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Evaluation of the role of vertebral augmentation in chronic vertebral compression fractures: A retrospective study☆

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ABSTRACT

Objectives: Vertebral augmentation is recommended for acute or subacute vertebral compression fractures (VCFs); few studies claim its usefulness in chronic VCFs also. Use of radionuclide imaging may improvise identification of chronic VCFs that may benefit from vertebral augmentation; hence we have evaluated efficacy of vertebral augmentation procedures in chronic VCFs with incomplete fracture healing suggested either by MRI or Tc99m-MDP bone scan.

Materials and Methods: Patients with chronic osteoporotic VCFs (>12 weeks) during the period of June 2013 to June 2019 were included in this retrospective study; patients with evidence of incomplete fracture healing either by MRI or bone scan imaging with Tc 99m-MDP underwent vertebroplasty or kyphoplasty. Primary outcome measure was patient's pain score measured by numerical rating scale (NRS); secondary outcome measures were patient's disability assessed by Roland Morris Disability questionnaire (RDQ); quality of life assessed by Quality of life questionnaire of European Foundation of Osteoporosis (QUALLEFO) and analgesic usage. $P < 0.050$ was considered as significant.

Results: 34 patients were enrolled for the study with median fracture age of 36 months. The median NRS pain scores, RDQ scores, QUALEFFO scores and analgesic usage were significantly reduced at all-time points as compared to the baseline value over the follow up period of 1 year after vertebral augmentation procedure ($P < 0.050$). Cement leakage was seen in 5 patients (15%).

Conclusion: Vertebral augmentation procedures provided significant improvements in pain scores, disability and quality of life in patients of chronic osteoporotic VCFs with median fracture age of 36 months.

1. Introduction

Vertebral augmentation procedures are used to provide pain relief in patients with vertebral compression fractures (VCFs) not responding to conservative measures. Majority of VCFs heal by medical management along with bed rest and external bracing; however, in significant proportion of patients pain is refractory to medical management [1]. Prolonged immobilisation secondary to pain increases bone loss and risk of new vertebral fractures in these patients; deep vein thrombosis, aspiration pneumonia, pressure sores and poor glycaemic control are few other complications [2], especially in the elderly population. Pain relief and early mobilisation following vertebral augmentation is very useful in these patients.

Vertebroplasty and kyphoplasty are commonly used minimally invasive techniques for percutaneous vertebral augmentation; these procedures are recommended for acute and subacute VCFs with severe pain despite medical management [3–5]. Cardiovascular and Interventional Radiological Society of Europe (CIRSE) guidelines on percutaneous vertebral augmentation recommends that vertebral augmentation should be considered in patients within four months of VCF with at least 3 weeks of failure of conservative treatment [5]. In cases of chronic VCFs more than 4 months old, vertebral augmentation can be done if there is evidence of incomplete fracture healing [5–10]; literature recommends that chronic VCFs with fracture age of up to 24 months achieve clinical benefit following vertebral augmentation [6–10].

Many patients with osteoporotic VCF referred to our pain clinic have

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fracture age of more than 24 months (determined from the first radiological evidence of vertebral fracture); majority of these patients have severe axial back pain worsened with movements and relieved in the supine position. Clinical examination revealed localised midline tenderness corresponding to the level of fractured vertebra. Pain did not respond to conservative measures, limiting their mobility and quality of life.

Over the past few years we have been performing vertebral augmentation procedure in these patients of chronic osteoporotic VCFs with evidence of incomplete fracture healing; the presence of incomplete fracture healing was identified by either magnetic resonance imaging (MRI) or bone scan imaging with Tc 99m-MDP. MRI identifies incomplete fracture healing by signal intensity changes indicating marrow oedema of the fractures in healing stage; bone scan imaging identifies the activity of osteoblastic cells through increased tracer uptake in the areas of ongoing fracture healing [11].

Evaluation of vertebral augmentation procedures in long standing chronic VCFs with incomplete fracture healing should give a better understanding of its usage in these cases. In the present study we have evaluated the efficacy of vertebral augmentation procedures in treating chronic VCFs; the case selection was done by the identification of incomplete fracture healing either by MRI or bone scan imaging with Tc 99m-MDP.

