound textbook corpus contains systematic image-caption pairs, which we processed into a structured dataset through automated format matching to ensure precise image-annotation correspondence. It should be noted that our constructed caption dataset contains cases with multiple images, which helps enhance the model's multi-image comprehension capability.

Ultrasound Image-Text Explanation Dataset: The ultrasound textbooks contain detailed textual descriptions of medical images. We first identify the text passages corresponding to each image, then process these descriptions through GPT using self-distillation to generate high-quality question-answer pairs. This approach ensures data accuracy while simultaneously enhancing the model's response diversity and instruction-following capabilities.

2.1.2 Public ultrasound datasets

To enhance the model's diagnostic capabilities across various tasks, we collected a substantial number of publicly available ultrasound datasets and established a unified data processing pipeline. We developed a unified file standard called **Ultrasound Data Protocol (UDP)** to harmonize diverse ultrasound tasks by converting them into a standardized JSON format. The protocol comprehensively handles diverse ultrasound tasks, supporting multimodal data types including ultrasound images, video sequences, segmentation masks, and associated quantitative measurements.

Specifically, we categorize ultrasound tasks into the following standardized classes: (1) **Anatomical Recognition** (2) **Standard View Identification** (3) **Diagnostic Classification** (4) **Tissue Segmentation** (5) **Biometric Measurement**. Corresponding ultrasound question-answering datasets were constructed for each task category. To mitigate hallucination risks, we developed over a hundred fixed question templates for each task category. For each sample, we randomly selected a question template and populated it with JSON-formatted content, thereby constructing a high-quality ultrasound question-answering dataset. Figure 2 presents an authentic diagnostic data sample from our constructed dataset.

Furthermore, to ensure data diversity, we employed GPT for partial data augmentation and utilized another LLM to evaluate response quality, guaranteeing that the JSON-formatted content remains embedded within the generated responses.

2.1.3 General data

To enhance the model's general capabilities while incorporating ultrasound-specific knowledge, we selected corresponding public datasets based on different competency requirements. The selected public datasets are primarily utilized to enhance the following model capabilities: (1) **Comprehension**; (2) **Conversational**; (3) **Deep reasoning**; (4) **Medical**; (5) **Image-text dialogue**; The primary public datasets adopted in our study are as follows: LLaVA-One-Vision. (Li et al., 2024), AutoIF. (Dong et al., 2024), Alpaca-GPT4 (Liu et al., 2023), Medical-O1-Reasoning (Chen et al., 2024). These datasets have been meticulously curated to comprehensively enhance the model's performance across multiple dimensions.

Figure 2: Overview of the Dolphin Ultrasound Public Data Pipeline. The framework includes data collection, expert-guided filtering, and standardization via the Dolphin Ultrasound Data Protocol (DUDP), ensuring consistency across multimodal sources. Tasks are unified into four categories—classification, detection, regression, and generation—covering diverse clinical scenarios. The dataset distribution demonstrates balanced coverage across major anatomical regions, supporting robust model generalization.

2.1.4 Distilled knowledge data

Following the methodology of (Xu et al., 2023b), we first constructed a set of ultrasound data question templates. The difficulty level of questions was enhanced through depth-wise augmentation, while their diversity was improved via breadth-wise expansion. All question categories were strictly standardized within the ultrasound medical domain, and we distilled ultrasound-specific data from both GPT and DeepSeek. Additionally, we designed a data screening pipeline that employs large language models to assess the logical consistency of outputs, ultimately yielding a high-quality distilled dataset.

2.2 Data Filtering

To ensure the quality and reliability of the distilled dataset, we implemented a rigorous data filtering pipeline consisting of multiple stages:

- **Model-Based Semantic Filtering**: Employed LLM-based scoring (e.g., GPT-4) to assess:
  - **Relevance**: Whether answers properly address the questions.
  - **Accuracy**: Factual correctness based on medical knowledge.
  - **Consistency**: Logical coherence within the response.
- **Rule-Based Filtering**:
  - **Content consistency:** Filtering incorrectly generated samples through character matching in JSON files or textbook captions.
  - **Format screening**: Filter out samples with overly short responses or excessive numbers of images, while also removing sensitive information

Question: You are analyzing an ultrasound image of a fetal abdomen; assess the visibility of key landmarks (stomach, umbilical vein, spine) to determine if the view is suitable for Abdominal Circumference (AC) measurement, and indicate the classification as bad, optimal, or suboptimal.

Answer: The sonographic features point to a bad condition for AC measurement.

Question: Clinical Lung Ultrasound Severity Score Diagnosis: - Score 0: Normal: Continuous pleural line, A-lines, sliding sign - Score 1: Mild: Scattered B-lines (≥3, non-coalescent), slightly irregular pleural line - Score 2: Moderate: Coalescent B-lines, broken pleural line, small consolidations - Score 3: Severe: Dense 'white lung' B-lines, large consolidations
You are a clinician skilled in Lung Ultrasound (LUS) classifying a lung ultrasound image; account for probe angle variations by relying on consistent features like B-line presence to assign a severity score, and classify it as **a. 0, b. 1, c. 2, d. 3.**
Answer: c

Question: When assessing the likelihood of malignancy in soft tissue masses, what key factors related to size and shape should be considered? How can these factors be combined with ultrasound images to analyze the nature of the current lesion?

Answer: In evaluating whether a soft tissue mass has the potential for malignancy, size and morphology are important reference factors. Typically, among soft tissue tumors with a diameter exceeding 5 centimeters, only 5% are benign, so larger masses require more vigilance for the possibility of malignancy. Additionally, malignant tumors (such as sarcomas) often exhibit eccentric growth, with shapes that are mostly round or oval, unclear boundaries, and stronger invasiveness. The current ultrasound image shows the lesion to have a lenticular morphology, a characteristic feature commonly seen in lipomas located within the inner layer of the fascia. Such lipomas can extend laterally to a larger size but have a shallow depth, consistent with the characteristics observed in the current image.
The ultrasound examination also shows that the mass has clear boundaries and uniform internal echoes, suggesting a higher likelihood of it being a benign lesion. Nevertheless, the final diagnosis still needs to be made in conjunction with clinical manifestations and other auxiliary examinations (such as imaging enhancement or biopsy if necessary). In summary, based on the current lesion's size, morphology, and location, it is more likely to be a benign lipoma, but further clinical verification is needed to rule out other possibilities.

Figure 3: Examples of constructed ultrasound question–answer pairs. The dataset integrates diverse clinical tasks, including fetal abdominal view assessment, lung ultrasound severity scoring, and soft tissue lesion evaluation, with corresponding expert-verified answers. These QA pairs provide structured supervision signals that enhance both low-level image understanding and high-level diagnostic reasoning in Dolphin models.

- **Expert Validation:** Assess the rationality of dataset construction through medical expert evaluation, and eliminate unreasonable datasets.

Through the aforementioned data filtering process, we obtained a high-quality medical ultrasound dataset that covers textbooks and publicly available data, encompassing multiple anatomical regions and diverse diagnostic tasks.

3 Model Training

Dolphin v1.0 is built upon the Qwen2.5-VL model architecture, which represents an advanced vision-language foundation model developed by (Bai et al., 2025). The system enhances the original framework with a redesigned Vision Transformer (ViT) for optimized visual processing.

We systematically trained two model variants: a base version with 7 billion parameters and an extended version with 72 billion parameters. For each scale, we optimized the training configurations separately, with particular emphasis on investigating the impact of training epochs on both the generalizability and domain-specific performance of the models.

3.1 Training Recipe

The **Dolphin v1.0** training pipeline follows a three-stage progressive framework, designed to integrate domain-specific knowledge, align with human preferences, and refine autonomous decision-making capabilities. The specific three stages are as follows: (1) **Domain-Specialized Training**; (2) **Instruction-Driven Alignment**; (3) **Autonomous Reinforcement Refinement**. Through two key phases - domain knowledge injection and instruction alignment - we developed the **Dolphin V1.0** model. Building upon this foundation, we conducted reinforcement learning training using extensive ultrasound image-text

data to obtain the **Dolphin R1** model. Our subsequent research further explored the significance and impact of reinforcement learning on large-scale medical models.

Figure 4: Training pipeline of the Dolphin series model. The process consists of three key stages: domain-specific pretraining on 2M multimodal medical data, instruction finetuning with 10.3k curated samples to enhance alignment with clinical tasks, and self-play reinforcement learning on 60.7k interactions to further improve reasoning and decision-making ability.

3.1.1 Domain-Specialized Training

The goal of the **Domain-Specialized Training** is to inject ultrasound-specific knowledge into the large language model while preserving its inherent generalizability to the greatest extent possible. During this phase, the model is trained on extensive textbook-based ultrasound data and publicly available ultrasound datasets. The training encompasses ultrasound images of 15 major anatomical systems, with particular emphasis on developing fundamental capabilities in **disease diagnosis**, **anatomical localization**, and **scan plane recognition**. Notably, we transform lesion localization information into standardized directional descriptors (e.g., "upper left quadrant"), thereby endowing the model with precise pathological assessment capabilities.

Recent studies conducted by (Chen et al., 2020), (Yang et al., 2025) have robustly evidenced that domain-specific fine-tuning of large language models with medical datasets may substantially compromise their core linguistic competencies, resulting in pronounced catastrophic forgetting phenomena. This empirical finding underscores the critical need for balanced adaptation strategies when specializing foundational models for medical applications.

During our model training process, we encountered the same issue. Therefore, when fine-tuning the model with ultrasound data using SFT (Supervised Fine-Tuning), we incorporated data from other domains, with particular emphasis on the model's fundamental capabilities in the following aspects: **reasoning**, **multi-turn dialogue**, **instruction-following** , **OCR detection**, and **mathematical reasoning**. The introduction of general-domain data helped maintain these core competencies.

Interestingly, we observed that as the volume of both ultrasound-specific data and general-domain data increased proportionally, the model demonstrated simultaneous improvements in both ultrasound-related tasks and general-domain performance. This synergistic enhancement suggests that domain-specific specialization and general capability maintenance can be mutually reinforcing when balanced appropriately during training.

3.1.2 Instruction-Driven Alignment

During the **Instruction-Driven Alignment** phase, our primary focus is refining the model's output to ensure strict adherence to predefined formats and content requirements. This involves fine-tuning the model's responses to align with structured templates, domain-specific conventions, or user-specified guidelines. Our methodology combines automated techniques with expert human oversight:

- **Distilled Knowledge Integration:**
  - We constructed a small-scale instruction dataset primarily derived from distilled knowledge data. This dataset captures high-quality, structured responses from existing aligned models. It enables the model to learn and replicate the desired stylistic patterns, ensuring consistency with established outputs while minimizing bias.
- **Expert-Guided Refinement:**
  - Submit first-phase model outputs to domain specialists (e.g., medical professionals) for review.
  - Incorporate expert feedback through Direct annotation of inaccuracies.
  - Implement iterative refinement cycles to progressively improve output quality

At this stage, to prevent degradation of the model's inherent capabilities, we adopted a relatively small learning rate and performed only 1 epoch of fine-tuning on the constructed Instruction-Driven Alignment dataset.

3.1.3 Autonomous Reinforcement Refinement.

Recent breakthroughs in reasoning models, such as OpenAI's o-series ((Jaech et al., 2024)) and DeepSeek-R1 ((Guo et al., 2025)), have demonstrated remarkable performance in complex tasks, largely due to innovations in reinforcement learning (RL) techniques. Among these, Group Relative Policy Optimization (GRPO; (Shao et al., 2024)) has gained prominence for its efficiency in optimizing model behavior through verifiable reward signals. Unlike traditional supervised fine-tuning (SFT), which often suffers from answer overfitting and shortcut learning(Hao et al., 2025), GRPO encourages models to explore reasoning pathways autonomously, improving robustness and generalization—particularly critical in high-stakes domains like medicine(Pan et al., 2025).

For GRPO model training, verifiable results are of paramount importance. Each sample within our meticulously constructed UDP dataset is annotated with precise categories and measurement outcomes to guarantee data reliability and reproducibility. For each ultrasound task, we systematically generate corresponding questions based on the desired output format. The constructed dataset is categorized into two primary types:

- **General Responses:** Open-ended answers requiring descriptive or analytical output.
- **Multiple-Choice Responses (A/B/C/D):** Structured selections with rigorously controlled proportions to ensure balanced representation.

During the training process, we adopted the configuration proposed by (Guo et al., 2025), setting the reward function to consist of format reward and outcome reward, both assigned a value of 1.0. Through our exploration, we found that the model's performance during the RL phase largely depends on the fundamental capabilities acquired in the SFT phase. The GRPO training approach primarily serves to activate the model's inherent capabilities rather than inject new knowledge into it.

4 Experiment

To evaluate the ultrasound understanding capabilities of large vision-language models (LVLMs), we adopt U2-Bench (Le et al., 2025), a comprehensive benchmark specifical designed for ultrasound-related tasks. The experimental results presented in Table 1 provide a comprehensive evaluation of various large vision-language models (LVLMs) on the U2-Bench, a benchmark specifically designed to assess ultrasound-related multimodal understanding. Among the models evaluated, the Dolphin series—particularly Dolphin v1.0, Dolphin R1, and their smaller variant Dolphin v1.0-7B—demonstrate competitive performance across multiple tasks, with Dolphin R1 achieving the highest U2-Score of 0.5835 among all models tested.

Table 1: **Results of different models on the U2-Bench.** To calculate the `\score` for random guessing, the BLEU scores are taken to be zero.

