

(別添様式)

## 未承認薬・適応外薬の要望に対する学会見解

## 1. 要望内容に関連する事項

会社名	日本イーライリリー株式会社	
要望された医薬品	要望番号	IV-167
	成分名 (一般名)	ガルカネズマブ
	販売名	エムガルティ®
要望内容	未承認薬・適応外薬の分類 (該当するものにチェックする。)	<input type="checkbox"/> 未承認薬 <input type="checkbox"/> 2009年4月以降に、FDA又はEMAで承認されたが、国内で承認されていない医薬品 <input type="checkbox"/> 上記以外のもの <input checked="" type="checkbox"/> 適応外薬 <input type="checkbox"/> 医師主導治験や先進医療B(ただし、ICH-GCPを準拠できたものに限る。)にて実施され、結果がまとめられたもの <input checked="" type="checkbox"/> 上記以外のもの
	効能・効果 (要望された効能・効果について記載する。)	群発頭痛発作の発症抑制
	用法・用量 (要望された用法・用量について記載する。)	300 mg
	備考 (該当する場合はチェックする。)	<input type="checkbox"/> 小児に関する要望 (特記事項等)
希少疾病用医薬品の該当性	約 7~50 万人 <推定方法> 2021年時点でわが国の総人口は1.257億人である。「頭痛の診療ガイドライン」作成委員会編集の「頭痛の診療ガイドライン」	

<p>(推定対象患者数、推定方法についても記載する。)</p>	<p>2021」<sup>1</sup>によると群発頭痛の有病率は56～401人/10万人であるため。</p>
<p>現在の国内の開発状況</p>	<p><input type="checkbox"/> 現在開発中 <input checked="" type="checkbox"/> 現在開発していない <input type="checkbox"/> 開発状況不明  (特記事項等) 2023年2月時点で日本イーライリリー株式会社としては群発頭痛発作の発症抑制をめざした開発は行っていないことを確認した。</p>
<p>「医療上の必要性に係る基準」への該当性  (該当するものにチェックし、分類した根拠について記載する。)</p>	<p>1. 適応疾病の重篤性  <input type="checkbox"/> ア 生命に重大な影響がある疾患(致死的な疾患)  <input type="checkbox"/> イ 病気の進行が不可逆的で、日常生活に著しい影響を及ぼす疾患  <input checked="" type="checkbox"/> ウ その他日常生活に著しい影響を及ぼす疾患  <input type="checkbox"/> エ 上記の基準に該当しない  (上記に分類した根拠) 群発頭痛は短時間ながら激しい頭痛と頭部自律神経症状を繰り返し、その間は大きな生活支障が生じる。かつ、次の発作に対する不安も大きい。</p> <p>2. 医療上の有用性  <input type="checkbox"/> ア 既存の療法が国内にない  <input type="checkbox"/> イ 欧米の臨床試験において有効性・安全性等が既存の療法と比べて明らかに優れている  <input type="checkbox"/> ウ 欧米において標準的療法に位置づけられており、国内外の医療環境の違い等を踏まえても国内における有用性が期待できると考  <input checked="" type="checkbox"/> エ 上記の基準に該当しない  (上記に分類した根拠) 反復性群発頭痛発作の発症抑制については、ベラパミルと副腎皮質ステロイドの併用に有効性が認められており<sup>2</sup>、「頭痛の診療ガイドライン2021」にも記載されている。ガルカネズマブは300mgの皮下注射の有効性が反復性群発頭痛患者に対して欧米で施行された第III相試験で報告されている。しかし、実際に先進国で認可されているのは米国とカナダのみであり、欧州では認可されていないことから標準的療法とは考えられない。アメリカ頭痛学会(AHS)のガイドライン<sup>3</sup>では、Level Aの発作予防療法は後頭下神経ブロックのみで、ベラパミル、リチウム、ワーファリン、メラトニンがLevel Cとなっており、最新の総説においてもガルカネズマブはそれらの治療が奏功しない場合に使用されると記載されており、第一選択薬とは位置づけられていない<sup>4,5</sup>。</p>
<p>備考</p>	

以下、タイトルが網かけされた項目は、個人又は患者団体より提出された要望書又は見解に補足等がある場合にのみ記載。

2. 要望内容に係る欧米での承認等の状況

欧米等6か国での承認状況 (該当国にチェックし、該当国の承認内容を記載する。)	<input type="checkbox"/> 米国 <input type="checkbox"/> 英国 <input type="checkbox"/> 独国 <input type="checkbox"/> 仏国 <input type="checkbox"/> 加国 <input type="checkbox"/> 豪州		
	[欧米等6か国での承認内容]		
		欧米各国での承認内容 (要望内容に関連する箇所に下線)	
	米国	販売名 (企業名)	
		効能・効果	
		用法・用量	
		備考	
	英国	販売名 (企業名)	
		効能・効果	
		用法・用量	
		備考	
	独国	販売名 (企業名)	
		効能・効果	
		用法・用量	
		備考	
	仏国	販売名 (企業名)	
		効能・効果	
		用法・用量	
		備考	
	加国	販売名 (企業名)	
		効能・効果	
		用法・用量	
		備考	
	豪州	販売名 (企業名)	
効能・効果			
用法・用量			
備考			