2. Methodology

2.1. Study design

The present study is a retrospective observational study conducted in a tertiary care hospital. After approval from the institutional ethics committee, we reviewed medical records of all patients with VCFs, who underwent vertebral augmentation procedures during the period of June 2013 to June 2019. Study protocol was approved from the institutional ethics committee (IEC code: 2017-131-IP-99) and registered in the Clinical Trials Registry-India (Registration number: CTRI/2020/09/027740).

2.2. Inclusion criteria

Patients with chronic osteoporotic vertebral compression fractures (>12 weeks) with evidence of incomplete fracture healing either by MRI or bone scan imaging with Tc 99m-MDP.

2.3. Exclusion criteria

We have excluded patients with fractures due to causes other than osteoporosis, acute (<6 weeks) or sub-acute fractures (6–12 weeks), and any psychiatric or cognitive condition limiting patient's ability to understand the scoring systems used for outcome assessment.

2.4. Study intervention

Vertebroplasty and kyphoplasty were performed under fluoroscopy guidance via transpedicular approach under local anaesthesia and conscious sedation [12]. The entry point was localised in the superolateral quadrant of the pedicle of target vertebra in oblique view and cephalo-caudal tilt. After local anaesthetic infiltration at the entry point, a stab incision was made; 11-guage vertebroplasty needle was introduced through the skin and advanced towards the pedicle. The vertebroplasty needle was positioned in the anterior third of the vertebral body under sequential oblique, anteroposterior and lateral fluoroscopic views. Polymethylmethacrylate (PMMA) bone cement was prepared to a paste like consistency and injected under continuous fluoroscopy guidance. The kyphoplasty procedure had few additional steps; 11-guage bone needle was placed in the posterior third of vertebral body, a K-wire was passed through it, a working cannula with blunt dissector was railroaded over the K-wire and was positioned in the posterior third of vertebral body. Channel for kyphoplasty balloon was created by advancing a manual drill within the working cannula; thereafter space for cement injection was created by inflating the balloon with radio-opaque contrast and cement injection was done under continuous fluoroscopy guidance [13].

After the cement injection, the patients remained prone for 20–30 min during which cement hardening occurs; thereafter patient remained supine for an hour. All the patients were monitored in post procedure area for 4 h and discharged afterwards; elderly patients with comorbidities were discharged on the next day. All patients were advised acetaminophen (325 mg) and tramadol (37.5 mg) combination thrice a day for three days for pain relief.

Table 1
Baseline characteristics of patients.

Characteristic	
Age	65 (15) years
Gender Distribution	23 Females; 11 Males
Duration of symptoms	36 (25) months
Initial NRS Pain Scores	8 (1)
RDQ scores	79 (10)
QUALEFFO scores	81 (5)
Medications	
Analgesics	34 patients
Calcium and Vit D supplements	32 patients
Bisphosphonates	23 patients
Spinal Segment of Fracture treated	
Thoracic (T4-T10)	9 patients
Thoracolumbar (T11 to L2)	11 patients
Lumbar (L3-L5)	14 patients
Number of vertebral bodies treated	
One	29 patients
Two	5 patients
Procedure Done	
Vertebroplasty	26 patients
Kyphoplasty	8 patients

Data are presented as numbers or median (inter-quartile range); NRS: Numerical Rating Scales; RDQ: Roland Morris Disability questionnaire; QUALEFFO: Quality of life questionnaire of European Foundation of Osteoporosis.

2.5. Outcome measures

Primary outcome measure was patient's pain score measured by numerical rating scale (NRS); NRS is a scale from 0 to 10 with 0 being no pain and 10 being maximum pain.

Secondary outcome measures were patient's disability assessed by Roland Morris Disability questionnaire (RDQ) [14]; quality of life assessed by Quality of life questionnaire of European Foundation of Osteoporosis (QUALEFFO) [15] and analgesic usage was assessed by the daily consumption of "acetaminophen (325 mg) and tramadol (37.5 mg)" fixed dose combination tablets. All these assessments were done before the procedure (baseline), immediately after the procedure, at 1 month, 3 months, 6 months and 1 year post-procedure; the patient assessments 1 month afterwards were done by telephonic communication.

2.6. Statistical analysis

Wilcoxon signed rank test was used to compare pre and post-treatment results of NRS, RDQ and QUALEFFO scores; Fisher's exact test was used to compare pre and post-treatment reduction in analgesic consumption. P value < 0.050 was considered as significant.