Models	DD		VRA		LL	OD	KD	CVE			RG			CG			U2-Score
	Acc.	F1	Acc.	F1	Acc.	Acc.	Acc.	RMSE	MAE	%tol	BLEU%	Rouge%	BERT%	BLEU%	Rouge%	BERT%	
Random Guessing	0.4143	0.4135	0.3195	0.3184	0.1118	0.0680	0.1120	0.5472	0.4352	18.776	-	-	-	-	-	-	0.2125
Medical-Specific Open-Source Models																	
MiniGPT-Med	0.3468	0.2828	0.1800	0.1048	0.1728	0.1789	0.0840	0.3056	0.2600	33.2259	6.4700	20.1300	74.6900	30.2000	47.7500	80.5000	0.2375
MedDr	0.4508	0.3118	0.2071	0.1214	0.0720	0.0881	0.0900	0.2144	0.1786	38.2642	2.7998	13.5060	72.2050	33.4939	49.6236	81.2078	0.2373
Open-Source Multimodal Models																	
Qwen-2.5-VL-3B-Instruct	0.4503	0.3591	0.2097	0.1492	0.0696	0.0649	0.0894	0.5008	0.4519	18.9055	3.5018	15.0327	72.8419	27.6748	44.7618	79.8849	0.2095
Qwen-2.5-VL-7B-Instruct	0.4821	0.3860	0.2181	0.1665	0.0750	0.0704	0.1000	0.4646	0.4337	19.7115	3.7100	15.5600	73.1500	29.4400	47.0000	81.1500	0.2235
Qwen-2.5-VL-3B-Instruct	0.4503	0.3591	0.2097	0.1492	0.0696	0.0649	0.0894	0.5008	0.4519	18.9055	3.5018	15.0327	72.8419	27.6748	44.7618	79.8849	0.2095
Qwen-2.5-VL-7B-Instruct	0.4821	0.3860	0.2181	0.1665	0.0750	0.0704	0.1000	0.4646	0.4337	19.7115	3.7100	15.5600	73.1500	29.4400	47.0000	81.1500	0.2235
Qwen-2.5-VL-32B-Instruct	0.4812	0.3860	0.2864	0.2071	0.1700	0.0755	0.0880	0.3414	0.3015	27.4038	1.1900	13.0100	68.1400	14.7700	38.6800	77.3900	0.2449
Qwen-2.5-VL-72B-Instruct	0.4895	0.4556	0.2559	0.1789	0.1150	0.0660	0.0860	0.3224	0.2733	37.9370	3.0900	15.0600	72.6600	28.1600	44.2800	80.9100	0.2421
DeepSeek-VL2	0.4126	0.3190	0.2268	0.1111	0.2950	0.1682	0.1320	0.2956	0.2505	12.3355	7.4700	20.5400	75.3800	11.4200	34.8500	77.2400	0.2630
InternVL3-9B-Instruct	0.4447	0.3716	0.1926	0.1083	0.3000	0.1416	0.0940	0.2429	0.1733	50.8738	2.1600	14.7000	72.2100	21.5900	43.1300	80.9800	0.2566
LLaVA-1.5-13B	0.4321	0.3055	0.1731	0.0755	0.1700	0.1259	0.1100	0.2307	0.1976	24.7964	6.2400	18.5800	73.7900	10.8300	29.4000	75.5000	0.2378
Phi-4-Multimodal-Instruct	0.3686	0.1148	0.2452	0.0537	0.0350	0.0815	0.1600	0.2249	0.2006	16.1972	3.2700	16.5800	73.2700	3.8700	22.9800	73.0800	0.2168
Mistral-Small-3.1-24B-Inst.	0.4359	0.0936	0.1964	0.0664	0.1300	0.0910	0.1060	0.1675	0.1331	45.9459	1.8000	14.9000	71.7200	20.7700	42.1200	80.7400	0.2356
Closed-Source Multimodal Models																	
Doubao-1.5-Vision-Pro-32k	0.5580	0.2597	0.2922	0.2147	0.1700	0.0729	0.1240	0.3664	0.3377	33.1731	0.7100	6.6450	72.4000	8.6400	33.3000	78.4200	0.2587
GPT-4o-Mini	0.4924	0.3784	0.1922	0.1272	0.1357	0.0846	0.0960	0.2267	0.1976	19.2308	4.9400	17.5200	74.1300	11.7300	36.2900	77.5300	0.2388
GPT-4o	0.4928	0.4132	0.1504	0.0974	0.1161	0.0850	0.0840	0.3712	0.3527	15.7895	2.6800	14.7700	73.3500	33.7700	49.9600	81.5800	0.2253
Gemini-1.5-Pro	0.3781	0.2247	0.0909	0.0476	0.2700	0.0661	0.0980	0.2772	0.2205	40.7051	0.5800	9.9400	70.5500	28.5800	45.9200	80.0200	0.1999
Gemini-2.0-Pro-Exp	0.4925	0.4194	0.1648	0.1323	0.1714	0.0945	0.0820	0.1945	0.1498	53.3333	0.2600	6.9200	40.2400	31.1800	48.6000	81.6000	0.2438
Gemini-2.5-Pro-Preview	0.4256	0.3112	0.2098	0.1493	0.2709	0.2714	0.2518	0.2937	0.2672	34.4970	5.5030	18.0180	74.4930	15.0110	38.0070	75.9890	0.2968
Claude-3.7-Sonnet	0.2121	0.0449	0.1453	0.0479	0.1356	0.0540	0.0760	0.1764	0.1500	36.0215	0.6900	12.2300	68.7400	1.2900	16.6600	71.6600	0.1596
Qwen-Max	0.4566	0.2676	0.1925	0.0871	0.1606	0.0761	0.0940	0.1248	0.0843	69.2308	3.5000	17.0200	73.9600	30.6700	49.0000	82.5500	0.2445
MedGemma-4B-it	0.5005	0.4336	0.3071	0.1520	0.2750	0.0858	0.0200	0.1667	0.1316	55.0962	1.5360	15.0348	74.0205	4.8777	35.9803	76.7859	0.2668
USFM-ViT	0.6815	0.5204	0.4791	0.3713	-	-	-	-	-	-	-	-	-	-	-	-	0.2321
Dolphin v1.0-7B	0.6704	0.5743	0.6681	0.5329	0.3185	0.4380	0.2200	0.3131	0.2304	30.4534	2.7357	14.8181	73.0423	41.4477	58.5160	89.3257	0.4905
Dolphin v1.0	0.6530	0.5667	0.6900	0.5791	0.4028	0.5302	0.3620	0.2717	0.2454	39.0725	3.8512	16.4303	74.1854	49.0289	64.2466	91.1290	0.5390
Dolphin R1	0.6819	0.5155	0.6943	0.5821	0.4775	0.6003	0.5080	0.2430	0.2273	38.6458	3.2193	15.1170	72.7287	54.0634	76.0111	92.9601	0.5835

4.1 Performance Overview

Dolphin R1 excels in classification and detection tasks, particularly in View Recognition and Assessment (VRA), where it achieves the highest accuracy (0.6943) and F1 score (0.5821), indicating strong spatial understanding and anatomical structure recognition capabilities. Similarly, it outperforms other models in Lesion Localization (LL), Organ Detection (OD), and Keypoint Detection (KD), with accuracy scores of 0.4775, 0.6003, and 0.5080 respectively, suggesting robust spatial reasoning and fine-grained visual recognition. These results highlight the model's ability to handle complex ultrasound-specific visual patterns and anatomical variations. Despite strong performance in classification and detection tasks, Dolphin R1 exhibits limitations in Clinical Value Estimation (CVE) and Report Generation (RG), achieving only moderate accuracy in numerical parameter.

In comparison, Dolphin v1.0 shows slightly lower but still strong performance across these tasks, while Dolphin v1.0-7B, as a smaller variant, exhibits a noticeable performance drop, particularly in OD and KD, indicating the importance of model scale in capturing fine-grained visual features.

4.2 Impact of Model Scale

The comparison between Dolphin v1.0-7B and its larger 72B counterparts—Dolphin v1.0 and Dolphin R1—highlights the significant impact of model scale on multimodal understanding in ultrasound-related tasks. The 72B models consistently outperform the smaller 7B variant across classification, detection, and generation tasks, with the most notable improvements seen in Organ Detection (OD), Keypoint Detection (KD), and Caption Generation (CG), indicating that larger models are better suited to capture the visual complexity and semantic nuances present in medical ultrasound imaging.

Moreover, Dolphin R1 achieves a significantly improved U2-Score compared to Dolphin v1.0, demonstrating that advanced training strategies such as GRPO can effectively enhance model performance. This highlights the importance of both model scale and training methodology in pushing the boundaries of ultrasound image understanding.

4.3 Comparison Between Standard Mode and Deep Reasoning Mode

As shown in Figure 5, we also evaluated the performance of our model, Dolphin R1, on disease diagnosis tasks under both standard mode and deep reasoning mode. The results demonstrate that, in the majority

Figure 5: Comparison of Standard and Deep Reasoning models on DolphinV1.0 classification tasks, evaluated by accuracy, precision, recall, and F1-score.

of tasks, enabling the deep reasoning mode leads to a notable improvement in diagnostic accuracy. Moreover, the deep reasoning mode offers a more thorough and detailed analytical process, providing interpretable and transparent reasoning trails. This enhanced interpretability not only supports more informed clinical decision-making but also aligns better with user preferences, as evidenced by the fact that physicians tend to favor the deep reasoning mode in practice.

5 Conclusion

In this work, we introduced Dolphin v1.0 and Dolphin R1, advancing multimodal ultrasound understanding through large-scale data curation and progressive training strategies. The 200w-scale dataset provided the foundation for robust learning across heterogeneous tasks, while the integration of reinforcement learning in Dolphin R1 endowed the model with superior reasoning and interpretability. Our experimental results show that Dolphin R1 achieved a U2-score of 0.5835, surpassing all competitors by a large margin and doubling the performance of the second-best system, whereas Dolphin v1.0 established a strong baseline in standard mode. The comparative analysis highlights that deep reasoning not only improves quantitative accuracy but also enhances the interpretability of diagnostic processes, aligning more closely with physician preferences. Looking forward, this dual-track design of standard vs. deep reasoning modes provides a flexible paradigm for future medical AI systems, balancing efficiency, accuracy, and clinical usability.

6 Authors

Core Contributors: Taohan Weng

Contributors[1]**:** Chi zhang, Chaoran Yan, Siya Liu, Xiaoyang Liu, Yalun Wu, Boyang Wang, Boyan Wang, Jiren Ren, Kaiwen Yan, Jinze Yu, Kaibing Hu, Henan Liu, Haoyun Zheng, Zhenyu Liu, Duo Zhang, Xiaoqing Guo

Project Leader: Hongcheng Guo, Anjie Le

References

Rawan AlSaad, Alaa Abd-Alrazaq, Sabri Boughorbel, Arfan Ahmed, Max-Antoine Renault, Rafat Damseh, and Javaid Sheikh. Multimodal large language models in health care: applications, challenges, and future outlook. *Journal of medical Internet research*, 26:e59505, 2024.

S. Bai, K. Chen, X. Liu, et al. Qwen2.5-vl technical report. *arXiv preprint arXiv:2502.13923*, 2025.

Junying Chen, Zhenyang Cai, Ke Ji, Xidong Wang, Wanlong Liu, Rongsheng Wang, Jianye Hou, and Benyou Wang. Huatuogpt-o1, towards medical complex reasoning with llms. *arXiv preprint arXiv:2412.18925*, 2024.

Sanyuan Chen, Yutai Hou, Yiming Cui, Wanxiang Che, Ting Liu, and Xiangzhan Yu. Recall and learn: Fine-tuning deep pretrained language models with less forgetting. *arXiv preprint arXiv:2004.12651*, 2020.

Matthew Christensen, Milos Vukadinovic, Neal Yuan, and David Ouyang. Vision–language foundation model for echocardiogram interpretation. *Nature Medicine*, 30(5):1481–1488, 2024.

Guanting Dong, Keming Lu, Chen Li, et al. Self-play with execution feedback: Improving instruction-following capabilities of large language models. *arXiv preprint arXiv:2406.13542*, 2024.

Adibvafa Fallahpour, Andrew Magnuson, Purav Gupta, Shihao Ma, Jack Naimer, Arnav Shah, Haonan Duan, Omar Ibrahim, Hani Goodarzi, Chris J Maddison, et al. Bioreason: Incentivizing multimodal biological reasoning within a dna-llm model. *arXiv preprint arXiv:2505.23579*, 2025.

Daya Guo, Dejian Yang, Haowei Zhang, Junxiao Song, Ruoyu Zhang, Runxin Xu, Qihao Zhu, Shirong Ma, Peiyi Wang, Xiao Bi, et al. Deepseek-r1: Incentivizing reasoning capability in llms via reinforcement learning. *arXiv preprint arXiv:2501.12948*, 2025.

Xuechen Guo, Wenhao Chai, Shi-Yan Li, and Gaoang Wang. Llava-ultra: Large chinese language and vision assistant for ultrasound. In *Proceedings of the 32nd ACM international conference on multimedia*, pp. 8845–8854, 2024.

Jiyeon Han, Jimin Park, Jinyoung Huh, Uran Oh, Jaeyoung Do, and Daehee Kim. Ascleai: A llm-based clinical note management system for enhancing clinician productivity. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*, pp. 1–7, 2024.

Yifan Hao, Xingyuan Pan, Hanning Zhang, Chenlu Ye, Rui Pan, and Tong Zhang. Understanding over-adaptation in supervised fine-tuning: The role of ensemble methods. *arXiv preprint arXiv:2506.01901*, 2025.

David W Hewson and Nigel M Bedforth. Closing the gap: artificial intelligence applied to ultrasound-guided regional anaesthesia, 2023.

Aaron Jaech, Adam Kalai, Adam Lerer, Adam Richardson, Ahmed El-Kishky, Aiden Low, Alec Helyar, Aleksander Madry, Alex Beutel, Alex Carney, et al. Openai o1 system card. *arXiv preprint arXiv:2412.16720*, 2024.

A Le, H Liu, Y Wang, and et al. U2-bench: Benchmarking large vision-language models on ultrasound understanding. *arXiv preprint arXiv:2505.17779*, 2025.

Changsun Lee, Sangjoon Park, Cheong-Il Shin, Woo Hee Choi, Hyun Jeong Park, Jeong Eun Lee, and Jong Chul Ye. Read like a radiologist: Efficient vision-language model for 3d medical imaging interpretation. *arXiv preprint arXiv:2412.13558*, 2024.

Bo Li, Yuanhan Zhang, Dong Guo, Renrui Zhang, Feng Li, Hao Zhang, Kaichen Zhang, Peiyuan Zhang, Yanwei Li, Ziwei Liu, et al. Llava-onevision: Easy visual task transfer. *arXiv preprint arXiv:2408.03326*, 2024.

[1] Alphabetical order.

Chunyuan Li, Cliff Wong, Sheng Zhang, Naoto Usuyama, Haotian Liu, Jianwei Yang, Tristan Naumann, Hoifung Poon, and Jianfeng Gao. Llava-med: Training a large language-and-vision assistant for biomedicine in one day. *Advances in Neural Information Processing Systems*, 36:28541–28564, 2023.

Bin Lin, Yang Ye, Bin Zhu, Jiaxi Cui, Munan Ning, Peng Jin, and Li Yuan. Video-llava: Learning united visual representation by alignment before projection. *arXiv preprint arXiv:2311.10122*, 2023.

Haotian Liu, Chunyuan Li, Qingyang Wu, and Yong Jae Lee. Visual instruction tuning. *Advances in neural information processing systems*, 36:34892–34916, 2023.

Christos P Loizou and Constantinos S Pattichis. Introduction to ultrasound imaging and speckle noise. In *Despeckle Filtering Algorithms and Software for Ultrasound Imaging*, pp. 1–20. Springer, 2022.

OpenAI. Gpt-4 technical report. *arXiv:2303.08774*, 2023.

Jiazhen Pan, Che Liu, Junde Wu, Fenglin Liu, Jiayuan Zhu, Hongwei Bran Li, Chen Chen, Cheng Ouyang, and Daniel Rueckert. Medvlm-r1: Incentivizing medical reasoning capability of vision-language models (vlms) via reinforcement learning. *arXiv preprint arXiv:2502.19634*, 2025.

Zhihong Shao, Peiyi Wang, Qihao Zhu, Runxin Xu, Junxiao Song, Xiao Bi, Haowei Zhang, Mingchuan Zhang, YK Li, Yang Wu, et al. Deepseekmath: Pushing the limits of mathematical reasoning in open language models. *arXiv preprint arXiv:2402.03300*, 2024.

Harshita Sharma, Lior Drukker, Aris T Papageorghiou, and J Alison Noble. Machine learning-based analysis of operator pupillary response to assess cognitive workload in clinical ultrasound imaging. *Computers in biology and medicine*, 135:104589, 2021.

Zhongyi Shui, Jianpeng Zhang, Weiwei Cao, Sinuo Wang, Ruizhe Guo, Le Lu, Lin Yang, Xianghua Ye, Tingbo Liang, Qi Zhang, et al. Large-scale and fine-grained vision-language pre-training for enhanced ct image understanding. *arXiv preprint arXiv:2501.14548*, 2025.

Giovanni Stasi and Elsa M Ruoti. A critical evaluation in the delivery of the ultrasound practice: the point of view of the radiologist. *Italian Journal of Medicine*, 9(1):5–10, 2015.

Thomas L Szabo. *Diagnostic ultrasound imaging: inside out*. Academic press, 2013.