<p>欧米等6か国での標準的使用状況  <u>(欧米等6か国で要望内容に関する承認がない適応外薬についてのみ、該当国にチェックし、該当国の標準的使用内容を記載する。)</u></p>	<input type="checkbox"/> 米国 <input type="checkbox"/> 英国 <input type="checkbox"/> 独国 <input type="checkbox"/> 仏国 <input type="checkbox"/> 加国 <input type="checkbox"/> 豪州		
	<p>[欧米等6か国での標準的使用内容]</p>		
		<p>欧米各国での標準的使用内容（要望内容に関連する箇所の下線）</p>	
	米国	ガイドライ ン名	
		効能・効果 (または効能・ 効果に関連の ある記載箇所)	
		用法・用量 (または用法・ 用量に関連の ある記載箇所)	
		ガイドライン の根拠論文	
		備考	
	英国	ガイドライ ン名	
		効能・効果 (または効能・ 効果に関連の ある記載箇所)	
		用法・用量 (または用法・ 用量に関連の ある記載箇所)	
		ガイドライン の根拠論文	
		備考	
	独国	ガイドライ ン名	
		効能・効果 (または効能・ 効果に関連の ある記載箇所)	
		用法・用量 (または用法・ 用量に関連の ある記載箇所)	
		ガイドライン の根拠論文	
		備考	
	仏国	ガイドライ	

		ン名	
		効能・効果 (または効能・効果に関連のある記載箇所)	
		用法・用量 (または用法・用量に関連のある記載箇所)	
		ガイドラインの根拠論文	
		備考	
	加国	ガイドライン名	
		効能・効果 (または効能・効果に関連のある記載箇所)	
		用法・用量 (または用法・用量に関連のある記載箇所)	
		ガイドラインの根拠論文	
		備考	
	豪州	ガイドライン名	
		効能・効果 (または効能・効果に関連のある記載箇所)	
		用法・用量 (または用法・用量に関連のある記載箇所)	
		ガイドライ	

		ンの根拠論	
		文	
		備考	

3. 要望内容に係る国内外の公表文献・成書等について

(1) 無作為化比較試験、薬物動態試験等に係る公表文献としての報告状況

<文献の検索方法（検索式や検索時期等）、検索結果、文献・成書等の選定理由の概略等>

1) PubMedにて galcanezumab and cluster headache で 46 文献が検出 (2023/02/09)。

<海外における臨床試験等>

1) Mo H, et al. Real-world experience with 240 mg of galcanezumab for the preventive treatment of cluster headache. J Headache Pain 2022 ;23:132. <sup>6</sup>

対象患者

47名の ICHD-3 による反復性群発頭痛患者  
韓国の3つの大学病院で施行。

試験薬

ガルカネズマブ 240 mg 皮下注

4週間毎投与

併用薬

急性期治療と予防薬は使用可能。ガルカネズマブは初回治療あるいは他の予防薬への add on 治療のいずれかで使用された。

主要評価項目

- ✓ 最初に寛解期に入るまでの時間の中間値（ガルカネズマブ治療のタイミングと開始後の週数で評価）
- ✓ 3週間の段階でベースラインの50%以上減少した患者の割合：群発頭痛発作回数と急性期治療薬使用日数
- ✓ 有害事象

結果

- ✓ 最初に寛解期に入るまでの時間の中間値（ガルカネズマブ治療のタイミングと開始後の週数で評価） 17日

Add on 治療群 15.5日

初回治療群 21.0日（ガルカネズマブ単独治療群 12.5日）

- ✓ 投与後第3週における群発頭痛発作がベースラインの50%以下に減少した患者の割合

群発頭痛発作回数

8.6→1.8

78.8% (add on 治療群: 83.3% vs. 初回治療群: 66.7%)

<日本における臨床試験等>

1)

※ICH-GCP 準拠の臨床試験については、その旨記載すること。

(2) Peer-reviewed journal の総説、メタ・アナリシス等の報告状況

1)

(3) 教科書等への標準的治療としての記載状況

<海外における教科書等>

1)

<日本における教科書等>

1)

(4) 学会又は組織等の診療ガイドラインへの記載状況

<海外におけるガイドライン等>

1)

<日本におけるガイドライン等>

1) 「頭痛の診療ガイドライン 2021」の IV 三叉神経・自律神経性頭痛 (TACs) の章の CQ IV-8 「群発頭痛発作期の予防療法にはどのような薬剤があり、どの程度有効か。」の推奨文に「(反復性群発頭痛の予防療法として) 米国ではガルカネズマブ皮下注が使用されているが、わが国において臨床試験は未施行である。なお、欧州医薬品庁は使用を許可していない。」と現状が記載されている。

(5) 要望内容に係る本邦での臨床試験成績及び臨床使用実態(上記(1)以外)について

1) 抗 CGRP 抗体である eptinezumab (静注) の反復性群発頭痛発作に対する予防効果と安全性を検討したグローバル第 III 相試験 (ALLEVIATE 試験) が施行中であり、わが国の 3 施設も参加している。2024 年 1 月に完了予定となっている。有効性についての主要評価項目は「投与後 2 週間の 1 週間当たりの発作回数のベースラインからの変化」となっている。

(6) 上記の(1)から(5)を踏まえた要望の妥当性について

<要望効能・効果について>

1) 今回の要望の根拠になっている NEJM の論文<sup>7</sup>(文献 7)では、欧米の反復

性群発頭痛 106 名を対象にして、主要評価項目である「試験薬投与後 3 週間における 1 週間当たりの群発頭痛発作頻度のベースラインからの変化」と副次評価項目である「試験薬投与後第 3 週における群発頭痛発作がベースラインの 50%以下に減少した患者の割合 (%)」についてガルカネズマブ 300 mg 投与がプラセボに比較して有意に低下させている。しかし、いずれも有意水準は 5%に近く第 III 相試験の結果としては実薬群とプラセボ群との間の有意差は比較的小さいと考えられる。先進国では米国とカナダでは承認されたが、欧州では承認に至っていない。また、それらの評価項目において、投与 5 週間以降はプラセボ群の方がむしろ良好な結果を示している部分が認められる。なお、ガルカネズマブ 300 mg 投与は慢性群発頭痛発作の予防効果は示されなかった<sup>8</sup>。別の抗 CGRP 抗体であるフレマネズマブの反復性群発頭痛の発作予防効果を検討した臨床試験は、有効性が得られない見込みが高くなり、早期中止となった<sup>4</sup>。以上の結果を考えると、複数の CGRP 関連抗体薬と CGRP 受容体拮抗薬が奏功する片頭痛に比較して、群発頭痛（特に慢性群発頭痛）の病態における CGRP の役割はそれほど大きくない可能性も指摘できる。