3. Results

A review of the medical records of patients with VCFs was done from June 2013 to June 2019; 34 consecutive patients who underwent vertebral augmentation procedures in this duration were enrolled in the present trial. The median age of the enrolled patients was 65 years; 23 of

Table 2
Numerical rating scale (NRS) pain scores over the follow up period of 1 year.

Follow Period	NRS Pain Scores
Prior to the procedure	8 (1)
Immediately after the procedure	3 (1) *
1 month after the procedure	2 (2) *
3 months after the procedure	1 (1) *
6 months after the procedure	2 (0.5) *
12 months after the procedure	2 (1) *

Data are presented as median (inter-quartile range); * P<0.050 during comparison of pain scores after the procedure with pain scores prior to the procedure.

these patients were females and 11 were males. The patient's baseline characteristics are summarized in Table 1.

The evidence of incomplete fracture healing was obtained by MRI in 9 cases (26%) and by bone scan imaging with Tc 99m-MDP in remaining 25 cases; bone scan imaging was done in only those cases in which MRI didn't reveal evidence of incomplete fracture healing. Vertebral augmentation procedures were done in the lumbar segment (14 patients), thoracolumbar segment (9 patients) and thoracic segment (11 patients) (Table 1); these procedures were done at one vertebral level in 29 patients and at two vertebral levels in 5 patients; vertebroplasty was done in 26 of these patients and kyphoplasty in 8 patients. The mean volume of PMMA bone cement used at one vertebral level was 4.2 ml.

The median NRS pain scores were significantly reduced at all-time points as compared to the baseline value over the follow up period of 1 year after vertebral augmentation procedure (P < 0.050) (Table 2). We found that there was 63% reduction immediately after the procedure and 75–87% reduction as compared to the baseline median pain scores over the follow up period of 1 year (Fig. 1). The analgesic consumption was also significantly reduced as compared to the baseline value, over the follow up period of 1 year after vertebral augmentation procedure (P < 0.05); there was 25% reduction immediately after the procedure and around 75% reduction of analgesic consumption over the follow up period of 1 year.

The median RDQ scores were significantly reduced at all time points as compared to the baseline value over the follow up period of 1 year (P < 0.050) (Fig. 2); during this period we found median RDQ scores were reduced by 43–56% as compared to the baseline values. Similarly, the median QUALEFFO scores were also found to be significantly reduced at all time points as compared to the baseline value over the follow up period of 1 year (P < 0.050) (Fig. 2).

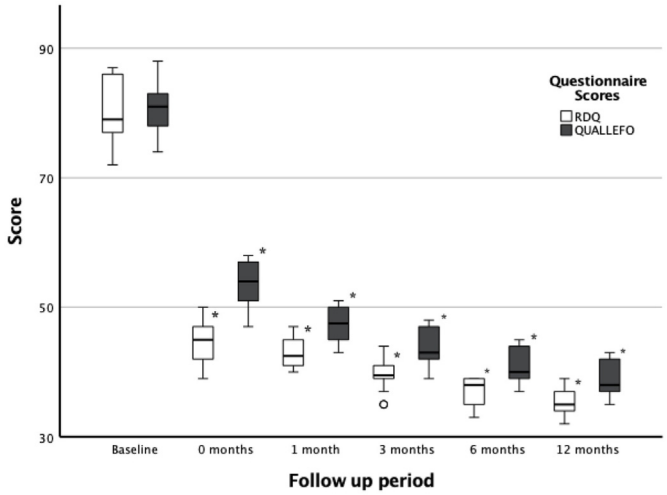

Fig. 2. Roland Morris Disability questionnaire (RDQ) scores and Quality of life questionnaire of European Foundation of Osteoporosis (QUALEFFO) scores over the follow up period of 1 year * P<0.050 during comparison of RDQ and QUALEFFO scores after the procedure with respective scores prior to the procedure.

Cement leakage was seen in 5 patients (15%), who underwent vertebroplasty; leakage was paravertebral in 3 patients (9%), intradiscal in 1 patient (3%) and epidural space in 1 patient (3%) (Fig. 3). There were no neurological deficits in the patient with epidural spread; this patient remained admitted for a period of three days after the vertebroplasty procedure at T12 vertebral level and achieved 50–60% pain relief immediately after the procedure.