Egor Volkov, Vadim Sechin, and Alexey Averkin. Visual-language model fine-tuning via lora for structed medical reports generating for lung x-ray skans. In *2025 XXVIII International Conference on Soft Computing and Measurements (SCM)*, pp. 438–442. IEEE, 2025.

Xinyi Wang, Grazziela Figueredo, Ruizhe Li, Wei Emma Zhang, Weitong Chen, and Xin Chen. A survey of deep learning-based radiology report generation using multimodal data. *arXiv preprint arXiv:2405.12833*, 2024.

Zhiyu Wu, Xiaokang Chen, Zizheng Pan, Xingchao Liu, Wen Liu, Damai Dai, Huazuo Gao, Yiyang Ma, Chengyue Wu, Bingxuan Wang, et al. Deepseek-vl2: Mixture-of-experts vision-language models for advanced multimodal understanding. *arXiv preprint arXiv:2412.10302*, 2024.

Can Xu, Qingfeng Sun, Kai Zheng, Xiubo Geng, Pu Zhao, Jiazhan Feng, Chongyang Tao, and Daxin Jiang. WizardLM: Empowering large language models to follow complex instructions. *CoRR*, abs/2304.12244, 2023a.

Can Xu, Qingfeng Sun, Kai Zheng, Xiubo Geng, Pu Zhao, Jiazhan Feng, Chongyang Tao, and Daxin Jiang. Wizardlm: Empowering large language models to follow complex instructions. *arXiv preprint arXiv:2304.12244*, 2023b.

Qimin Yang, Jiexin Chen, Yue Sun, Yapeng Wang, and Tao Tan. Fine-tuning medical language models for enhanced long-contextual understanding and domain expertise. *Quantitative Imaging in Medicine and Surgery*, 15(6):5450, 2025.

A Appendix

Brachial Plexus

Question: Observe and analyze the comparison of this ultrasound image of bilateral interscalene brachial plexus.

Doctor's observation:
- Comparison of the ultrasound images on both sides reveals that the right brachial plexus nerve roots are thickened.

Dolphin V1.0: Based on the analysis of the provided brachial plexus nerve image, the following diagnostic recommendations are made:

1. Ultrasound Feature Analysis
- **Nerve Thickening**: The right brachial plexus nerve is significantly thicker than the left. Normally, the diameter of the brachial plexus nerve should be less than 2 mm. Abnormal thickening suggests possible pathological changes in the nerve (such as nerve edema, inflammation, or compression).
- **Unclear Internal Structure**: The internal fascicular structure of the right nerve is not clearly visible. Normally, the brachial plexus nerve shows a "honeycomb-like" hypoechoic pattern with hyperechoic septa of the nerve fascicles. The unclear structure may be associated with nerve edema, fibrosis, or inflammation.
- **Irregular Borders**：The borders of the right nerve are not clear, with a blurred demarcation from the surrounding soft tissue, which may indicate involvement of the nerve sheath or local inflammatory response.
- **Inhomogeneous Echo**：The internal echo distribution of the right nerve is inhomogeneous, showing patchy hypoechoic or mixed echo patterns, suggesting possible pathological changes such as edema, hemorrhage, or fibrosis.

2. Differential Diagnosis
- **Neuritis or Neurofibroma:**The edema and thickening of the interscalene brachial plexus nerve need to be differentiated from neurofibromas, perineuriomas, or inflammatory neuropathies. Neurofibromas usually appear as well-defined hypoechoic masses with rich internal blood flow signals, while inflammatory changes have blurred borders and inhomogeneous echoes.
- **Nerve Compression Syndrome**: It is necessary to assess whether the patient has a history of trauma, cervical spondylosis, or local space-occupying lesions (such as tumors, hematomas) causing nerve compression. Ultrasound can show whether the nerve continuity is interrupted and whether there is compression by surrounding tissues.
- **Nerve Trauma or Postoperative Changes**：If the patient has a history of trauma or surgery, nerve injury or postoperative scar formation leading to nerve thickening should be considered.

3. Recommendations for Further Examination
- **Clinical Correlation:**The patient's medical history (such as trauma, cervical spondylosis, pain location), physical examination (such as nerve traction test, Tinel's sign), and neurophysiological examinations (such as electromyography, nerve conduction velocity) should be combined.
- **Contrast Ultrasound or MRI**: If ultrasound suggests space-occupying lesions within or around the nerve, contrast ultrasound or MRI is recommended to clarify the nature of the lesion (such as neurofibroma, perineurioma).
- **Ultrasound-Guided Biopsy (if necessary)**：For cases highly suspected of malignant tumors, ultrasound-guided biopsy may be considered.

Conclusion
The thickening of the right interscalene brachial plexus nerve with structural abnormalities should primarily consider lesions such as neuritis or neurofibroma. It is recommended to combine clinical and further imaging examinations to clarify the diagnosis. During the diagnostic process, it is necessary to exclude nerve compression or other space-occupying lesions to avoid misdiagnosis.

Note: The above analysis is based on ultrasound image features. The specific diagnosis should be combined with the patient's clinical manifestations and other examination results.

GPT: Based on the analysis of the provided brachial plexus nerve image, the following diagnostic recommendations are made:

1. Image Basic Information
- **Location**：Bilateral upper clavicular areas of the neck root, showing the brachial plexus.
- **Orientation**：The left image is marked as R (right side), and the right image is marked as L (left side).
- **Annotation:** The yellow arrow indicates the hypoechoic/medium-low echo oval nerve trunk along the course of the brachial plexus.

2. Normal Ultrasound Appearance
- **Ultrasound Appearance**：On ultrasound cross-sectional imaging, the brachial plexus appears as a "honeycomb-like" or "bunch of grapes" pattern, characterized by uniform, well-defined, and regularly sized hypoechoic circular/oval structures separated by hyperechoic interstitial tissue.
- **Location**：Within the interscalene groove, the brachial plexus is typically located between the anterior and middle scalene muscles.

3. Comparative Image Analysis
- **Right side (R):**The nerve plexus is clearly visible with a relatively regular arrangement; multiple hypoechoic oval structures are present with uniform size and shape; the hyperechoic septa between nerve fascicles are distinct and structurally intact; this represents a normal or slightly thickened appearance.
- **Left side (L):**The nerve plexus appears diffusely thickened with multiple nerve trunks showing irregular hypoechoic patterns; the boundaries of nerve fascicles are relatively blurred with disordered arrangement; some nerve cross-sections are enlarged with a swollen appearance.This suggests pathological changes, commonly seen in: brachial plexus neuritis (edema and thickening due to inflammation); compression or space-occupying lesions (tumors, nodules, fibrosis); neuropathy (such as demyelinating diseases).

Conclusion
Right brachial plexus: The ultrasound appearance is essentially normal；Left brachial plexus: Diffuse thickening and disordered arrangement are shown, indicating brachial plexus pathology, with a higher likelihood of brachial plexus neuritis or space-occupying compressive lesions.

Lung

Question: Observe this lung ultrasound image and perform an analysis diagnosis

Doctor's observation:
- Abnormal thickening of the pleural line;
- diffuse B-lines;
- Consider pulmonary interstitial syndrome.

Dolphin V1.0: Based on the analysis of the provided lung ultrasound image, the following diagnostic recommendations are made:

1. Imaging Findings
- **Diffuse Increase in B-lines:** Dense B-lines (>5 per field of view) are visible throughout the lung fields, presenting a "white lung" appearance, indicative of severe interstitial syndrome. In some areas, B-lines are confluent, which may be associated with alveolar fluid exudation or fibrosis.
- **Pleural Line Abnormalities:** Bilateral thickening and local irregularity of the pleural line are observed, which may be related to chronic inflammation or previous lung injury.
- **Focal Consolidation:** A hypoechoic area with indistinct margins is seen in the left middle lobe, without clear air bronchograms, raising suspicion for atypical pathogen infection (e.g., COVID-19) or organizing pneumonia.

2. Diagnostic Recommendations
- **Viral Interstitial Pneumonia (e.g., COVID-19, influenza virus):** The presence of diffuse B-lines and the absence of typical air bronchograms in the consolidation areas are consistent with the pattern of viral injury.
- **Early Acute Respiratory Distress Syndrome (ARDS):** Severe interstitial syndrome with consolidation is noted; the diagnosis should be confirmed in conjunction with the PaO_2 /FiO_2 ratio and clinical course.
- **Cardiogenic Pulmonary Edema:** This should be excluded by assessing heart function, with BNP and echocardiography as ancillary tests.
- **Acute Exacerbation of Pulmonary Fibrosis:** A history of underlying idiopathic pulmonary fibrosis would support this diagnosis.

- **3. Clinical Recommendations**
- **Urgent Assessment:** Measure arterial blood gas (ABG) to evaluate oxygenation status; perform chest CT to delineate the distribution of lesions (typical viral pneumonia shows peripheral reticular opacities).
- **Laboratory Tests:** Conduct viral screening for SARS-CoV-2 antigen/PCR, influenza virus antigen; assess inflammatory markers such as CRP, IL-6, and D-dimer.
- **Treatment Direction:** Initiate antiviral therapy (e.g., nirmatrelvir/ritonavir for COVID-19); restrict fluid intake to prevent worsening of pulmonary edema; consider corticosteroids if necessary (weighing the risk of infection).
- **Precautions:** Be vigilant for multifactorial etiologies of diffuse B-lines (e.g., viral infection with secondary bacterial infection); monitor changes in ultrasound findings dynamically: a reduction in B-lines suggests effective treatment, while persistent increase may indicate progression of ARDS.

Conclusion:
The lung ultrasound findings suggest a high likelihood of viral interstitial pneumonia. It is recommended to promptly initiate antiviral therapy and complete imaging and laboratory investigations.

GPT: Based on the analysis of the provided lung ultrasound image, the following diagnostic recommendations are made:

1. Image Characteristics
- Multiple bright hyperechoic lines are visible in the image, extending downward from the pleural line, almost parallel to the ultrasound beam, and spanning the entire screen.
- These lines appear and disappear in synchrony with respiratory movements and are referred to as B-lines or comet-tail artifacts.
- B-lines originate from the pleural line, extend vertically downward, have strong echoes, do not attenuate with depth, and are spaced approximately evenly.

2. Normal vs. Abnormal
- **Normal:** In healthy lung tissue, 0–2 isolated B-lines may occasionally be present.
- **Abnormal:** If there are ≥3 B-lines in a single scanning plane, and they are diffuse and bilaterally distributed, this suggests involvement of the lung interstitium.

3. Possible Clinical Significance
- Increased B-lines are commonly seen in: pulmonary edema (cardiogenic/non-cardiogenic → most typical manifestation); interstitial lung diseases (e.g., fibrosis, inflammation causing interstitial thickening); ARDS (acute respiratory distress syndrome); early pneumonia or interstitial involvement. If combined with irregular or fragmented pleural lines, it also suggests chronic interstitial disease.

Conclusion:
This image shows multiple distinct B-lines, indicating an interstitial syndrome of the lungs.The most common causes need to be differentiated based on medical history: acute heart failure/pulmonary edema (if associated with bilateral lower limb edema, cardiac dysfunction); ARDS/pneumonia (if there is infection, respiratory distress); chronic interstitial lung disease (if there is long-term dyspnea, abnormal lung function). Further clarification of the etiology is needed in combination with clinical history (heart failure, infection, ARDS risk) and other imaging (chest X-ray/CT).

Liver

Question: Observe this liver ultrasound image and perform an analysis diagnosis

Doctor's observation:
- An oval-shaped anechoic mass is visible, with a regular shape, clear boundaries, good acoustic transmission, and marked posterior acoustic enhancement.
- Considered as a simple hepatic cyst, regular follow-up is recommended.

Dolphin V1.0: Based on the analysis of the provided liver ultrasound image, the following diagnostic recommendations are made:

1.Ultrasound Image Feature Description:
- **Lesion Morphology and Location:** An oval-shaped hypoechoic area is visible in the lower left region, with clear boundaries and a size of approximately 2.5×2.0 cm.
- **Internal Echo:** The interior presents as uniformly anechoic, with no septations or solid components observed.
- **Posterior Acoustic Effect:** There is a marked enhancement of the posterior echo.

2.Diagnostic Analysis: Simple Hepatic Cyst
- **Basis:** The smooth boundary, anechoic interior, and posterior enhancement are consistent with the typical appearance of a simple cyst.
- **Differential Diagnosis Excluded:** Abscess (no wall thickening, heterogeneous internal echo, or surrounding inflammatory signs); Hemangioma/Solid Tumor (not hyperechoic and lacking blood flow signals); Biliary Cyst (no biliary dilation or connecting structures observed).

3.Recommendations:
- **No Special Treatment Required:** Simple hepatic cysts are mostly benign. Asymptomatic individuals can undergo regular ultrasound follow-up (e.g., annually).
- **Clinical Correlation:** If the patient experiences abdominal pain, cyst enlargement, or other liver diseases, further evaluation is needed.
- **Additional Examinations:** If the diagnosis is in doubt, abdominal CT/MRI with contrast can be chosen to clarify the nature.

Conclusion:
The ultrasound findings in this case highly suggest a simple hepatic cyst. It is recommended to monitor with routine follow-up, with no intervention needed at present.

GPT: Based on the analysis of the provided liver ultrasound image, the following diagnostic recommendations are made:

1.Basic Image Observation
- **Background:** The liver parenchyma appears with uniform medium echo and relatively clear structure.
- **Lesion:** A round/ovoid hypoechoic area is seen within the liver parenchyma (anechoic interior with clear boundaries).
- **Acoustic Features:** The interior is purely anechoic (black), with no internal echo structures; the edge is smooth, with a thin wall; there is a marked enhancement of the posterior echo (good acoustic transmission).

2.Ultrasound Sign Analysis
- This appearance is consistent with the typical features of a cystic lesion: anechoic, thin-walled, with posterior echo enhancement and regular shape.

3.Considering the Typical Imaging Features, the Most Common Consideration is
- **Hepatic Cyst:** The most common benign liver lesion, with typical imaging features: clear boundaries, thin wall, anechoic, and posterior echo enhancement.
- **Other Differential Diagnoses (to be considered if the presentation is atypical):** Cystic metastasis (usually with irregular borders, internal septations/nodules); Liver abscess (may show flocculent or septated echoes within the cyst, with unevenly thick walls); Parasitic cyst (hydatid disease) (calcified cyst wall, internal septations, or “cyst within a cyst” sign).

Conclusion:
The image shows a typical simple hepatic cyst. If the patient is asymptomatic (e.g., no abdominal pain, compressive symptoms), no special treatment is usually required, and only regular ultrasound follow-up is necessary. If the cyst is large (>5 cm) and symptomatic, interventional drainage or surgical intervention may be considered.

Knee

Question: Observe this knee ultrasound image and perform an analysis diagnosis

Doctor's observation:
- An irregular hypoechoic band is visible within the lateral meniscus of the knee joint, indicating a meniscal tear.
- Meniscal Protrusion

Dolphin V1.0: Based on the analysis of the provided knee ultrasound image, the following diagnostic recommendations are made:

1. Anatomical Abnormalities:
- Meniscal Echogenicity Disruption: Localized interruption of meniscal echogenicity is observed, with the tear region presenting as linear hypoechoic or anechoic areas, contrasting with the surrounding normal meniscal hyperechoic tissue.

2. Associated Signs (Clinical Correlation Required):
- **Effusion:** Meniscal tears often accompany joint capsule distension or synovial thickening, manifesting as hypoechoic effusion regions.
- **Joint Space Widening:** The tear may cause the meniscus to lose support, potentially leading to knee instability or widened joint spaces.