#### <要望用法・用量について>

1) 欧米で施行された第 III 相臨床試験では 300 mg が使用されている（文献 7）。一方、わが国で片頭痛の予防療法には 240 mg でローディングして、その後は 1 ヶ月ごとに 120 mg を投与することとなっており、用量が異なる。ガルカネズマブ 240 mg の反復性群発頭痛の発作予防効果がリアルワールドで検討されているが、プラセボとの比較を行っていないため実際の効果の大きさは評価不能である<sup>6</sup>。

#### <臨床的位置づけについて>

1) 前述のように、反復性群発頭痛の予防療法としてはベラパミルと副腎皮質ステロイドの有効性が確認されており<sup>2</sup>、わが国でも広く使用されている。ベラパミルと副腎皮質ステロイドの併用は投与後 1 週間でベースラインに比較して発作回数をプラセボに比較して有意に減少させている<sup>2</sup>。欧米で施行された第 III 相臨床試験で実証されたガルカネズマブの効果は主として投与 2 週間以降に特にあらわれており、これは抗体の皮下注する研究デザインを考えると妥当な所見と解釈できる<sup>7</sup>。ガルカネズマブは現時点では第一選択薬とは考えられないが、ベラパミルと副腎皮質ステロイドが無効な反復性群発頭痛症例に対するセカンドラインの発作予防療法として開発することを考慮してもよいと思われる。そのためには日本人反復性群発頭痛患者での有効性と安全性を実証する臨床試験が必要である。前述のように抗 CGRP 抗体である eptinezumab（静注）の反復性群発頭痛発作に対する予防効果と安全性を検討したグローバル第 III 相試験（ALLEVIATE 試験）が施行中であり、わが国の 3 施設も参加している。有効性についての主要評価項目は「投与後 2 週間の 1



週間当たりの発作回数のベースラインからの変化」となっている。2024年1月に完了予定になっていることから、この試験の結果を見極めることは重要と考えられる。あわせて、非侵襲的迷走神経刺激術 (non-invasive vagal nerve stimulation: nVNS)の群発頭痛治療法としてのわが国での開発状況にも注目が必要であろう。

#### 4. 実施すべき試験の種類とその方法案

1) ガルカネズマブ 300 mg あるいは 240 mg の有効性と安全性を検討する国内でのプラセボを対照とする NEJM の論文に準じた第 III 相臨床試験の実施が必要と考えられる。約 100 名の患者の割り付けを行うには、希少疾患であること、群発期と間欠期の存在、発作の変動性などを考えるとリクルートには最低 2 年かかり、国内の 30 以上の専門医療施設の参加が必要と推定される。ただし、この試験は現在進行中の薬剤、刺激機器の開発状況を考慮に入れて待機的に施行すべきと考える。

#### 5. 備考

<その他>

1)

#### 6. 参考文献一覧

1. 頭痛の診療ガイドライン作成委員会. 頭痛の診療ガイドライン 2021. 2021.
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RESEARCH

Open Access



# Real-world experience with 240 mg of galcanezumab for the preventive treatment of cluster headache

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## Abstract

**Background:** Galcanezumab of 300 mg monthly is the FDA approved preventive medication for cluster headache (CH) during the cluster period. Compared to the 120 mg galcanezumab syringe for the treatment of migraines, the 100 mg syringe for CH has globally not been as widely available. The aim of our study was to investigate the preventive efficacy and tolerability of two 120 mg galcanezumab doses for episodic CH in clinical practices.

**Methods:** We evaluated patients with CH who received at least 1 dose of 240 mg (2 prefilled syringe of 120 mg) of galcanezumab in the 3 university hospitals from February 2020 to September 2021. In the patients with episodic CH, the efficacy and safety data of galcanezumab were analyzed regarding to the presence of the conventional preventive therapy at the timing of therapy of galcanezumab. The data of other subtypes of CH were separately described.

**Results:** In 47 patients with episodic CH, galcanezumab was started median 18 days after the onset of current bout (range 1–62 days) and 4 patients (10.8%) received second dose of galcanezumab. The median time to the first occurrence of 100% reduction from baseline in CH attacks per week after galcanezumab therapy was 17 days (25% to 75% quartile range: 5.0 ~ 29.5) in all patients with episodic CH, 15.5 days (3.8 ~ 22.1) in 36 patients with galcanezumab therapy add-on conventional preventive therapy, 21.0 days (12.0 ~ 31.5) in 11 patients started galcanezumab as initial preventive therapy. Among 33 patients with headache diary, the proportion of patients with 50% or more reduction in weekly CH attacks at week 3 from baseline were 78.8%. There was no significant difference in the proportion of patients with a reduction of at least 50% in weekly frequency of CH attacks at week 3 between 24 patients received galcanezumab therapy add-on conventional preventive therapy and 9 patient who received initial galcanezumab therapy. (83.3%, vs 66.7%,  $p = 0.36$ ). There were no significant differences in proportion of “very much better” or “much better” between 36 patients received galcanezumab therapy add-on conventional preventive therapy and 11 patient who received initial GT (86.1%, vs 63.6%,  $p = 0.18$ ).

**Conclusion:** One 240 mg dose of galcanezumab with/without conventional therapy for the prevention of CH is considered effective and safe in clinical practices, as seen in the clinical trial of galcanezumab.