4. Discussion

In the present study we observed that vertebral augmentation provides significant pain relief in cases of chronic osteoporotic vertebral compression fractures with median fracture age of 36 months; suggesting the usefulness of vertebral augmentation procedures in chronic VCF patients with evidence of incomplete fracture healing.

Presently, use of vertebral augmentation is recommended primarily for acute or subacute VCFs with ongoing fracture healing within four months of fracture [16]. Few clinical trials claim that vertebral

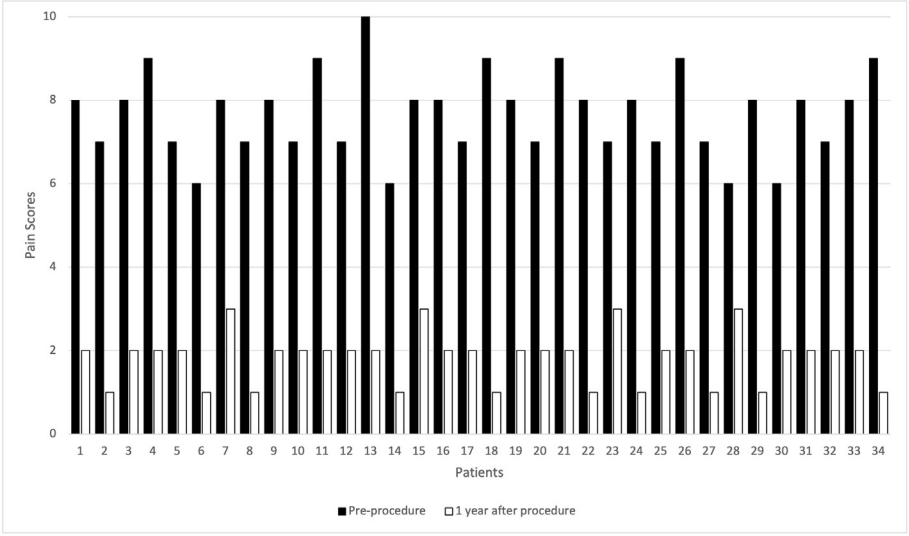

Fig. 1. Comparison of pain scores 1 year after vertebral augmentation with the baseline values in all the patients included in the study.