3. Differential Diagnosis:
- **Ligament Injury (e.g., Lateral Collateral Ligament Injury):** Ultrasound may reveal ligament thickening, heterogeneous echogenicity, or rupture.
- **Cartilage Damage:** Cartilage defects appear as hypoechoic or anechoic areas with exposed subchondral bone, though meniscal tears are more common on the lateral side of the knee.
- **Synovitis:** Synovial proliferation presents as hypoechoic tissue, with or without blood flow signals, distinct from the hyperechoic band-like structures seen in meniscal tears.

4. Clinical Significance and Recommendations:
- **Symptom Correlation:** Patients may experience medial knee pain, difficulty in flexion and extension, or a clicking sensation (impingement symptoms). Severe tears can lead to locking (meniscal fragments impinging the joint space).
- **MRI Examination:** To delineate the extent of the tear and assess the relationship between the meniscus and cartilage complex, providing more detailed information for surgical planning.
- **Ultrasound-Guided Treatment:** After a clear diagnosis, consider ultrasound-guided injections of corticosteroids or hyaluronic acid to alleviate symptoms.

Conclusion
The ultrasound image clearly shows a longitudinal tear in the lateral meniscus, which needs to be confirmed further with clinical symptoms and MRI. Timely intervention is recommended to prevent the progression of chronic injury.

GPT: Based on the analysis of the provided knee ultrasound image, the following diagnostic recommendations are made:

1. Image Observation
- **Location:** Knee joint (the image shows a longitudinal section below the patella or near the patellar tendon).
- **Arrow-Indicated Area:** Below the skin and subcutaneous tissue, near the joint surface, an irregular hypoechoic band can be seen.
- **Echo Characteristics:** A hypoechoic/irregular area is visible in the joint space; the boundary is indistinct; there is no obvious acoustic shadow below the ultrasound beam, but the continuity of the joint surface is affected.

2. Possible Pathological Manifestations
- **Meniscal Injury:** Characterized by hypoechoic clefts/irregular echoes within or at the edge of the meniscus, commonly seen in sports injuries or degeneration of the knee joint.
- **Articular Cartilage Damage:** If the arrow points to the articular cartilage surface of the femoral condyle, it suggests cartilage thinning or abnormal echoes.
- **Synovial Hypertrophy or Inflammatory Changes:** If accompanied by joint effusion, it may indicate synovitis or arthritis.

3. Preliminary Diagnostic Opinion
- **Ultrasound Findings:** Hypoechoic linear/band-like areas with abnormal continuity of the joint space structure. The image appearance is most consistent with meniscal tear/injury.
- **Further Recommendations:** Correlate with clinical symptoms (knee pain, locking, limited mobility); MRI examination (more sensitive for diagnosing meniscal injuries).

Conclusion:
The ultrasound image of the knee joint suggests a possible meniscal tear, which needs to be further clarified in conjunction with clinical findings and MRI.

Thyroid

Question: Observe this Thyroid ultrasound image and perform an analysis diagnosis

Doctor's observation:

- A very hypoechoic nodule is visible in the middle of the lower pole of the right thyroid lobe, with a relatively regular shape, indistinct borders, and fine hyperechoic calcifications within. CDFI shows relatively rich blood flow signals.
- TI-RADS Category 4C nodule, ultrasound contrast or biopsy is recommended.

Dolphin V1.0: Based on the analysis of the provided Thyroid ultrasound image, the following diagnostic recommendations are made:

1. Ultrasound Feature Analysis

- **Shape and Border:** The nodule has an irregular shape with indistinct borders and microlobulated features, which suggest a possible malignancy.
- **Echo Characteristics:** The interior presents as hypoechoic or very hypoechoic, possibly with microcalcifications (confirmation shoul d be combined with the presence of microcalcification points), which is typical of papillary thyroid carcinoma.
- **Blood Flow Signal (CDFI):** Rich blood flow signals are visible within the nodule, distributed in a multi-point or tree-branch pattern, in dicating active tumor angiogenesis and supporting a malignant tendency.
- **Completeness of the Halo:** An incomplete or absent halo further suggests a possible malignancy.

2. Diagnostic Recommendations

- **TI-RADS Classification:** The comprehensive features may be categorized as Class 4 (suspicious for malignancy) or Class 5 (highly suspicious for malignancy).

3. Management Suggestions:

- **Fine-Needle Aspiration (FNA):** To clarify the pathological nature, especially sampling from areas with microcalcifications and rich bl ood flow.
- **Regular Follow-Up:** If surgery is not immediately indicated, it is recommended to re-examine with ultrasound every 3-6 months to m onitor changes in the nodule.
- **Clinical Assessment:** Combine with patient symptoms (such as hoarseness, enlarged cervical lymph nodes), laboratory tests (TSH, thyroid antibodies), and family history for a comprehensive judgment.

Conclusion:

Indistinct borders, irregular shape, hypoechoic interior with possible microcalcifications, rich blood flow signal and incomplete halo all sug gest a higher risk of malignancy, particularly the likelihood of papillary thyroid carcinoma. According to TI-RADS classification, it may bel ong to Class 4 or 5, and fine-needle aspiration (FNA) is recommended to confirm the pathological diagnosis.

Notes:

The final diagnosis should be combined with multimodal imaging (such as elastography) and clinical data. If the patient has Hashimoto's thyroiditis or other endocrine diseases, the diagnostic threshold should be adjusted. It is recommended to develop an individualized treat ment plan under the guidance of a professional physician.

GPT: Based on the analysis of the provided Thyroid ultrasound image, the following diagnostic recommendations are made:

1. Basic Image Information

- The image is a transverse section of the thyroid gland (indicated by the icon in the lower left corner). The colored Doppler flow signal s (CFI) are shown within the right frame. The background echo demonstrates that the nodule is markedly hypoechoic.

2. Nodule Sonographic Features

- **Echo:** Predominantly hypoechoic, significantly lower than the surrounding normal thyroid tissue.
- **Shape:** Roughly round/ovoid, with the length-to-width ratio close to 1.
- **Border:** Relatively clear, but with some slight roughness visible.
- **Internal Structure:** The echo is relatively uniform, with no obvious cystic components.
- **Calcification:** No typical hyperechoic points or acoustic shadows indicative of microcalcifications are seen.
- **Vascularity:** Color Doppler shows a few blood flow signals within and around the nodule (the vascularity is not abundant, but presen t).

3. TI-RADS Risk Assessment Key Points

- Hypoechoic (2 points);Shape: Width greater than height (0 points);Border: Partially irregular (2 points);Calcification: No typical calcific ations (0 points);Vascularity: A few blood flows inside (indicating activity)
- The total score is approximately 4 points (ACR TI-RADS Category 4, moderate to high suspicion).

4. Clinical Significance and Recommendations

- This nodule is considered suspicious (TI-RADS 4) and needs to be evaluated in conjunction with its size to determine whether a biop sy is necessary. For TI-RADS 4 nodules >1 cm, fine-needle aspiration (FNA) is recommended; if <1 cm, follow-up observation is sug gested (recheck in 6-12 months), with particular attention to any increase in size, increased vascularity, or new calcifications.
- If the patient has high-risk factors for thyroid cancer (family history, abnormal cervical lymph nodes, etc.), early FNA is more inclined.

Conclusion:

The thyroid solid hypoechoic nodule, with limited vascularity and no typical microcalcifications, is classified as TI-RADS 4. It is recommen ded to decide on FNA or follow-up based on the size and risk factors.

Carotid Artery

Question: Observe this carotid artery ultrasound image and perform an analysis diagnosis

Doctor's observation:
- A hypoechoic plaque is visible on the posterior wall at the bifurcation of the carotid artery, with a regular shape, smooth margins, and heterogeneous internal echoes.

Dolphin V1.0: Based on the analysis of the provided carotid artery ultrasound image, the following diagnostic recommendations are made:

1. Plaque Characterization:
- **Location:** The plaque is attached to the inner wall of the carotid artery and may affect hemodynamics.
- **Morphology and Echo:** It presents as a hypoechoic or mixed-echo area, suggesting the presence of a lipid core or hemorrhage within the plaque.
- **Surface Features:** No clear signs of surface irregularity or ulceration are observed, but stability needs to be confirmed with additional tests.
- **Size and Distribution:** The plaque has a moderate length, and specific measurements are needed to assess the risk of stenosis.

2. Vulnerable Plaque Risk Assessment:
- **Vulnerability Indicators:** Hypoechoic areas indicate lipid deposition and possible hemorrhage (heterogeneous internal echoes).
- **Thrombotic Risk:** No thrombus signs are seen in the lumen, but thrombus formation is possible if the plaque ruptures, which needs to be evaluated clinically.

3. Clinical Recommendations:
- **Further Examinations:** Intravascular ultrasound (IVUS) or photoacoustic imaging is recommended to clarify plaque stability.
- **Risk Factor Management:** Evaluate the control of hypertension, hyperlipidemia, diabetes, etc.
- **Therapeutic Interventions:** Lifestyle modifications (smoking cessation, dietary control) and pharmacological treatment (statins).

Conclusion:
The image shows a hypoechoic or mixed-echo plaque on the carotid artery wall. There is a need to be vigilant about the possibility of a vulnerable plaque. It is recommended to develop an individualized treatment plan based on comprehensive imaging and clinical data to reduce the risk of cardiovascular events.

GPT: Based on the analysis of the provided carotid arter ultrasound image, the following diagnostic recommendations are made:

1. Imaging Basics
- The image is a longitudinal B-mode ultrasound of the carotid artery.
- An irregular hypoechoic/mixed-echo area is visible within the lumen, located on the vessel wall.
- Localized thickening of the vessel wall and partial narrowing of the lumen are observed.
- The affected area is marked with a “cross.”

2. Ultrasound Findings Analysis
- **Vessel Wall:** Localized thickening of the intima-media complex (IMT).
- **Plaque Appearance:** Irregular hypoechoic plaques are visible, some with areas of stronger echoes, suggesting the possible presence of fibrous components or calcification.
- **Lumen Condition:** The lumen is narrowed due to the lesion, but the image does not show complete occlusion.
- **Blood Flow (Color Doppler Not Used):** The image does not display blood flow signals, so the degree of stenosis is primarily assessed using B-mode imaging.

3. Clinical Evaluation and Recommendations
- **Further Examination:** It is recommended to perform color Doppler ultrasound and spectral analysis to measure the peak systolic velocity (PSV) and assess the degree of stenosis. CT angiography (CTA) or magnetic resonance angiography (MRA) may be necessary for further confirmation if needed.
- **If the stenosis is mild (<50%):** Lifestyle intervention + medication (statins for lipid-lowering, antiplatelet drugs).
- **If the stenosis is moderate to severe (≥50%):** Strict pharmacological treatment and consideration of interventional or surgical procedures (carotid endarterectomy or stenting) are necessary.

Conclusion:
The image shows localized thickening of the carotid artery wall with irregular hypoechoic plaques, indicating carotid atherosclerosis and lumen stenosis. Further color Doppler ultrasound is recommended to assess the degree of stenosis and to intervene based on clinical risk factors.

Skin

Question: Observe this skin ultrasound image and perform an analysis diagnosis

Doctor's observation:
- An anechoic cystic nodule is visible in the subcutaneous tissue of the palm, with a regular shape and clear margins.

Dolphin V1.0: Based on the analysis of the provided skin ultrasound image, the following diagnostic recommendations are made:

1. Nodule Characteristics
- **Location and Shape:** The nodule is located between the epidermis and dermis, with an uneven surface, clear margins, and a round/oval shape.
- **Size:** The maximum diameter is approximately 0.69cm × 0.30cm, indicating a small volume.
- **Echo:** Internally, it presents as hypoechoic or anechoic, with a high-echo halo visible at the edge (possibly related to the cyst wall or fibrous capsule).
- **Posterior Acoustic Shadowing:** No significant acoustic shadowing is present, suggesting that the contents are fluid or soft tissue, rather than calcified or solid hard tissue.

2. Differential Diagnosis
- **Epidermoid Cyst:** Typically characterized by a well-defined hypo/anechoic nodule with a high-echo edge and possible internal septations, which matches the features of this case.
- **Lipoma:** Usually a uniformly hypoechoic solid mass, but commonly located in the deeper subcutaneous tissue and not directly connected to the skin surface.
- **Sebaceous Cyst:** Similar to an epidermoid cyst but occurs near the sebaceous gland orifice and may be associated with dilated hair follicles or sebaceous ducts on the skin surface.
- **Fibroma:** Solid with high or mixed echoes and heterogeneous internal echoes, but the edges are usually not as smooth as those of a cyst.

3. Exclusion of Malignancy
- The nodule's small volume and clear margins make malignancy highly unlikely. If it were a rare malignancy such as dermatofibrosarcoma protuberans, it would typically present with a larger volume, infiltrative growth, and abundant blood flow.

4. Recommendations
- **Clinical Correlation:** A comprehensive judgment should be made in conjunction with the medical history (e.g., nodule growth rate, pain, itching, etc.).
- **Follow-up Observation:** If asymptomatic and with typical ultrasound features, regular ultrasound follow-up (e.g., every 6-12 months) is recommended to monitor stability.
- **Other Tests:** Fine-needle aspiration biopsy may be performed if necessary to aid in the diagnosis, especially for inflammatory lesions such as tuberculous granulomas.

Conclusion:
The ultrasound features are suggestive of a benign cystic lesion (such as an epidermoid cyst), but a final diagnosis should be made in combination with clinical and pathological results. Close observation and follow-up are recommended.

GPT: Based on the analysis of the provided skin ultrasound image, the following diagnostic recommendations are made:

1. Imaging Basics
- A focal lesion is visible in the superficial layer of the skin, measured with calipers at approximately 0.69 cm × 0.30 cm. The lesion is located relatively superficially, at the junction of the skin/dermis and subcutaneous fat.

2. Ultrasound Characteristics of the Lesion
- **Boundary and Shape:** The lesion is oval-shaped, with a long axis significantly larger than the short axis. The boundary is clear, with a complete capsule-like echo visible.
- **Echo:** The lesion is hypoechoic, with a homogeneous internal structure, no significant areas of high echo or anechoic regions suggestive of liquefaction. There is mild posterior acoustic enhancement, suggesting a cystic or fluid component.

3. Ultrasound Diagnosis Considerations
- **Epidermoid Cyst :** Superficial, oval-shaped, well-defined, hypoechoic or mixed echo, with possible mild posterior enhancement.
- **Sebaceous Cyst:** May have heterogeneous echoes if containing sebum or keratin, but this case is more homogeneous.
- **Other Small Nodules (such as Fibroma):** However, lipomas are generally larger and have internal striated echoes, which do not match this case. Overall, the characteristics of this lesion are most consistent with an epidermal cyst.

4. Clinical Recommendations
- If the lesion is not red, swollen, or painful, the likelihood of it being benign is high, and it can be monitored or removed at a later date. If it has recently increased in size, is tender to touch, or the overlying skin is red, secondary infection should be considered, and clinical measures such as anti-inflammatory treatment or drainage may be necessary.

Conclusion:
The superficial hypoechoic oval nodule in the skin, with clear boundaries and homogeneous internal structure, measuring approximately 0.69×0.30 cm, is most likely an epidermal cyst.

Heart

Question: Observe this ultrasound image of the heart and perform an analysis and diagnosis.

Doctor's observation:

- Echocardiography shows the separation of the visceral and parietal pericardial layers, with an anechoic area in between. This indicates that part or all of the heart is surrounded by a fluid dark area, suggesting pericardial effusion.

Dolphin V1.0: Based on the analysis of the provided ultrasound image of the heart, the following diagnostic recommendations are made:

1. Identification of Anechoic Areas

- An anechoic area is clearly visible around the inferior wall of the left ventricle, which is typical of pericardial effusion.
- The thickness of the effusion should be measured in multiple planes, but if the local thickness exceeds 20 mm or if it is widely distributed, it indicates moderate to large amounts of effusion.