**Keywords:** Cluster headache, Galcanezumab, Migraine, Preventive treatment

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## Introduction

Cluster headache (CH) is a disabling primary headache disorder characterized by clustering of severe headache attacks lasting between 15 and 180 minutes. Prophylactic therapy is recommended from the onset of the cluster period or bout [1, 2]. The burden of cluster headaches are so severe that it significantly impairs the occupational life



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and work efficacy of those impacted [3]. It is also known to be associated with increased emotional stress and suicidal idea [4].

There are various known therapeutic approaches to treat CH: traditional preventive therapy such as verapamil or lithium, and transitional therapy such as suboccipital steroid injection or short-term steroid therapy. Several possible effective therapies are recommended with level C evidence: valproic acid, topiramate, melatonin, baclofen, frovatriptan, and warfarin (only for the patients with chronic cluster headache) [1, 2]. However, only one-third of the patients with episodic CH and half of the patients with chronic CH opt for prophylactic treatment [5]. This low adherence of prophylaxis may be partly due to the adverse events (AE) associated with the medication and patients being uninformed about the importance of prevention.

Galcanezumab, a monoclonal antibody targeting calcitonin gene-related peptide, is the first and the only FDA approved preventive medication for both episodic CH and migraine [6–8]. The approved dosage of galcanezumab for CH is 300 mg monthly during the cluster period and that for migraine is 120 mg monthly after 240 mg loading dose. More than 70% of CH patients, on a 300 mg galcanezumab dose, were reported a reduction of at least 50% in the weekly frequency of cluster headache attacks at week 3 in that trial with a dose of 300 mg of galcanezumab [6]. Galcanezumab may have some merits of rapid efficacy and low AE [9].

Compared to the approval and availability of the 120 mg galcanezumab syringe for the treatment of migraines, the 100 mg syringe of galcanezumab for CH has been unavailable in several countries including Korea. The 1-year prevalence of CH was estimated to be 53–119 per 100,000, consequently its rarity may halt the proper induction of its efficacy as a proven treatment. A retrospective analysis of off-label treatment attempts showed that a 240 mg dose of galcanezumab or a 70–140 mg dose of erenumab for chronic CH had comparable efficacy [9]. Approximately 15% of CH patients also reported having comorbid migraine, for which clinician can accordingly offer a loading dose of 240 mg galcanezumab [10].

We investigated the preventive efficacy and tolerability of two 120 mg galcanezumab doses for episodic cluster headaches in clinical practices [9, 11, 12].

## Materials and methods

### Study design and patients

In this multi-centered observational study, we collected the data of patients with CH who received at least one 240 mg galcanezumab dose (2 prefilled syringe of 120 mg) at the 3 university hospitals, from February 2020 to September 2021. The eligible participants were 18 to 60 years

of age, and the diagnosis of episodic CH (ECH) was according to the diagnostic criteria of the International Classification of Headache Disorders (ICHD), 3rd edition [13]. Investigators carefully evaluated the patients and made the CH diagnosis based on the patient's history and clinical presentation using the third edition of the ICHD. We excluded the data of galcanezumab therapy (GT) for second cluster bout in 2 patients in this analysis due to duplication of the same patients (Fig. 1).

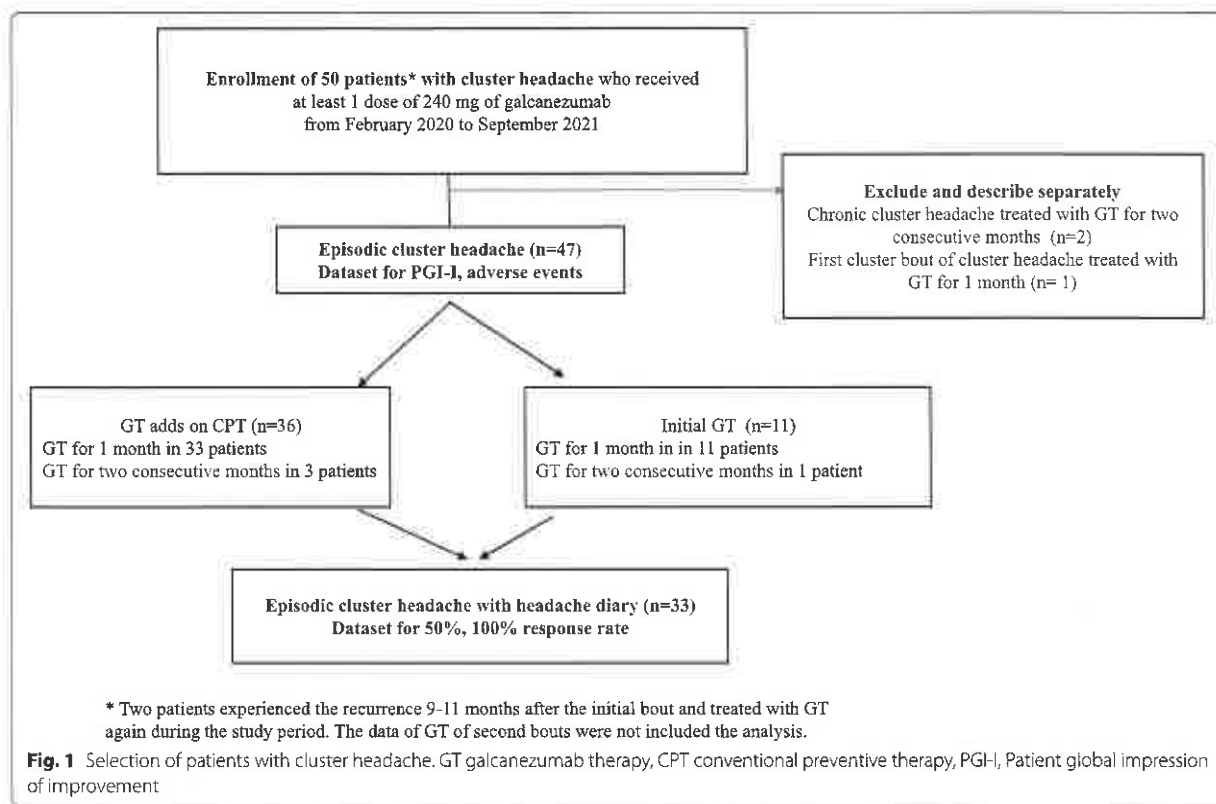
The study protocols of prospective and retrospective registry were approved by the institutional review board (IRB) at each hospital (EMCS 2021–10–032-001). For the patients who received galcanezumab for prevention of cluster headache before the IRB approval, IRB allowed the process of written informed consent to be waived due to retrospective data collection and fully anonymity. After IRB approval, all patients were given full explanation of the study purposes and provided written informed consent before their voluntary participation. This study was conducted in accordance with the principles of the Declaration of Helsinki.