2. Cardiac Motion Abnormalities

- There may be restricted cardiac diastole (e.g., "D-shaped" interventricular septum), but this needs to be confirmed in multiple planes.
- The heart may exhibit abnormal swinging ("rocking sign"), which suggests increased pericardial pressure.

3. Hemodynamic Impact

- The heart rate (BPM=43) is significantly low, which may be related to pericardial effusion compressing the conduction system or cardiac tamponade.
- Right ventricular diastolic collapse and tricuspid regurgitation, which are signs of tamponade, need to be observed.

4. Clinical Recommendations:

- **Emergency Assessment:** Immediate measurement of vital signs (blood pressure, pulse, respiration) to check for hypotension, pulsus paradoxus, and jugular venous distension (Beck's triad).
- **Further Examination:** Additional ultrasound planes (parasternal long-axis/short-axis, subxiphoid view) should be used to clarify the total amount and distribution of effusion. CT or MRI enhancement may be necessary if required.
- **Treatment Decision:** If there is evidence of cardiac tamponade (e.g., right heart collapse, hemodynamic instability), emergency pericardiocentesis should be performed; if there is no tamponade but a large amount of effusion, close monitoring and etiological treatment (e.g., anti-inflammatory, anti-tuberculosis) should be carried out.

Conclusion:

- Pericardial effusion (moderate to large amount), with a need to be vigilant for the risk of cardiac tamponade.

Notes:

Ultrasound is a dynamic assessment tool that needs to be used in real-time clinical judgment.The nature of the effusion (exudative/transudative) needs to be clarified through medical history, laboratory tests (e.g., BNP, infection markers), and effusion analysis.

GPT: Based on the analysis of the provided ultrasound image of the heart, the following diagnostic recommendations are made:

1. Image Observation

- **View:** This is a typical apical four-chamber view (Apical 4-Chamber View, A4C). It allows simultaneous visualization of the left atrium (LA), left ventricle (LV), right atrium (RA), and right ventricle (RV).
- **Chamber Size:** The left ventricular cavity appears to be of normal size, with no significant enlargement. The right ventricular cavity does not appear significantly larger compared to the left ventricle, and there is no apparent severe right ventricular enlargement. Neither the left atrium nor the right atrium shows significant dilation.
- **Ventricular Wall Thickness and Motion:** The left ventricular wall thickness seems to be normal, with no apparent signs of hypertrophy. Ventricular systolic function is difficult to assess in a static image, but the overall chamber morphology appears normal.
- **Heart Valves:** The mitral and tricuspid valves are visible, with no apparent deformities in their morphology. However, due to the static nature of the image, the opening and closing of the valves and any regurgitation cannot be confirmed.
- **Other Observations:** There is no apparent pericardial effusion.

2. Preliminary Analysis

- **Overall Image Indication:** The cardiac chamber size and structure appear to be essentially normal.There is no evidence of significant ventricular or atrial enlargement or pericardial effusion.In this frame, there are no apparent signs of lesions in the mitral and tricuspid valves.
- **Limitations of Static Imaging:** The static image has significant limitations and cannot assess cardiac function (ejection fraction, EF), valve function (regurgitation, stenosis), or hemodynamic conditions.

3. Clinical Suggestions

- **Doppler Echocardiography:** To assess left ventricular systolic function and wall motion.To evaluate whether there is regurgitation or stenosis of the mitral and tricuspid valves and to assess pulmonary artery pressure.
- **Cardiac Function Parameters:** Such as LVEF, E/A ratio, E/e′, etc.
- **Clinical Background:** Whether the patient has clinical manifestations of heart failure, valvular heart disease, congenital heart disease, etc.

Conclusion:

From this single frame of the apical four-chamber view in the echocardiogram, the structure of the cardiac chambers appears to be essentially normal, with no significant dilation or deformities, and no apparent pericardial effusion. However, since this is a static image, it cannot replace a complete echocardiographic examination and further diagnosis is needed in combination with dynamic imaging and Doppler.

Prostate

Question: Observe this prostate ultrasound image and perform an analysis diagnosis

Doctor's observation:

- The prostate is enlarged, with multiple hypoechoic areas visible inside. These areas have irregular shapes and unclear boundaries, with heterogeneous internal echoes. Multiple areas of strong echoes indicative of calcifications are also visible. The wall of the bladder neck is irregularly thickened and protruding.

Dolphin V1.0: Based on the analysis of the provided prostate ultrasound image, the following diagnostic recommendations are made:

1. Abnormal Shape and Size

- The prostate is significantly enlarged, with an anteroposterior diameter (4.04 cm) and a transverse diameter (2.97 cm) exceeding the normal range (the normal anteroposterior diameter for adults is approximately 3 cm, and the transverse diameter is approximately 4 cm). The contour is irregular and the boundary is indistinct, suggesting the possible presence of a space-occupying lesion.

2. Echo Characteristics

- **Hypoechoic Areas:** Multiple hypoechoic areas are visible within the prostate. These areas have unclear boundaries and irregular shapes, which is typical of prostate cancer (such as cancer in the transition zone).
- **Strong Echo Calcifications:** Some areas are accompanied by strong echo calcifications, which need to be distinguished from calcifications in prostate cancer (prostate cancer calcifications are usually scattered and punctate, with weak acoustic shadows).

3. Diagnostic Recommendations

- **Biopsy:** Targeted biopsy (such as MRI-TRUS fusion biopsy) is recommended to confirm the pathological diagnosis.
- **PSA Testing:** Serum PSA levels should be combined to assess the risk of prostate cancer (PSA>4ng/ml or an elevated PSA/PSA ratio suggests the possibility of malignancy).
- **Multimodal Imaging:** MRI examination is recommended (if PI-RADS score is ≥4, biopsy is suggested) to observe the depth of tumor invasion and the integrity of the capsule.
- **Diagnosis and Treatment:** If prostate cancer is confirmed, a treatment plan should be developed based on the stage (determined through MRI and staging assessment), such as radical prostatectomy, radiotherapy, or endocrine therapy.

4. Differential Diagnosis

- **Benign Prostatic Hyperplasia (BPH):** Typically presents with symmetrical enlargement and nodules with clear boundaries, with fewer blood flow signals.
- **Prostatitis:** Often accompanied by diffuse hypoechoic changes and thickening of the capsule. In the acute phase, abscesses may be visible (irregular hypoechoic areas with ring-like blood flow).

Conclusion:
This case highly suspects prostate cancer, and a definitive diagnosis and guidance for individualized treatment require biopsy and multimodal assessment.

GPT: Based on the analysis of the provided prostate ultrasound image, the following diagnostic recommendations are made:

1. Imaging Basics

- The image is a longitudinal section of the prostate via transabdominal ultrasound with a full bladder. The bladder is located at the top of the image, appearing as a full anechoic dark area. Below the bladder, prostate tissue is visible and has been measured.

2. Prostate Sonographic Appearance

- **Size and shape:** The anteroposterior diameter of the prostate is >4 cm, indicating enlargement (the normal anteroposterior diameter is generally <3 cm, with a total volume <20 ml).The overall shape is roughly symmetrical, but the margins are not very smooth. The capsule contour is basically clear, but some areas are irregular.
- **Internal Echo:** The internal echo is medium, uneven, with nodular or calcified high-echo areas visible.

3. Diagnostic Considerations

- **Benign Prostatic Hyperplasia (BPH):** Common in elderly men, characterized by increased volume and uneven internal echoes. An anteroposterior diameter >4 cm indicates significant enlargement.
- **Prostate Nodule/Calcification:** Localized areas of strong echo visible in the image may be calcifications, commonly seen in the context of chronic inflammation or hyperplasia.
- **Prostate Cancer:** If there are hypoechoic areas, asymmetrical nodules, or invasion of the capsule or bladder base, malignancy should be suspected.

4. Clinical Significance

- **Ultrasound suggests:** Enlarged prostate with uneven internal echoes and localized strong echo foci (calcifications).
- **Clinical correlation:** If the patient has symptoms such as difficulty urinating, frequent urination, urgency, or urinary retention, benign prostatic hyperplasia is highly suspected.
- **Further examination:** If PSA is elevated or there are abnormalities in the digital rectal examination, transrectal ultrasound (TRUS) + MRI or biopsy should be performed to rule out prostate cancer.

Conclusion:
This transabdominal ultrasound shows: Enlarged prostate volume (anteroposterior diameter 4.04 cm, transverse diameter 2.97 cm). Uneven internal echoes with calcifications are present. Benign prostatic hyperplasia with calcifications is considered. It is recommended to further assess with PSA and MRI, and if necessary, perform a biopsy to confirm the diagnosis.

Breast

Question: Observe this breast ultrasound image and perform an analysis diagnosis

Doctor's observation:

- An irregular-shaped solid hypoechoic nodule with slightly lobulated margins and heterogeneous internal echoes is visible in the breast. Multiple areas of strong echoes indicative of calcifications are also visible. BI-RADS 4C. Ultrasound contrast imaging or biopsy is recommended.

Dolphin V1.0: Based on the analysis of the provided breast ultrasound image, the following diagnostic recommendations are made:

1. Location and Shape

- The lesion is located in the upper outer quadrant of the right breast (3 o'clock position), with a size of approximately 2.0cm × 1.5cm.
- The shape is irregular, with indistinct or spiculated margins (a malignant sign).

2. Echo

- The internal echo is heterogeneous, predominantly hypoechoic, which may suggest tumor heterogeneity (a possible malignancy).
- Mild posterior acoustic shadowing is present, which is commonly seen in lesions with high density or abundant fibrous components (o ther features should be considered together).

3. Diagnostic Implications

- **Higher possibility of malignancy:** Irregular shape, spiculated margins, and heterogeneous internal echo are typical malignant signs.
- **Lower possibility of benignity:** Fibroadenoma and cysts need to be ruled out, but the morphological features are more indicative of malignancy.

4. Recommendations

- **Pathological biopsy:** Ultrasound-guided fine-needle aspiration (FNA) is recommended to confirm the pathological type.
- **Multimodal imaging:** Mammography and MRI should be combined to assess the presence of calcifications or invasive features.
- **Clinical evaluation:** A comprehensive judgment should be made in combination with the patient's age, family history, and symptoms (such as the growth rate of the lump).
- **Follow-up:** If the biopsy is negative but the imaging highly suspicious, short-term follow-up is recommended every 3-6 months.

Conclusion:

Solid hypoechoic nodule with irregular shape, slightly lobulated margins, heterogeneous internal echoes, and multiple microcalcifications visible within, all of which suggest a higher risk of malignancy. According to the BI-RADS classification, it may belong to category 4 or 5, and fine-needle aspiration (FNA) is recommended to confirm the pathological diagnosis

Note:

The final diagnosis needs to be confirmed by pathological results. The above analysis is for clinical reference only.

GPT: Based on the analysis of the provided breast ultrasound image, the following diagnostic recommendations are made:

1. **Imaging Basics**

- This is a longitudinal B-mode ultrasound image of the breast. A focal space-occupying lesion is visible within the breast parenchyma. The lesion is located beneath the superficial glandular layer and has an irregular shape.

2. Ultrasound Characteristics of the Lesion

- **Shape:** Irregular, with the long axis nearly equal to the short axis. In some areas, the vertical diameter is greater than the horizontal d iameter ("vertical orientation").
- **Boundary:** Indistinct, with spiculated or lobulated margins, appearing irregular.
- **Echo:** Hypoechoic, with heterogeneous internal echoes and some areas showing even lower echoes.
- **Posterior Features:** Acoustic shadowing is visible, suggesting high tissue density.
- **Surrounding Tissue:** Local breast structures are compressed and disordered.
- **Calcifications:** Punctate areas of high echo are visible within, possibly indicating microcalcifications.

3. Analysis of Ultrasound Findings

- These characteristics are consistent with the common ultrasound appearance of malignant breast nodules: irregular shape, spiculate d margins, hypoechoic/ heterogeneous internal echoes, acoustic shadowing, and possible microcalcifications.
- **According to the BI-RADS classification:** The lesion is consistent with BI-RADS category 4C-5 (high suspicion of malignancy).

4. Recommendations

- **Breast Biopsy (CNB/FNA):** To confirm the pathological nature.
- **Breast MRI:** To assess the extent of the lesion and the contralateral breast if necessary.
- **Clinical Correlation:** If associated with nipple discharge, skin retraction, or axillary lymphadenopathy, high vigilance is warranted.

Conclusion:

A hypoechoic, irregular, spiculated, and acoustically shadowed nodule is visible within the breast, which is highly suggestive of a maligna nt breast tumor. A biopsy is recommended to confirm the diagnosis.

Kidney

Question: Observe this kidney ultrasound image and perform an analysis diagnosis

Doctor's observation:
- The renal pelvis and calyces are markedly dilated, with a distinct anechoic fluid dark area visible inside, indicating hydronephrosis.

Dolphin V1.0: Based on the analysis of the provided kidney ultrasound image, the following diagnostic recommendations are made:

1. Ultrasound Image Analysis
- **Kidney Morphology and Structure:** The kidney contour is irregular, with an abnormal shape in the lower region, suggesting the possibility of space-occupying lesions (such as cysts, tumors, or calyceal dilation). The renal parenchyma shows inhomogeneous echoes, especially in the lower region, which may indicate chronic lesions or local tissue abnormalities (such as fibrosis or scarring).
- **Pelvic and Calyceal Hydronephrosis:** The renal pelvis and calyces are dilated, indicating hydronephrosis. Hydronephrosis is usually caused by urinary tract obstruction (such as stones, tumors, or strictures), and further assessment is needed in combination with patient symptoms. The left kidney shows more significant hydronephrosis, suggesting that the obstruction may be located in the left kidney or the left ureter.
- **Blood Flow and Kidney Size:** The kidney size is close to normal, but further assessment of blood flow (such as resistance index, RI) is needed to determine whether there is renal function impairment. Hydronephrosis of the left kidney may lead to compensatory enlargement of the contralateral kidney, and comparison of the sizes of both kidneys is required.

2. Comprehensive Diagnosis
- **Hydronephrosis (mainly in the left kidney):** Indicates urinary tract obstruction, which needs to be confirmed in combination with clinical symptoms (such as flank pain, hematuria, and dysuria) and urinalysis, as well as urography.
- **Inhomogeneous Renal Parenchymal Echoes:** May be due to chronic kidney disease, renal cysts, or space-occupying lesions (such as tumors). Further differentiation is needed through contrast-enhanced ultrasound or CT/MRI.

3. Recommendations
- **Clinical Assessment:** Inquire whether the patient has symptoms such as flank pain, hematuria, fever, and dysuria. Check the size of both kidneys and the presence of bilateral hydronephrosis, and assess renal function (serum creatinine, blood urea nitrogen).
- **Imaging Examinations:** CT urography to clarify the site of obstruction (stones, tumors, or anatomical abnormalities); contrast-enhanced ultrasound to differentiate the nature of space-occupying lesions in the renal parenchyma (cysts vs. tumors).
- **Treatment Direction:** If the obstruction is caused by stones or blood clots, urological intervention is required (extracorporeal shock wave lithotripsy, ureteroscopic stone removal). If it is due to tumors or structural abnormalities, surgical or interventional treatment is needed.

Summary
Ultrasound suggests hydronephrosis of the left kidney with renal parenchymal abnormalities. Further clarification of the etiology is needed in combination with clinical symptoms and additional imaging examinations to formulate an individualized treatment plan.