### Treatment

The decision to use GT for prevention of CH was made of the patients own volition after the investigator's recommendation, as this specific course of treatment for CH is not covered by the Korean national insurance. Only a 120 mg syringe of galcanezumab was available in Korea, 1 dose of 240 mg (2 prefilled syringe of 120 mg) of galcanezumab was given to patients with CH. There was no restriction regarding the usage or dosage of any other abortive and preventive medication besides GT. After 1 month of initial injections, the second dose of galcanezumab was recommended, but the treatment decision was made based on the status of remission and patient's preference.

### Data collection

The following demographic data was extracted from the patients' electronic medical records: onset and end date of cluster bout and feature of CH, acute and preventive treatment, and history of comorbid migraine. Patients from the prospective registry were asked to keep a headache diary and record the frequency of CH attacks, the number of days with acute medication, and the pain severity. Patient global impression of improvement (PGI-I) and adverse drug responses were assessed 4 weeks after the last dose of galcanezumab. The following information about patients from the retrospective registry were obtained by medical records or telephonic interviews: information about the last day of cluster bout, PGI-I, and adverse drug responses.



### Efficacy and safety assessments

The efficacy and safety data of galcanezumab were analyzed in patients with ECH according to the timing and the approach of GT: whether GT was added onto the conventional preventive therapy (CPT), or whether GT was started as the initial preventive therapy. Median time to first occurrence of 100% baseline reduction (remission) in CH attacks after the first GT was assessed by timing of GT and the week after GT. PGI-I and adverse response were assessed by the timing of GT.

Fifty % reduction from baseline to 3-week in CH attacks per week and the days with acute medications per week were assessed in patients with headache diary who enrolled for prospective registry.

The data of other subtypes of cluster headache, such as chronic cluster headache, probable cluster headache, or the first episode of cluster bout were separately described.

Safety assessment data were collected from the patients' EMR, self-reported headache diary, or telephone interviews.

### Statistical analyses

Patient baseline characteristics and clinical features were the two-sample *t*-test and Mann-Whitney U-test were

used to compare the mean values according to whether or not each variable conformed to a normal distribution. The normality of data distribution was evaluated by the Shapiro-Wilks test. The chi-square test or Fisher's exact test was used to compare categorical variables. All tests were two-tailed, and a *p*-value < 0.05 was considered to represent statistical significance. All analyses were performed using R for Windows (ver. 4.1.2; R Foundation for Statistical Computing, Vienna, Austria) and RStudio (ver. 2022.02.0 + 443; RStudio, Boston, MA, USA).

### Results

#### Selection of enrolled patients, baseline characteristics, and prevention with Galcanezumab therapy

Fifty patients with CH who received at least 1 dose of 240 mg (2 prefilled syringe of 120 mg) of galcanezumab were enrolled during our study period. Two patients with chronic CH and one patient during his first cluster episode were excluded from the analysis for the GT efficacy in episodic cluster headache (ECH) (Fig. 1).

The mean age of the 47 patients with ECH was 40.4 (range 25–61) years and they had experienced 2–28 bouts before the current bout. The 47 patients were comprised of 39 males (83.0%) and 8 females. Thirteen patients (27.7%) had a previous history of migraines.

Regarding the timing of GT for current cluster bout: 36 patients added the GT on their CPT and 11 patients started GT as their initial preventive therapy. During total period of preventive therapy, 2 patients received three preventive drugs (verapamil, lithium, and other drug such as candesartan), 21 patients received two preventive drugs (verapamil and topiramate 15, verapamil and lithium 4, topiramate and other medications 1, verapamil and other drug 1), 12 patients received one preventive drug (verapamil 8, lithium 3, other drug 1), and 1 patient received only transitional therapy. In the initial GT group, mean onset age of CH was about 5 years younger and disease duration of cluster headache was somewhat longer than GT with CPT group. However, there was no significant difference of baseline characteristics between the two groups including psychiatric comorbidities or suicidal idea (Table 1).

Galcanezumab of 240 mg was injected an average of 18 days after the onset of current bout (range 1–62 days). Among 12 patients who had ongoing attacks 1 month after GT, 8 patients were initially included GT

add-on CPT and 4 were included in initial GT group. Four patients, 3 patients in GT add-on CPT and 1 patient in initial GT group, received the second galcanezumab dose of 120 or 240 mg an average of 31 days after initial GT.

#### Occurrence of 100% and 50% reduction in CH attacks and days with acute medications after 240 mg of GT among ECH

Median time to the first occurrence of 100% reduction from baseline in CH attacks per week after the first GT was 17 days (25% to 75% quartile range: 5.0~29.5) in 47 patients with ECH. 100% reduction in CH attacks per week were achieved within 1 week in 13 patients (27.7%), within 2 weeks in additional 10 patients (21.3%), within 3 weeks in 6 more patients (12.8%). Finally, 35 patients got remission 1 month after GT.

Regarding the timing of GT, median time to first occurrence of 100% reduction from baseline in CH attacks per week was 15.5 days (3.8~22.1) in 36 patients with GT add-on CPT, 21.0 days (12.0~31.5) in 11 patients with initial GT, and 12.5 days (12.0~19.8) in 6 patients with GT as sole prevention. No recurrence was observed

**Table 1** Baseline characteristics of the patients with episodic cluster headache according to the timing of 240 mg of galcanezumab therapy (GT)

	GT add-on CPT (n = 36)	Initial GT (n = 11) <sup>a</sup>	P-value
Age, years	40.1 ± 8.7	41.5 ± 9.4	0.68
Male sex, n (%)	29 (80.6)	10 (90.9)	0.73
Onset age, years	29.5 (22.0, 35.3)	24 (20.0, 29.5)	0.20
Duration of CH disease, years	8.5 (5.0, 12.5)	10 (8.0, 21.5)	0.07
Average duration of cluster period, weeks	6 (5.0, 8.0)	8 (4.5, 10.0)	0.67
time to GT from the onset of cluster bout, days	19 (13.2, 28.2)	9.0 (8.5, 23.5)	0.23
BMI, kg/m <sup>2</sup>	24.3 ± 4.3	23.5 ± 1.9	0.41
Ever-smoker, n (%)	22 (61.1)	7 (63.6)	1.00
Current alcohol drinking, n (%)	19 (52.7)	7 (63.9)	1.00
Comorbid migraine, n (%)	11 (30.4)	2 (18.2)	0.68
PHQ-9 score*	7.9 ± 6.6	9.9 ± 7.3	0.50
GAD-7 score*	8.5 ± 5.5	10.6 ± 7.2	0.42
EQ-5d scores*	0.91 (0.86, 1.00)	0.84 (0.79, 0.94)	0.46
Passive suicidal idea*	70.5%	87.5%	0.62
Abortive treatment			
Oxygen, n (%)	10 (27.8)	3 (27.2)	1.00
Triptan, n (%)	29 (80.6)	4 (36.4)	0.26
CPT			
Verapamil, n (%)	27 (75.0)	—	
Lithium, n (%)	6 (16.7)	—	
Prednisolone, n (%)	26 (72.2)	—	
Occipital nerve block, n (%)	23 (63.9)	—	
Topiramate, n (%)	14 (38.9)	—	

Age and BMI are presented as mean (standard deviation). The remaining data are presented as median (quartile) according to normality of variable  
GT galcanezumab therapy, CPT conventional preventive therapy, CH cluster headache, BMI body mass index

\*Data about psychiatric comorbidities and suicidal idea were available among 26 patients (GT add-on CPT 17, Initial GT 8). No patient attempted suicide

<sup>a</sup> Five patients added other conventional preventive therapies after the start of GT

**Table 2** Efficacy of 240mg of galcanezumab therapy at week 3 compared to baseline in patients with episodic cluster headache based on the headache diary (n=33)

	Baseline	Week 1	Week 2	Week 3	Week 4	Patients with a reduction of at least 50%, n (%)	Patients with a 100% reduction, n (%)
Number of attacks per week	7.0 (6.0, 10.0)	4.0 (1.0, 6.0)	4.0 (0, 6.0)	0 (0, 4.0) <sup>b</sup>	0.0 (0, 1.0)	26 (78.8)	18 (54.5)
Days with acute medications per week <sup>a</sup>	7.0 (3.0, 7.0)	1.5 (0.0, 4.0)	1 (0, 3.0)	0 (0, 1.3) <sup>b</sup>	0 (0, 0)	23 (79.3)	18 (62.1)
Pain intensity during attacks [0–10]	8.0 (7.0, 9.0)	6.0 (4.8, 7.3)	4.5 (0, 5.3)	0 (0, 5.0) <sup>b</sup>	0 (0, 1.8)	NA	NA

Data is presented as median (quartile) according to normality of variable

<sup>a</sup> 4 patients did not take any oral abortive medications during baseline

<sup>b</sup> P-value < 0.001, comparison from baseline to week 3

within 3 months after the occurrence of 100% reduction from baseline in CH attacks.