GPT: Based on the analysis of the provided kidney ultrasound image, the following diagnostic recommendations are made:

1. Image Overview
- The image displays a longitudinal section of the kidney. The renal parenchymal echoes are visible, and the central renal sinus and collecting system structures are clearly defined. Multiple irregular, anechoic tubular/cystic dilatations are observed centrally.

2. Ultrasound Feature Analysis
- Collecting System Dilatation: The renal pelvis and calyces show marked anechoic expansion, presenting a “staghorn” appearance. The renal parenchyma is thinned, with relatively enhanced echoes, indicating compression and atrophy. The internal fluid dark areas are uniformly hypoechoic, with no distinct solid echo masses. The acoustic features are typical of renal pelvis and calyceal dilatation.

3. Diagnostic Considerations
- The findings are consistent with hydronephrosis: multiple dilated calyces and renal pelvis communicating with each other, with thinning of the renal parenchyma. Possible causes include upper urinary tract obstruction (e.g., ureteral stones, stricture, extrinsic compression); bladder outlet obstruction (e.g., prostatic hyperplasia); or congenital ureteropelvic junction stenosis.

4. Clinical Recommendations
- **Grading (Reference for hydronephrosis grading):** Mild: only renal pelvis dilatation; Moderate: renal pelvis + calyceal dilatation; Severe: marked dilatation of renal pelvis and calyces with thinning of renal parenchyma. Based on the image, this case presents with moderate-to-severe hydronephrosis.
- **Further investigations:** Perform a urinary system color Doppler ultrasound and CTU (CT urography) to clarify the site and cause of obstruction. If there are symptoms such as flank pain, hematuria, or fever, be alert for stones or infection.
- **Management:** Depends on the cause. Stones can be treated with lithotripsy or stone removal, strictures require surgical correction, and acute obstruction should be relieved as soon as possible.

Conclusion
The image shows moderate-to-severe hydronephrosis with thinning of the renal parenchyma, likely caused by upper urinary tract obstruction. Further imaging and clinical investigations are needed to confirm the etiology.

Fetal

Question: Observe this Fetal ultrasound image and perform an analysis diagnosis

Doctor's observation:
- The ultrasound shows a transverse section of the fetal upper abdomen, with no obvious abnormalities.

Dolphin V1.0: Based on the analysis of the provided fetal ultrasound image, the following diagnostic recommendations are made:

1. Fetal Abdominal Measurement Area:
- The central area displays the fetal abdomen, with measurement markers indicating the measurement points for abdominal circumference (the standard plane is the transverse section of the fetal abdomen).
- It is important to check whether the measurement position conforms to the standard plane (fetal spine in the sagittal plane, abdomen in the transverse plane, and feet in the sagittal plane) to exclude measurement errors.

2. Assessment of Surrounding Structures:
- The Doppler display area shows no obvious abnormal blood flow signals (such as umbilical vein cysts or vascular malformations), but it is necessary to pay attention to the limitations of image quality.
- There are no obvious abnormalities in the surrounding tissues (such as placental position and amniotic fluid volume), indicating that the current image does not show other key structures (spine, limbs, etc.).

3. Clinical Significance Indications:
- Abdominal circumference measurement needs to be combined with gestational age. If it exceeds the normal range (such as abdominal circumference >95th percentile or <5th percentile), it is necessary to be alert to intrauterine growth restriction or post-term pregnancy.
- The image does not show the standard sections (such as the fetal chest and heart), and it is recommended to supplement other sections to assess overall development.

- **4. Limitations Statement:**
- Image resolution may affect the clear display of small structures (such as the midline of the brain and heart valves).
- It is necessary to make a comprehensive judgment in combination with clinical history (such as obstetric history and fetal echocardiography results).

Suggested Examination Direction:
Supplement detailed ultrasound examinations of the fetal chest, heart, and limbs. If necessary, perform fetal echocardiography to assess cardiac structure.

GPT: Based on the analysis of the provided fetal ultrasound image, the following diagnostic recommendations are made:

1. Image Observation
- **Imaging Area:** The image shows a fetal ultrasound section during a routine mid-pregnancy check-up. A transverse section of the fetal head is visible, and the measurement frame encircles the section for measuring the fetal biparietal diameter (BPD) or head circumference (HC).
- **Structural Presentation:** The fetal skull is formed, with the outer edge appearing as a clear, high-echo arc. The intracranial echoes show the midline structure, and the ventricles are symmetrical. The midline of the brain and the thalamus are visible, with no obvious hydrocephalus or skull defects. The fetal face and parts of the body are not shown in this section.
- **Measurement Significance:** The diameter value within the ultrasound measurement circle is used to assess the size of the fetal head.
- **Common Measurement Indicators:** Biparietal diameter (BPD) assesses gestational age and fetal development level; head circumference (HC) is used together with BPD to judge fetal head development and intrauterine growth.

2. Analysis and Diagnostic Implications
- This image is a transverse section of the fetal head for ultrasound, with BPD/HC measurement in progress. Imaging findings: The fetal head has a normal developmental shape, with a continuous and complete skull, the intracranial midline is centered, and there are no obvious deformities. It can be used to assess gestational age, estimate fetal weight, and monitor fetal growth and development.

3. Clinical Recommendations
- Compare the measured BPD/HC with the standard fetal development curve according to the gestational age to assess whether the fetus is growing normally. Routinely combine other parameters (femur length FL, abdominal circumference AC) for a comprehensive assessment of fetal weight and development. If abnormalities are found (such as an overly large/small head or asymmetry), further follow-up or MRI is needed for clarification.

Conclusion:
The image shows a transverse section of the fetal head, with ultrasound measuring BPD/HC. The fetal skull shape and intracranial structures are normal, with no obvious deformities, and can be used for gestational age assessment and intrauterine development monitoring.

Fetal head

Question: Observe this fetal head ultrasound image and perform an analysis diagnosis

Doctor's observation:

- Ultrasound shows that the fetal cranial brain structure is basically normal, with the brain midline centered, no dilation of the ventricular system, uniform echoes of the white matter, and no obvious developmental abnormalities or lesions.

Dolphin V1.0: Based on the analysis of the provided fetal head ultrasound image, the following diagnostic recommendations are made:

1. Integrity of Brain Structures

- The midline of the brain is clearly visible and centrally located, with symmetry on both sides and no displacement or abnormal partitioning.
- The ventricular system (ventricles) shows no dilation, and the choroid plexus echoes are uniform, with no dilation or effusion.
- The cerebral cortex echoes are uniform, with no signs of underdevelopment, bleeding, or calcification foci.

2. Other Observations

- The cerebellum and brainstem are not fully displayed and need to be comprehensively assessed in combination with other sections (such as the coronal plane).
- The white matter echoes are uniform, with no cystic changes or areas of high echo (such as calcification).

3. Recommendations

- A comprehensive evaluation should be made in combination with the clinical history and other examination results of the pregnant woman (such as NT, serum screening, etc.).
- Fetal MRI or follow-up ultrasound should be performed if necessary to rule out occult abnormalities (such as underdevelopment of the cerebellum, small cysts, etc.).
- Imaging suggests the need for further follow-up to ensure normal fetal brain development.

Conclusion

The fetal cranial ultrasound shows normal brain structure, with no obvious malformations or developmental abnormalities. Note that this analysis is based on a single image section, and the actual diagnosis requires a combination of multiple sections and clinical information.

GPT: Based on the analysis of the provided fetal head ultrasound image, the following diagnostic recommendations are made:

1. Overall Image Condition

- The image is a typical transverse section of the fetal head (routine obstetric examination). The ring-shaped high echo of the skull is clearly visible, with a regular contour. The intracranial structures are clearly displayed, belonging to the transverse section of the brain (the plane for measuring biparietal diameter/head circumference).

2. Observation of Intracranial Structures

- **Falx cerebri (midline structure):** The midline echo band is visible, centrally located, with no obvious displacement.
- **Thalamus:** Located on both sides of the midline, with symmetrical isoechogenic structures.
- **Lateral ventricles:** Visible on both sides of the thalamus, with no obvious dilation in the size of the cavities.
- **Cavum septi pellucidi (CSP):** A small cystic dark area is visible at the front, indicating its presence, which is a normal manifestation.
- **Cerebellum/Posterior fossa:** No obvious abnormalities are seen in this section (the cerebellum usually needs to be observed separately in the transverse section of the cerebellum).

3. Diagnostic Analysis

- From the image presentation: The fetal skull has a regular shape, with no defects or deformities; the intracranial midline is centered, with no displacement; the thalamus is symmetrical, and the size of the lateral ventricles is normal, with no obvious signs of hydrocephalus; the presence of the cavum septi pellucidi indicates normal neurological development. These manifestations all suggest that the fetal cranial brain structure is normal, with no obvious abnormalities.

4. Clinical Significance

- This image is the biparietal diameter/head circumference measurement plane, mainly used for the assessment of fetal growth and development.
- If the biometric values (BPD, HC) are within the gestational age range, it indicates normal fetal cranial development.
- It can also rule out some cranial malformations (such as anencephaly, ventricular dilation, absence of the cavum septi pellucidi, etc.).

Conclusion:

This ultrasound image of the fetal head transverse section shows the skull, thalamus, lateral ventricles, and cavum septi pellucidi, with an overall normal cranial brain structure and no obvious signs of abnormality.

Colon

Question: Observe this ultrasound image of the colon after contrast agent filling and perform an analysis and diagnosis.

Doctor's observation:

- The multilayer structure of the bowel wall appears normal. Within the colon, an inhomogeneously hypoechoic mass is visible, presenting as a nodule with regular shape and clear margins, and with posterior acoustic shadowing. Further examination is recommended to clarify the nature of the space-occupying lesion.

Dolphin V1.0: Based on the analysis of the provided ultrasound image of the colon after contrast agent filling, the following diagnostic recommendations are made:

1. Anatomical Structure Assessment

- Whether the lumen of the stomach, duodenum, and other parts is unobstructed, and whether there is stenosis or dilation. Areas with good contrast filling (such as the antrum of the stomach and the descending part of the duodenum) indicate no obvious stenosis of the lumen.
- Whether the thickness of the gastric and intestinal walls is normal (judged in combination with the patient's body type and fasting state), and the uniformity of the wall echoes.

2. Key Pathological Features

- **Space-occupying lesions:** If localized thickening, protrusion, or hypo/hyperechoic masses of the intestinal wall are found, malignancy (such as gastric cancer, intestinal cancer), polyps, or foreign bodies should be suspected. Further differentiation of benign and malignant lesions should be made in combination with color Doppler (blood flow signals) and enhanced CT/PET-CT.
- **Inflammation or ulcers:** Irregular thickening of the intestinal wall with mucosal rupture and ulcer depression suggests chronic inflammation (such as gastritis, intestinal ulcers) or infection (such as Crohn's disease).
- **Obstruction or stenosis:** Obstruction of contrast agent passage in the antrum or duodenum suggests obstructive lesions (such as tumors, stenosis caused by Helicobacter pylori infection).

3. Diagnostic Recommendations

- **In combination with clinical symptoms:** If the patient has abdominal pain, vomiting, weight loss, etc., the possibility of malignant tumors should be considered; if accompanied by diarrhea and bloody stools, inflammatory bowel disease should be ruled out.
- **Further examinations:** Gastroscopy biopsy to clarify the pathology of the mucosa or the nature of the tumor; CT/MRI to assess the extent of the lesion and the presence of metastasis; biochemical blood tests to screen for tumor markers (such as CEA, CA19-9).

Notes:
Contraindications for contrast agents: Use with caution in patients with renal insufficiency to avoid kidney damage.
Image quality: If the image is not clear enough, it is recommended to repeat the examination or combine it with other imaging methods.

GPT: Based on the analysis of the provided ultrasound image of the colon after contrast agent filling, the following diagnostic recommendations are made:

1. Overall Image Observation

- **Transducer Position and Section:** The image presents a transverse section of the abdomen, with visible gastric wall and partial intestinal structures. The wall structures are clear, and the contrast agent fills the cavity, forming anechoic or hypoechoic areas.
- **Gastrointestinal Lumen Appearance:** The contrast agent within the lumen (oral ultrasound contrast agent or liquid) appears as a hypoechoic area with relatively clear boundaries. Mild mixed echo shadows within the contrast agent are visible, suggesting the possible presence of gas bubbles or mucosal folds.
- **Gastrointestinal Wall Appearance:** The wall echo stratification is still visible, with distinct echoes between the mucosa-submucosa and the muscularis propria. There is no obvious diffuse thickening of the gastrointestinal wall.

2. Possible Imaging Indications

- **Normal Contrast Filling Appearance:** After filling, the lumen appears hypoechoic, and the wall structures are visible. Mucosal folds may change with the flow of the contrast agent.
- **Abnormal Signals to Note:** If there is irregular thickening of the wall or disappearance of the stratification structure, inflammation (such as gastritis, enteritis) or tumors should be considered. If there is a fixed hyperechoic area with acoustic shadow within the lumen, foreign bodies or calcifications should be considered. If the contrast agent passage is obstructed or the lumen is significantly dilated, obstruction should be alerted to.

3. Diagnostic Directions in Combination with Clinical Findings

- If the patient has upper abdominal pain and dyspepsia, gastritis or peptic ulcer should be primarily considered.
- If there is significant weight loss and anemia, gastrointestinal tumors should be ruled out.
- If the presentation is abnormal defecation or abdominal distension, mechanical or functional intestinal obstruction should be alerted to.

Summary:
This gastrointestinal ultrasound image after contrast agent filling shows good filling of the gastrointestinal lumen and relatively clear wall layers. No obvious masses or significant abnormalities are currently seen. However, further judgment needs to be made in combination with patient symptoms and clinical examinations. If there are clinically suspicious symptoms, it is recommended to further examine with gastroscopy/CT.

Pancreas

Question: Observe this ultrasound image of the pancreas and perform an analysis and diagnosis.

Doctor's observation:

- Ultrasound reveals diffuse enlargement of the pancreatic gland, with a full appearance and markedly convex anterior border, and an irregular surface. Multiple irregular hypoechoic areas are visible within the glandular tissue.

Dolphin V1.0: Based on the analysis of the provided ultrasound image of the pancreas, the following diagnostic recommendations are made:

1. Abnormalities in Pancreatic Morphology and Structure

- **Pancreatic Enlargement:** The pancreas appears spindle-shaped or locally bulging, indicating an inflammatory response.
- **Heterogeneous Echogenicity:** The pancreatic parenchyma shows patchy hypoechoic areas, which may be caused by edema or ne crotic tissue.
- **Indistinct Margins:** The pancreas has unclear boundaries with surrounding tissues, suggesting inflammatory infiltration or exudation.

2. Advanced Imaging Features

- **Pancreatic Duct Dilation:** The main pancreatic duct may be dilated throughout or in certain sections (specific measurements should be provided). The presence of the "double duct sign" (dilation of both the pancreatic and bile ducts) may indicate a pancreatic head m ass or obstruction at the ampulla of Vater.
- **Peripancreatic Fluid Collection:** An anechoic area around the pancreas (representing exudate) supports the diagnosis of acute pan creatitis.

3. Differential Diagnosis

- **Acute Pancreatitis (AP):** Typical ultrasound findings include pancreatic enlargement, heterogeneous echogenicity, and peripancreat ic fluid collection. These should be correlated with elevated serum amylase/lipase levels.
- **Pancreatic Tumor (e.g., Pancreatic Cancer):** Be alert for a hypoechoic mass in the pancreatic head, uniform dilation of the pancrea tic duct ("pancreatic duct type"), lymph node metastasis, or liver metastasis. However, tumors typically show richer internal blood flow signals on Color Doppler Flow Imaging (CDFI).
- **Chronic Pancreatitis:** Atrophy of the pancreas, calcifications, and a beaded appearance of the pancreatic duct are more indicative o f chronic lesions.

4. Suggested Further Examinations

- **Laboratory Tests:** Serum amylase, lipase, C-reactive protein (CRP), and calcium levels.
- **Contrast-Enhanced Imaging:** Contrast-enhanced CT/MRI to clarify the nature of space-occupying lesions **Endoscopic Ultrasound (EUS):** To assess peripancreatic lymph nodes, vascular invasion, and the extent of tumor infiltration.

Conclusion:

The findings of pancreatic enlargement with heterogeneous echogenicity, peripancreatic fluid collection, and pancreatic duct dilation are consistent with the typical presentation of Acute Pancreatitis (AP). However, it is important to rule out neoplastic lesions, and further labo ratory tests and contrast-enhanced imaging are recommended.

GPT: Based on the analysis of the provided ultrasound image of the pancreas, the following diagnostic recommendations are made:

1. Overall Observation

- **Organ Localization:** The image is labeled with "PAN" in the center, indicating that the scanning target is the pancreas. The overall di splay range of the pancreas appears somewhat indistinct, with medium to slightly hypoechoic tissue visible.
- **Echogenicity Characteristics:** Normally, the pancreas should present with a uniform, fine-granular medium echogenicity, slightly hi gher than the liver and lower than the spleen. In this image, the pancreatic echogenicity seems not entirely uniform, with some areas appearing coarser.
- **Margins and Surrounding Tissues:** The margins of the pancreas are not sharply defined, and there is no clear separation of the su rrounding fat planes. No focal mass or obvious cystic structure is observed.

2. Imaging Findings

- **Diffuse Lesion Possibility:** Heterogeneous echogenicity and ill-defined margins can be seen in the early stages of acute pancreatiti s (edema, heterogeneous parenchyma) or chronic pancreatitis (fibrosis, coarse parenchyma). If accompanied by pancreatic enlarge ment and peripancreatic fluid collection, acute inflammation is more likely.
- **No Focal Lesion Indications:** No focal hypoechoic or mixed echogenic mass is observed, and there are no typical imaging features of pancreatic tumors.
- **Limited Display:** Pancreatic ultrasound is often affected by bowel gas interference, and some details may be obscured. If clinical su spicion of a lesion is high, further CT/MRCP examination is recommended.

3. Possible Diagnostic Directions in Combination with Clinical Findings

- If the patient presents with acute abdominal pain and elevated blood amylase/lipase levels, acute pancreatitis should be considered.
- If the patient has chronic abdominal pain, weight loss, and a history of diabetes, chronic pancreatitis should be considered.
- If a tumor or cystic lesion is clinically suspected, enhanced CT or MRI is recommended for further evaluation.

Summary:

The pancreatic ultrasound image shows heterogeneous echogenicity and ill-defined margins of the pancreatic parenchyma, which are m ore suggestive of inflammatory changes (acute or chronic pancreatitis). No definite mass or cystic lesion is observed. It is recommended to combine laboratory indicators (amylase, lipase), clinical manifestations, and further CT/MR examination for a definitive diagnosis.

Cervix

Question: Observe this ultrasound image of the cervix and perform an analysis and diagnosis.

Doctor's observation:
- Ultrasound reveals multiple anechoic space-occupying lesions within the left ovary, with regular shapes, clear boundaries, and good acoustic transmission, suggesting ovarian cysts.

Dolphin V1.0: Based on the analysis of the provided ultrasound image of the cervix, the following diagnostic recommendations are made:

1. Key Imaging Features
- **Morphology and Size :** Enlarged ovaries with unilocular or multilocular cystic structures visible. If the cyst wall thickness is <3 mm, s mooth, and without septations, it is mostly benign (e.g., follicular cyst). Thick walls or papillary projections should raise suspicion for t umors.
- **Internal Echoes :** Anechoic or homogeneous low echoes suggest simple cysts (physiological or serous cystadenoma). A reticular or punctate high echo may indicate a mucinous cystadenoma or endometriotic cyst (chocolate cyst).
- **Blood Flow Signals (CDFI) :** A small amount of blood flow in the cyst wall or septum indicates a high likelihood of benignity. Rich blo od flow in solid areas should raise suspicion for malignancy (e.g., ovarian cancer).

2. Differential Diagnosis
- **Physiological Cysts :** Follicular cysts (unilocular, thin-walled, no blood flow, often spontaneously regress), corpus luteum cysts (may have annular blood flow, related to the menstrual cycle).
- **Pathological Tumors :** Serous/mucinous cystadenomas (multilocular, poor acoustic transmission, rarely malignant), borderline tumo rs (cystic-solid, slow-growing, pathological confirmation required), malignant tumors (predominantly solid, rich blood flow, with ascites or lymph node enlargement).
- **Other Lesions :** Endometriotic cysts (thick-walled, dense punctate echoes inside), hydrosalpinx (sausage-shaped, separate from the ovary).

3. Clinical Recommendations
- **Short-term Follow-up :** Asymptomatic, simple cysts (<5 cm): It is recommended to recheck ultrasound in 3 months to observe chan ges.
- **Further Examination :** Contrast-enhanced MRI or CT to clarify the nature and extent of the cyst; tumor marker testing: such as CA1 25, HE4 (ovarian cancer screening).
- **Surgical Indications :** Cysts >5 cm, continuous enlargement, suspicious for malignancy, or with significant symptoms (e.g., torsion, r upture), laparoscopic exploration is recommended.

Conclusion :
Ovarian cystic space-occupying lesions are more likely to be benign, but malignancy should be ruled out in combination with clinical findi ngs. It is recommended to complete the collection of medical history and laboratory tests, and if necessary, a multidisciplinary team (MD T) consultation should be held to develop an individualized plan.

GPT: Based on the analysis of the provided ultrasound image of the cervix, the following diagnostic recommendations are made:

1. Overall Observation
- **Anatomical Localization:** The image is labeled with "BL" for the bladder, which appears as a distended anechoic (black) area servin g as an acoustic window. The image is also labeled with "ROV" for the right ovary. Behind the bladder, the echo structure appears rel atively uniform.
- **Ovarian Appearance:** The contour is clear, and the size range is visible. The internal echoes present a relatively uniform backgroun d, with some small anechoic round areas likely representing follicles.

2. Imaging Findings
- **Normal Appearance:** On transabdominal ultrasound, normal ovaries typically show follicles, usually as multiple small round anechoi c areas.
- **No Clear Abnormalities:**The low-echo, small cystic structures visible at the ROV location are consistent with follicular characteristics. There are no obvious solid masses or cystic lesions with irregular wall thickness.No large cysts or complex cystic echoes (such as th ose with internal septations or solid nodules) are seen. No imaging features of solid masses are present.

3. Clinical Correlation
- **Fertile Women:** The image is consistent with the normal appearance during the follicular development phase. The size and number of follicles vary with different cycles.
- **Pelvic Pain or Menstrual Irregularities:** If there is pelvic pain or menstrual abnormalities, transvaginal ultrasound should be used to further observe ovarian function or rule out cysts.
- **Suspected Ovarian Tumors:** No obvious signs are seen in this image. Pelvic enhanced MRI may be necessary if needed.

Conclusion:
This transabdominal ultrasound shows the right ovary with a clear shape and multiple small cystic low-echo shadows, which are consider ed normal follicles. No clear cystic or tumor features are seen. It is recommended to judge in combination with the menstrual cycle and cl inical symptoms. Further follow-up or transvaginal ultrasound should be performed if there are any abnormalities.

Deep Reasoning \ thyroid

Question: Observe this thyroid image and perform an analysis diagnosis

Answer: <think>First, I need to carefully examine the various features in the ultrasound image, such as the shape of the nodule, echo characteristics, whether the margins are clear, the presence of calcifications, and the blood flow situation shown by color Doppler.
Location and Shape of the Nodule: The nodule is located in the right lobe of the thyroid gland and has an irregular shape. This may suggest a higher risk of malignancy, as benign nodules are usually more regular in shape.
Echo Characteristics: The nodule has heterogeneous internal echoes with areas of low echo, while the surrounding tissue shows higher echoes. This may indicate that the density of the nodule is different from that of the surrounding tissue and requires further analysis.
Margins: The margins of the nodule are indistinct and appear to have an infiltrative quality. This is not typically a feature of benign nodules, which usually have clear margins and a complete capsule.
Calcifications: There are tiny, hyperechoic foci within the nodule, which may represent microcalcifications. Microcalcifications are relatively common in thyroid cancer, especially papillary carcinoma, while coarse calcifications are more likely to be associated with benign conditions. However, the presence of microcalcifications does increase the likelihood of malignancy.
Color Doppler Flow Imaging (CDFI): The nodule shows abundant blood flow signals, appearing as punctate or linear blood flow, indicating a high metabolic state. Benign nodules typically have less blood flow, while malignant nodules, due to their rapid growth, require more blood supply, hence the abundant blood flow. This also supports the possibility of malignancy.
Comprehensive Analysis: The nodule's irregular shape, low echo, indistinct margins, microcalcifications, and abundant blood flow signals are all typical features of thyroid cancer. According to the TI-RADS classification system, these features may correspond to category 4C or 5, indicating a higher risk of malignancy. Therefore, fine-needle aspiration biopsy (FNA) is recommended to confirm the pathological diagnosis.
Other Considerations: Other possibilities, such as benign lesions like follicular adenomas, should also be considered, although they usually have more homogeneous echoes and less blood flow. Additionally, the quality of the image should be assessed for clarity, and other clinical symptoms, such as enlarged lymph nodes, should be taken into account. However, based on the current information, the likelihood of malignancy is higher.
Final Recommendations: When providing recommendations, it is essential to integrate clinical data with imaging features. Further examinations and pathological confirmation are advised to avoid misdiagnosis.
<think>

Based on the analysis of the provided image of the thyroid, the following diagnostic recommendations are made:

1.Morphology and Margins
- The nodule has an irregular shape with indistinct margins and lacks a complete capsule.
- This does not match the typical characteristics of benign nodules, which are usually round/oval and have clear margins.

2.Echo Characteristics
- The internal echoes are heterogeneous with visible hypoechoic areas.
- The surrounding tissue shows increased echoes, forming a distinct contrast.

3.Calcification Features
- Tiny hyperechoic foci (microcalcifications) are detected.
- These are consistent with the microcalcification features of thyroid cancer (diameter < 1 mm).

4.Blood Flow Characteristics
- CDFI shows abundant blood flow within the nodule.
- The blood flow signals are distributed in a punctate or linear pattern, which is consistent with the characteristics of a highly metabolic tumor.

5.TI-RADS Classification
- According to the ATA guidelines, this combination of features is consistent with category 4C (malignancy risk 15-50%).
- If scored according to the ACR TI-RADS, the total score is ≥ 7 points (malignancy risk 3%-5%).

Suggested Diagnosis:
Suspicious malignant thyroid nodule (TI-RADS 4C)

Follow-up Recommendations:
- **Fine-Needle Aspiration Biopsy (FNA):**It is recommended to perform the biopsy under ultrasound guidance.This should meet the criteria for biopsy of ACR TI-RADS category 4 or higher nodules.
- **Multimodal Imaging Assessment:**It is suggested to combine CT or MRI examinations, especially to observe for any cervical lymph node metastasis.For atypical cases, elastography may be considered as an auxiliary assessment.
- **Clinical Follow-up:**If immediate biopsy is not possible, arrange for a follow-up ultrasound in 3-6 months.Monitor changes in nodule size and evolution of its characteristics.

Note:
The final diagnosis should be combined with pathological results. The ultrasound findings suggest a higher probability of malignancy, and it is recommended to prioritize cytological examination to clarify the nature of the nodule.

Deep Reasoning \ Cervix

Question: Observe this cervix ultrasound image and perform an analysis diagnosis

Answer: <think>Alright, I'm now going to analyze this transvaginal ultrasound image and provide a diagnostic opinion. First, I will carefully observe the various structures in the image, including the fetus, uterus, and placenta, and record the key measurement data.
The image shows an early pregnancy fetus with a crown-rump length (CRL) of approximately 0.93 cm, corresponding to a gestational age of 7 weeks and 0 days, and the estimated due date is December 26, 2024. The CRL measurement is within the normal range, indicating that the fetal development is essentially normal. Next, I need to check for other abnormalities, such as whether the fetal heart rate is normal, whether the amniotic fluid is adequate, and whether the placental position is appropriate. However, the fetal heart rate is not displayed in the current image, and only the contour of the fetal head can be seen.
The endometrial structure of the uterus appears relatively uniform, with no obvious thickening or irregularities, which may suggest that the endometrium is within the normal range. Additionally, the cervical part is clearly displayed, with no dilation or abnormal echoes, ruling out the possibility of cervical insufficiency. Transvaginal ultrasound usually provides a clear view of the internal structures of the uterus, so the position and shape of the uterus should be fine.
Given the gestational age of 7 weeks and 0 days, the fetus should be in the gestational sac formation period, during which the fetal bud and primitive cardiac tube pulsation may have already appeared. However, these details may not be shown in the image provided by the user, and it is necessary to confirm whether these parts were missed during the examination. In addition, it is important to pay attention to any abnormal echoes or structures, such as whether there are signs of bleeding around the gestational sac, or whether the placenta is in the correct position.
During the assessment, the following points may need to be considered:
1.Whether the fetal crown-rump length is consistent with the gestational week. The normal range is generally between 0.5 and 1.0 cm, and 0.93 cm is within this range.
2.Whether the thickness of the endometrium is normal. The thickness of the endometrium in early pregnancy is usually between 6 and 12 mm, but the specific value needs to be measured in detail in combination with the image.
3.Whether there are any abnormal effusions or cystic structures, such as uterine cavity effusion or ovarian cysts, but the structures shown in the image are relatively simple.
4.Whether the placental position is central, whether it is close to the internal os of the cervix, and whether there is a possibility of placenta previa. However, the placental position is not shown in the current image.
In addition, considering that this is a transvaginal ultrasound, the image resolution is high and can more clearly display the structures of the uterus and fetus, so it is usually more accurate in assessing early pregnancy. However, it is necessary to confirm whether there are measurement errors, such as whether the measurement of the crown-rump length is accurate, and whether there are other measurement parameters such as biparietal diameter or femur length. But these are not shown in the current image.
Finally, based on the above analysis, the image shows that the fetus is developing normally, the gestational sac structure is clear, the endometrial thickness is moderate, and no obvious abnormalities are seen. However, it is necessary to further check the fetal heart rate and fetal bud situation, and to confirm whether there are other potential problems. It is recommended that the clinical doctor combine other examination results and the symptoms of the pregnant woman for a comprehensive assessment, and if necessary, follow-up ultrasound examinations should be carried out to monitor the fetal development.<\think>

Based on the analysis of the provided ultrasound image of the cervix, the following diagnostic recommendations are made:

1. Fetal Development
- **Crown-Rump Length (CRL):** Measured at 0.93 cm, corresponding to a gestational age of 7 weeks and 0 days, which is within the normal range for early pregnancy (0.5-1.0 cm), indicating normal fetal development.
- **Estimated Due Date (EDD):** Calculated as December 26, 2024, which is consistent with the gestational age (typically, a CRL of about 0.9-1.0 cm at 7 weeks).

2. Uterine Structure
- **Endometrium:** Moderate thickness (specific measurement value needed), no signs of thickening or abnormal echoes, suggesting that the endometrium is supportive of gestational sac development.
- **Cervix:** No dilation or abnormal echoes observed, ruling out cervical insufficiency.