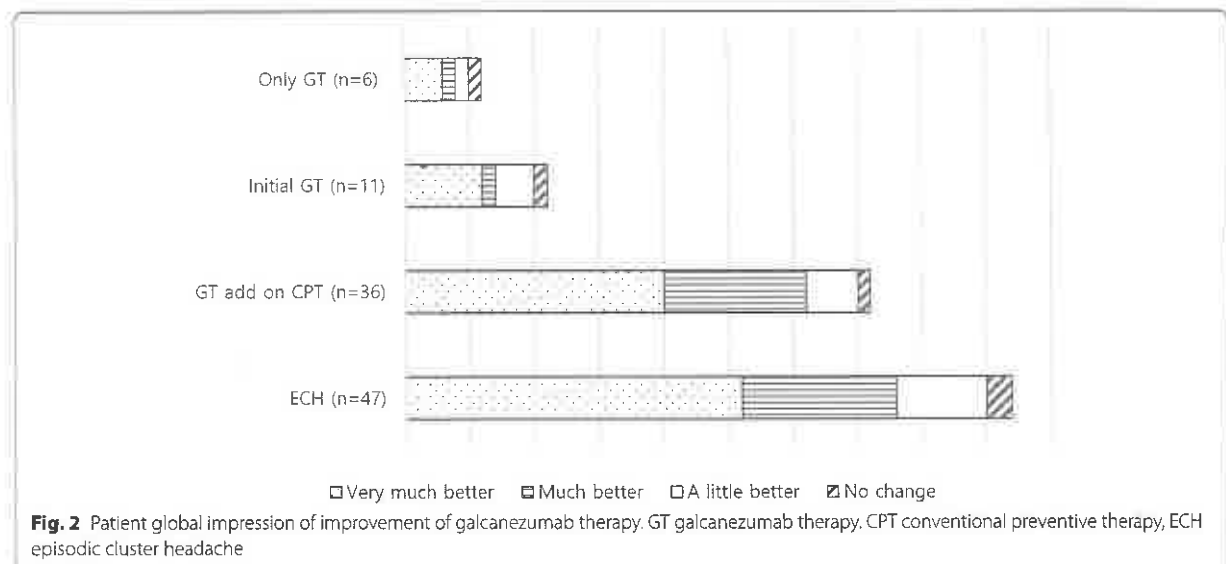
The efficacy of GT was analyzed about a reduction of at least 50% in weekly frequency of CH attacks and the days with acute medications per week at week 3 from baseline in 33 patients with headache diary data. The mean numbers of CH attacks were decreased from 8.6 attacks (SD 4.8) in baseline to 1.8 attacks (SD 2.4) in week 3. The median number of weekly CH attacks and the median days with acute medication per week significantly decreased after GT (Table 2). At week 3, the proportion of patients with a 50% or more reduction in weekly CH attacks was 78.8% and the proportion with a 50% or more reduction in days with acute medication per week was 79.3%. There was no significant difference in the proportion of patients with a reduction of at least 50% in weekly frequency of CH attacks at week 3 between 24 patients received GT add-on CPT and 9 patient who received initial GT. (83.3%, vs 66.7%,  $p=0.36$ ).

Among 12 patients who had ongoing attacks 1 month after GT, 4 patients who received the second GT had

finished their CH bout 52–66 days after the first dose of GT (19–35 days after the second dose of GT) and 8 patients who did not receive the second GT finished their CH bout 31–99 days after the first dose of GT.

**Patient global impression of improvement and adverse response after galcanezumab therapy**

Among 47 patients with ECH, PGI-I were reported as feeling “very much better” in 26 patients, “much better” in 12 patients, “a little better” in 7 patients, and “no change” in 2 patients. No patients reported feeling of any worse. The proportion of “very much better” or “much better” was 80.9% in 47 patients with ECH. There were no significant differences in proportion of “very much better or “much better” between 36 patients received GT add-on CPT and 11 patient who received initial GT (86.1%, vs 63.6%,  $p=0.18$ ). There were no definite differences in the proportion of “very much better” or “much better” according to presence of transitional therapy such as sub-occipital steroid injection or short-term steroid therapy. (86.4% vs. 60%,  $p=0.08$ , Fig. 2).



**Fig. 2** Patient global impression of improvement of galcanezumab therapy. GT galcanezumab therapy. CPT conventional preventive therapy, ECH episodic cluster headache

**Table 3** Adverse events of 240 mg of galcanezumab therapy in patients with episodic cluster headache

	GT add-on CPT (n = 36)	Initial GT (n = 11) <sup>a</sup>	p-value
None	22 (61.1)	8 (72.7)	0.72
Constipation	11 (30.6)	2 (18.2)	0.70
Hiccup	1 (2.7)	0	1.00
Myalgia	0	1 (9.1)	1.00
Neck pain	1 (2.7)	0	1.00
Injection-site swelling	1 (2.7)	0	1.00
Nocturia	1 (2.7)	0	1.00

GT galcanezumab therapy, CPT conventional preventive therapy

<sup>a</sup> Five patients added other conventional preventive therapies after the start of GT

No serious AE occurred during the study period. More than half of the patients in both groups did not report any AE during GT (61.1% vs 72.7%,  $p=0.72$ , Table 3). There were no differences in the frequency of AE according to the timing of GT.

#### Experience of galcanezumab therapy in 2 patients with chronic CH and 1 patient with first cluster bout

A 24-year-old male patient with primary chronic CH, enrolled 6 years after the onset of cluster bout and remitted after 2 months of consecutive GT. A 19-year-old male with secondary chronic CH enrolled 7 months after the onset of the cluster period and remitted 3 months after consecutive GT. A 29-year-old male in the first episode of cluster bout enrolled 2 months after the onset of cluster headache and remitted 24 days after GT. The patients had several conventional preventive therapies added onto the GT and none of them had a history of migraine. PGI-I were reported as feeling “very much better” in a patient primary secondary chronic CH and “much better” in a patient secondary chronic CH and a patient with the first episode of cluster bout. Only one patient with primary chronic CH reported mild constipation after GT.

#### Discussion

The main findings of our real-world study of GT over 20-months for the prevention of CH, were follows: (1) one dose of 240 mg of GT with/without conventional therapy for prevention of CH is effective in this study. Median time to remission after the first GT was 17 days and the proportion of patients with 50% reduction at week 3 from baseline about the numbers of CH attacks per week was 78.8%; (2) Patient with ECH received GT about 2 weeks after the onset of cluster bout and 91.5% of patients with ECH received GT just once in clinical practice; (3) In patients with relatively low frequency of CH attacks, as observed in Asians, the efficacy of GT

with/without CPT was comparable to Western data; (4) GT was safe and well tolerable with/without CPT in patients with CH; (5) If other treatments are ineffective during several months of cluster bout, adding GT can be a good option to get much better improvement or obtain remission in patient with CH, even in patients with chronic CH or the first cluster bout.