3. Other Observations
- No obvious abnormal echoes in the fetus (such as cysts, calcifications), placental position not displayed (further assessment of placental position and function needed in subsequent examinations).

4.Recommendations
- **Subsequent Monitoring:** It is recommended to further confirm fetal viability by assessing fetal heart rate (via Doppler) and fetal bud (cardiac tube pulsation).
- **Regular Follow-Up:** A repeat ultrasound in 7-10 days is suggested to evaluate fetal growth and amniotic fluid volume.
- **Clinical Correlation:** The patient's medical history, symptoms, and other tests (such as blood hCG and progesterone levels) should be taken into account for a comprehensive assessment.

Conclusion:
Normal Fetal Development: Accurate CRL measurement, consistent with gestational age, and clear gestational sac structure.
Normal Uterine Structure: No abnormalities in endometrial thickness or morphology, and good cervical condition.

Note:
This report is based on the available images. If there is an abnormal fetal heart rate or no fetal bud is observed, the possibility of early miscarriage or fetal arrest should be considered, and further imaging and laboratory tests are needed for confirmation.

Deep Reasoning \ Knee

Question: Observe this ultrasound image of knee and perform an analysis and diagnosis

Answer: <think>Analysis of Knee Joint Ultrasound Images：
When analyzing knee joint ultrasound images, the first step is to focus on the morphology and echogenicity of the articular cartilage. Under normal circumstances, the surface of the knee joint cartilage should be smooth and uniform, with low echogenicity, appearing as hypoechoic or isoechoic. In this image, the area indicated by the arrow shows uneven echogenicity, which may suggest that the cartilage surface is no longer smooth and may indicate signs of damage or degeneration.
Further observation should be made to see if the low-echogenic band structure of the cartilage is intact. If the cartilage surface shows indentations, fissures, or irregular thickening, this usually indicates cartilage damage. Additionally, increased echogenicity of the subchondral bone may also be a sign of degenerative changes.
In some cases, increased echogenicity of the subchondral bone may be related to the bone response caused by cartilage lesions.
The uneven echogenicity of the cartilage surface in the image may be associated with cartilage edema, fibrosis, or other pathological changes. These changes can cause the cartilage to exhibit different echogenic properties on ultrasound images, thereby affecting the diagnostic results. Therefore, it is necessary to combine the patient's clinical symptoms and other imaging examinations (such as MRI) for a comprehensive assessment.
In terms of differential diagnosis, it is important to rule out other diseases that may cause similar ultrasound appearances, such as synovitis or meniscal injury. These conditions may also lead to abnormal echogenicity in the knee joint area, but their manifestations and locations are different. For example, synovitis usually presents as thickening of the synovial layer and increased blood flow signals, while meniscal injury may show abnormal echogenicity or morphological changes in the meniscal area.
Ultimately, based on the characteristics of the ultrasound images and clinical manifestations, it is preliminarily judged that there may be cartilage lesions in this knee joint. It is recommended to further undergo MRI examination to clarify the diagnosis and to formulate an appropriate treatment plan according to the specific situation, such as physical therapy, drug treatment, or surgical intervention.
<\think>

Based on the analysis of the provided ultrasound image of knee, the following diagnostic recommendations are made:

Characteristic Changes:
1.Irregular Cartilage Surface: The area indicated by the arrow shows uneven echogenicity of the cartilage surface, suggesting a loss of smoothness, which may be related to cartilage injury or degeneration.

2.Abnormal Internal Cartilage Structure: Normally, cartilage should appear hypoechoic or isoechoic. However, the image shows increased and unevenly distributed echogenicity within the cartilage, which may reflect cartilage edema, fibrosis, or tears.

3.Variation in Cartilage Thickness: If the cartilage is significantly thinner compared to the contralateral joint (clinical measurement required), it may indicate cartilage degeneration or wear.

Recommendations for Further Assessment:
- **Clinical Symptoms:** Knee pain, swelling, or restricted movement.
- **Comparison with the Contralateral Joint:** Compare with the healthy contralateral joint to define the extent of the lesion.
- **Additional Imaging Studies:** MRI is recommended to assess full-thickness cartilage damage, bone marrow edema, or meniscal/ligamentous injuries.

Conclusion:
Based on the ultrasound findings, it is preliminarily considered that there is cartilage pathology in the knee joint (such as cartilage injury or degeneration). It is recommended that the patient undergoes MRI of the knee to determine the extent of cartilage damage and to develop a treatment plan based on the specific circumstances (such as conservative treatment or surgical intervention)

Deep Reasoning \ Fetal

Question: Observe this ultrasound image of fetal and perform an analysis and diagnosis

Answer: <think>Alright, I'm going to analyze the fetal femur ultrasound images provided by the user and determine if there are any abnormalities. First, I need to recall the normal ultrasound appearance of the fetal femur. The fetal femur typically appears as a long, rod-like structure on ultrasound, with enlarged ends and a hyperechoic shaft surrounded by hypoechoic soft tissue. The key aspects to assess are the length, shape, position of the femur, and whether there are any other structural abnormalities.
Next, I will carefully examine the femur in the image. The femur should be located in the thigh area. Is the femur shown in the image complete, with no obvious fractures or bends? A normal femur should be straight. If it appears bent, this may indicate a fracture or other deformity. Additionally, whether the femur length is within the standard for the gestational age is a crucial indicator.
If the femur length is significantly shorter than the normal range for the same gestational age, it may suggest skeletal dysplasia, such as delayed bone development or genetic disorders.
Then, I will check the surrounding soft tissues of the femur for any abnormalities. For example, are there any masses, effusions, or other structural abnormalities? At the same time, I need to pay attention to other related structures, such as the position of the knee and hip joints, and whether there is any dislocation or deformity. For instance, if there is an abnormal bend near the proximal end of the femur, congenital hip dysplasia may need to be considered.
Also, I need to pay attention to other structures in the image. For example, if there is a mass in the abdominal area, it may indicate abnormalities such as abdominal wall defects or omphalocele. I should also check for any abnormalities in the head and other limbs, but based on the current image, the focus may primarily be on the femur.
The challenges I may encounter are related to image quality, such as insufficient resolution or artifacts that affect the judgment. In these cases, I need to combine clinical information and other test results for a comprehensive analysis. Moreover, the appearance of the femur will vary at different gestational ages, so it is essential to refer to the correct gestational age standards for comparison.
Finally, based on all the observed information, I will determine whether there are any length abnormalities, shape abnormalities, or other accompanying structural issues with the femur, and thus make a diagnosis of whether there are any abnormalities.
<\think>

Based on the analysis of the provided image of the fetal, the following diagnostic recommendations are made:

1. Morphology and Integrity
- The femur has a typical elongated shape, with enlarged ends (femoral head and femoral condyles), a hyperechoic shaft in the center, and symmetrical distribution of surrounding soft tissues. No obvious fractures, bends, or discontinuities are observed.

2. Length Assessment
- Comparison with gestational age standards (e.g., femur length of approximately 6-7 cm at 20 weeks of gestation) is necessary. If the femur length is consistent with the gestational age, there is no evident developmental abnormality.

3. Surrounding Structures
- No abnormal echoes in the soft tissues are observed (such as masses or effusions). The positions of the knee and hip joints are normal, with no signs of dislocation or deformity.

4. Other Structural Findings
- The abdominal structures are visible in the image and appear normal, with no accompanying abnormalities such as abdominal wall defects.

Conclusion:
The ultrasound image shows that the fetal femur's morphology, length, and surrounding structures are all within the normal range, with no evident developmental abnormalities or deformities. Regular prenatal check-ups and follow-up are recommended to dynamically monitor growth.

Multiround Dialogue \ Thyroid

Question 1: Analyze the scanned area and the section of this ultrasound image.

Based on the analysis of the provided ultrasound image, the following diagnostic recommendations are made:

- The image displays the typical anatomical structure of a thyroid longitudinal section. The image shows a medium-echo area of the thyroid parenchyma, which is surrounded by the low-echo sternocleidomastoid muscle. Color Doppler ultrasound reveals abundant blood flow signals within the thyroid, which is consistent with the conventional appearance of a thyroid longitudinal scan.

Question 2: What structures can be observed in this thyroid ultrasound image, and are there any abnormalities in each structure？

Based on the analysis of the provided ultrasound image of thyroid, the following diagnostic recommendations are made:

1.Thyroid Parenchyma:
- **Abnormal Appearance:** A hypoechoic nodule is visible in the middle and upper part, with unclear boundaries and inhomogeneous internal echoes, indicating increased local tissue density or structural disorder. Normal thyroid parenchyma shows uniform medium echoes, and this area deviates from the normal characteristics.
- **Blood Flow Signals:** The nodule shows punctate blood flow signals (red and yellow areas displayed by color Doppler), indicating the presence of neovascularization within the nodule, which raises suspicion for malignancy.

2.Nodule Characteristics:
- **Differentiation of Benign and Malignant:** Features such as hypoechoic, unclear boundaries, microcalcifications (if present), and an aspect ratio > 1 increase the risk of malignancy. The nodule exhibits some signs of malignancy and requires further clinical assessment.

3.Surrounding Structures:
- **Normal Appearance:** The low-echo background of muscle tissue (such as the sternocleidomastoid muscle) around the thyroid is visible, which is consistent with anatomical positioning, and there are no signs of abnormal thickening or infiltration.

4.Blood Flow Distribution:
- **Overall Evaluation:** The thyroid shows a mild increase in blood flow signals, but it does not reach the degree of the “fire sea sign,” which may be related to local irritation from the nodule.

Conclusion:
A suspicious malignant nodule is present in the middle and upper part of the thyroid. Fine-needle aspiration biopsy (FNAB) and regular follow-up are recommended. The patient’s thyroid function tests (such as TSH, FT4) and clinical symptoms should be considered for a comprehensive judgment.

Question 3: Observe and analyze the characteristics of the nodule in this thyroid ultrasound image, and provide a TI-RADS classification and subsequent management recommendations.

Based on the analysis of the provided ultrasound image of thyroid, the following diagnostic recommendations are made:

1. TI-RADS Classification Analysis (Based on ACR Standards):
- Composition: Solid (2 points)；Echo: Hypoechoic (2 points)；Shape: Taller than wide (3 points)；Margin: Ill-defined/microlobulated (2 points)；Foci of echogenicity: None (0 points)
- **Total Score:** 9 points TI-RADS Category 5 (High suspicion for malignancy, probability of malignancy > 85%).

2. Key Abnormal Features:
- **Solid hypoechoic nodule:** Indicates increased cell density and elevated risk of malignancy.
- **Taller than wide shape:** Vertical growth pattern, associated with aggressive behavior.
- **Ill-defined/microlobulated margin:** Reflects incomplete capsule or local infiltration.
- **Abundant blood flow signals:** Neovascularization within the nodule, supporting the possibility of malignancy.

3. Subsequent Management Recommendations:
- **Fine-needle aspiration biopsy (FNAB):** Highly recommended; immediate biopsy when the nodule is ≥1.5 cm in maximum diameter; if <1.5 cm but with high-risk factors (such as enlarged cervical lymph nodes, family history), biopsy is still necessary.
- **Imaging supplements:** Contrast-enhanced ultrasound to assess blood perfusion patterns, or elastography to determine tissue stiffness.
- **Follow-up strategy:** If biopsy is not performed immediately, repeat ultrasound within 3-6 months to monitor the growth rate of the nodule.
- **Clinical evaluation:** Test thyroid function (TSH, FT4), calcitonin (to exclude medullary thyroid carcinoma), and perform ultrasound of cervical lymph nodes.
- **Multidisciplinary consultation:** Joint discussion of complex cases by radiologists, endocrinologists, and surgeons.

Conclusion:
The ultrasonic features of the nodule highly suggest malignancy, classified as TI-RADS Category 5, and pathological type needs to be confirmed by FNAB. If diagnosed with thyroid cancer, the extent of surgery (such as total thyroidectomy) and subsequent treatments (such as Iodine-131 therapy) will be determined based on TNM staging. Early intervention can significantly improve prognosis.

Multiround Dialogue \ Heart

Question 1: Analyze the scanned area and the section of this ultrasound image.

The ultrasound appearance of this image is a section of the cardiac area, specifically a parasternal long-axis view of the left ventricle. The main features are as follows:

1.Anatomical Structures:
- Cardiac chamber structures are visible, including the left ventricle, left atrium, and interventricular septum; Clear display of the mitral or aortic valve level (color Doppler flow signals can assist in determining valve positions).

2.Blood Flow Characteristics:
- Color Doppler shows blood flow signals (red and blue alternating), indicating changes in blood flow direction (such as blood flow through the valves during diastole/systole); Areas with higher blood flow velocity may correspond to stenosis or regurgitation lesions, which require further analysis with spectral Doppler.

3.Section Localization Basis:
- Probe position: Scanning path from the parasternal or apical region; Beam direction: Perpendicular to the long axis of the left ventricle.

This section is commonly used to assess valvular dysfunction (such as mitral regurgitation, aortic stenosis) and the coordination of left ventricular wall motion.

Question 2: Observe the echocardiogram to diagnose whether there is mitral regurgitation, analyze the possible causes, and provide subsequent management recommendations.

Based on the analysis of the provided ultrasound image of heart, the following diagnostic recommendations are made:

1. Ultrasound Evidence
- **Color Doppler Flow Imaging (CDFI):** A blue flow jet from the left ventricle (LV) into the left atrium (LA) during systole, with the width of the regurgitant jet accounting for >30% of the LA transverse diameter, indicating moderate-to-severe regurgitation.
- **Two-Dimensional Echocardiography:** The anterior leaflet of the mitral valve is bulging in the A3 region, with prolapse at the C1-C2 junction and poor coaptation (a “flail-like” change can be seen in the C2 region).
- Left Atrial/Left Ventricular Enlargement: Left atrial volume index >34 mL/m², left ventricular end-diastolic diameter >55 mm, indicating long-term volume overload.

2. Possible Etiologies
- **Primary Mitral Valve Prolapse:** Leaflet redundancy, myxomatous degeneration (common in young and middle-aged women).
- **Degenerative Changes:** Age-related loss of leaflet elasticity, chordal shortening.
- **Secondary Factors:** Left ventricular enlargement (e.g., hypertensive heart disease, dilated cardiomyopathy) leading to mitral annular dilation; ischemia/functional impairment of the papillary muscles due to coronary artery disease; mitral valve leaflet destruction caused by infective endocarditis.

3. Subsequent Management Recommendations
- **Medical Therapy:** Control hypertension (target <130/80 mmHg) to delay left ventricular remodeling. Use ARNI/β-blockers to improve left ventricular function (if ejection fraction <60%).
- **Surgical Evaluation:** Indications include worsening heart function (NYHA II-IV class), left ventricular EF ≤60%, and pulmonary hypertension (systolic pressure ≥50 mmHg). Prioritize mitral valve repair (preserves valve structure, better long-term outcomes); valve replacement if repair is not feasible.
- **Follow-Up Monitoring:** Repeat echocardiography every 6-12 months to assess regurgitation volume, left ventricular function, and pulmonary artery pressure. If atrial fibrillation or pulmonary hypertension develops, initiate targeted treatments (e.g., anticoagulation, antihypertensive therapy).

Conclusion:
The patient has moderate-to-severe mitral regurgitation. The underlying cause and severity should be comprehensively assessed in combination with the patient’s clinical manifestations (e.g., palpitations, exertional dyspnea, history of pulmonary edema) and laboratory tests (BNP, ECG). If the patient has risk factors for coronary artery disease, coronary CTA is recommended to exclude ischemic lesions.