This observational study was similar in the following ways to the historical randomized clinical trial (RCT) published in 2019 [6]: in mean age, sex ratio, and numbers of the participants who received galcanezumab. The following differences were noted between the two studies: proportions of smoking exposure (62% in this study, 79% in the RCT), the number of CH attacks per week in baseline (7.9 in those with diary data vs 17.8 in the RCT), and combination of other preventives (not allowed in the RCT) were different between two studies. Regarding the efficacy of GT of the 33 patients with headache diary in this study, the percentage of patients with at least 50% reduction in headache frequency at week 3 was 78.8% (71% in the RCT) and mean reduction of in the weekly CH frequency at week 3 was 6.8 attacks (8.7 attacks in the RCT). Our results supported that the treatment effect in observational studies was reported as similar to those obtained in RCT [14]. The real-world situation is not similar to the RCT conditions, but similar efficacy may be mixed effect of variability of status of patients and combined treatment in actual practices.

In this study, 91.5% of ECH received only one GT and 74.5% of ECH went into remission within 1 month after GT. We cannot rule out the influence of delayed start of GT and relatively shorter cluster bout on this one-shot GT efficacy. Although CH patients in Asia may have low proportion of smoking exposure, a lower attack frequency, and shorter bout duration [15, 16] compared to European and American populations, the efficacy of GT may be similar worldwide. The higher percentage of “very much better” or “much better” by PGI-I after GT also supported this conclusion. Considering only 1 patient was included in the RCT, this study can give practical information about GT for Asian CH patients.

The best time for GT in ECH is uncertain. Many patients are unable to come to the clinic from the onset of their cluster bout. The average duration from onset before GT intervention was about 2 weeks. Some CH patients were able to predict the upcoming bout based on early symptoms prior to the active bout. CH attacks may be less severe, less frequent, or shorter or longer duration especially around beginning and end of cluster bout [13, 17]. Whether early GT intervention can shorten the duration of cluster bout remains elusive and requires further evaluation.



Reports of AEs of GT were variable, none were serious, and most were well tolerable with/without CPT. The risk of AEs was reported as relatively high after verapamil or lithium or galcanezumab, but the burden of AEs is reasonable in the patients with GT and conventional preventive therapies. Prescription medication for the prevention of constipation, as is the usual practice for CH patients, may influence this result.

Our study had several limitations. First, the observed efficacy of GT can be an effect of spontaneous remission. Average duration of previous CH bouts was 6–8 week and the interval between onset of CH bout was 18 days, so it seems some patients' remission might be due to the natural course of their bout. The actual efficacy of GT may be re-evaluated as an initial treatment for the next CH bout. Although placebo group was lack, PGI-I of the patients with long duration of cluster disease may support the efficacy of GT. Second, it is impossible to separate the efficacy of GT from that of CPT. Discontinuation of other preventive therapies after GT or withhold before GT can be also dilemma to both physicians and patients. Third, sample size of this study was too small to assess the efficacy of GT with various combination of conventional preventives, different starting date of GT, and personal diversity of cluster period. The role of transitional therapy after GT is reasonable to evaluate in a larger number of patients. Finally, we cannot avoid selection bias from university hospital setting with special interest in CH and data with/without headache diary. There are no differences in age, sex, and life-time duration of cluster disease between those with and without headache diary in this study. In addition, age, sex, and percentage of smoking exposure was similar to those in the patients of Korean Cluster Headache Registry. However, these results could only reflect a group of referral or more severely affected CH patients and may not well represent the real-world situations of the total CH populations.

## Conclusions

GT may be effective and safe in the treatment of ECH with or without CPT, even 2 weeks after cluster bout onset.

## Abbreviations

AE: Adverse events; CH: Cluster headache; CPT: Conventional preventive therapy; ECH: Episodic cluster headaches; GT: Galcanezumab therapy; ICHD: the international classification of headache disorders; IRB: Institutional review board; KCHR: Korean cluster headache registry; PGI-I: Patient global impression of improvement; RCT: Randomized clinical trial.

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## Authors' contributions

Study design and conceptualization were done by Soo-Jin Cho, Byung-Kun Kim, Heui-Soo Moon, and Heejung Mo. Data collection and analysis were done by Byung-Kun Kim, Heui-Soo Moon, and Soo-Jin Cho. Original draft was done by Heejung Mo and Soo-Jin Cho. Review and editing were done by Soo-Jin Cho, Byung-Kun Kim, Heui-Soo Moon, and Heejung Mo. The authors read and approved the final manuscript.

## Funding

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## Availability of data and materials

The data used in the present study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

The study protocol was approved by the ethics committee in each participating hospital and complied with the Declaration of Helsinki and Good Clinical Practice guidelines. For the patients who received galcanezumab for prevention of cluster headache before the IRB approval, IRB allowed the process of written informed consent to be waived due to retrospective data collection and fully anonymity. After IRB approval, all patients were given full explanation of the study purposes and provided written informed consent before their voluntary participation.

### Consent for publication

Not applicable.

### Competing interests

Dr. Mo was involved as a site investigator of multicenter trial sponsored Biohaven Asia Pacific Ltd. Dr. Kim was a principal investigator for a multicenter trial sponsored by Otsuka Korea, Novartis International AG, Ildong Pharm and Eli Lilly and Company. BKK worked as an advisory member for Lundbeck Korea, Sanofi Korea, Teva Korea and received lecture honoraria from GSK Korea, SK Chemicals, Allergan Korea and Yuyu Pharmaceutical Company in the past 24 months. Dr. Moon reported no conflict of interest.

Dr. Cho was a site investigator of a multicenter trial sponsored by Allergan, Abbvie Inc., Ildong Pharmaceutical Co., LTD, Novartis International AG, Eli Lilly and Company, Hyundaiapharm. Co. Ltd., Biohaven Asia Pacific Ltd., and H. Lundbeck A/S (Lundbeck), and received lecture honoraria from Allergan Korea, WhanIn Pharm Co., LTD, Boryung Pharmaceutical Co., Ltd., Shinpoong Pharma. Co., Ltd., Yuyu Pharmaceutical Company, and SK chemicals in the past 24 months.

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