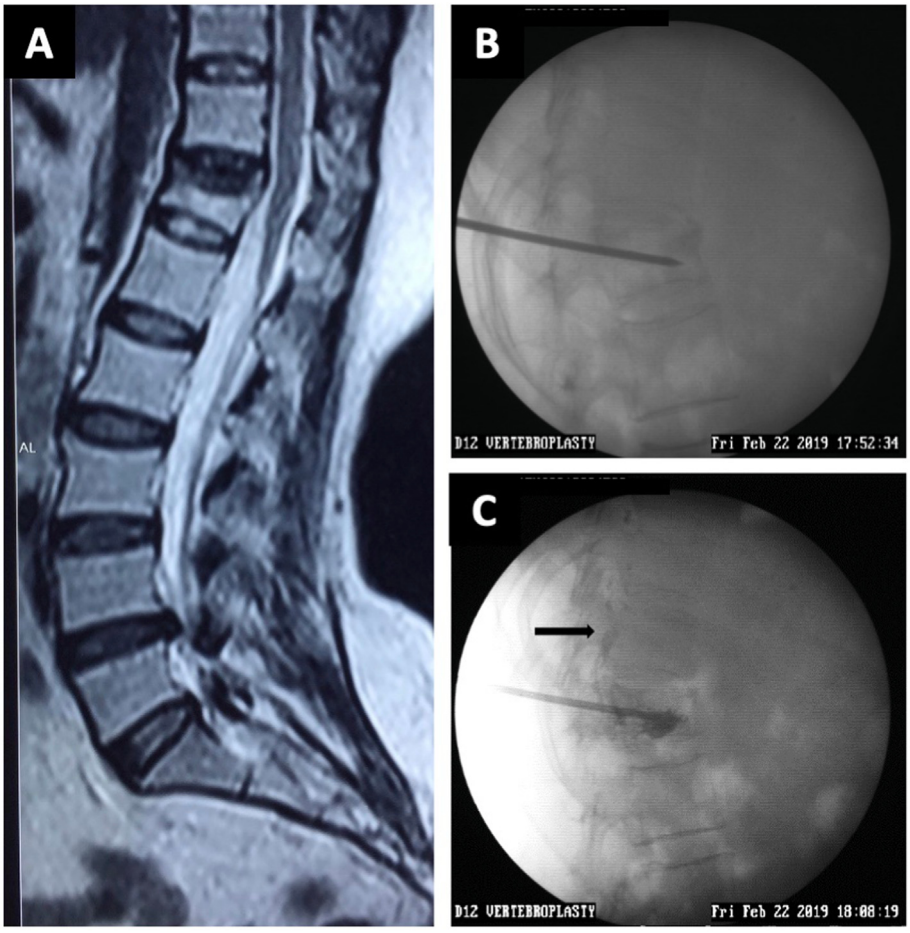

Fig. 3. Epidural cement leakage during D12 vertebroplasty 3A: T2W sagittal image of D12 vertebral compression fracture 3B: Vertebroplasty needle placed in D12 vertebra in a lateral fluoroscopy image 3C: Cement injected in D12 vertebra; cement leakage visualised in epidural space at D11 vertebra (solid arrow).

augmentation is also useful in chronic VCFs, if there is evidence of incomplete fracture healing [5–10]. The fracture healing is suggested to be an important predictor of response following vertebroplasty or kyphoplasty [11,16]; ongoing fracture healing is suggested by hypointense signal on T1-weighted images along with hyperintense signal on T2-weighted images in MRI [16] (Fig. 4) and increased tracer uptake in bone scan imaging with Tc 99m-MDP suggestive of increased osteoblastic activity and bone turnover [11].

The clinical trials supporting use of vertebral augmentation for chronic VCFs have included cases based on the duration of fracture age as suggested by the duration of back pain [6–10]; two of these trials have also used MRI findings suggestive of ongoing fracture healing in case selection [9,10]. However, bone scan imaging with Tc 99m-MDP is more accurate in detecting ongoing fracture healing in fractures older than 4 months [16,17]; hence, many long standing VCFs with ongoing fracture healing may be described as already healed by the MRI and hence, deferred from the beneficial effects of vertebroplasty or kyphoplasty. As per the protocol followed in our pain clinic, we have used bone scan imaging with Tc 99m-MDP in patients with clinical features suggestive of back pain arising from VCFs, while MRI findings suggesting that the fracture has already healed; we presumed, that utilization of bone scan imaging in the evaluation of chronic VCFs, would help in more accurate identification of VCFs that would significantly benefit from vertebral augmentation.

MRI and bone scan imaging with Tc 99m-MDP are comparable in identification of VCFs with favourable response following vertebral augmentation up to 4 months of fracture age; beyond this, bone scan imaging is more accurate, because increased tracer uptake persists for up to 12 months after fracture [17]. Tracer uptake indicates increased osteoblastic activity and ongoing healing process; the ongoing healing fractures have a better response to vertebral augmentation than healed fractures, because newly formed bone is softer and more likely to expand following cement injection [16]. Moreover, in case of healed fractures, cement extravasation occurs more frequently; as a result, lesser amounts of the injected cement volume remains inside the fractured vertebral body [4].

In the present study median fracture age of VCFs was 36 months; all the cases included were having clinical features suggesting that back pain was arising from fractured vertebra. Hence, there is a possibility that trivial trauma might have given rise to microfractures with ongoing fracture healing in these cases; as a result, bone scan imaging with Tc 99m-MDP has shown increased tracer uptake even after a fracture age of more than 12 months. Another significant advantage of bone scan imaging is identification of appropriate level of VCF responsible for back pain, in case of multilevel VCFs; this helps in performing vertebral augmentation at specific level of VCF giving rise to pain [18].

5. Study limitations

Firstly, retrospective nature of the study with small sample size and no control group. Better designed prospective studies may go a great way in clarifying the outcomes. Secondly, the analgesic regimen in seven patients included paracetamol and non-steroidal anti-inflammatory drug combination along with paracetamol-tramadol combination prior to the vertebral augmentation procedure; after the procedure paracetamol-tramadol combination was prescribed as per the protocol mentioned in

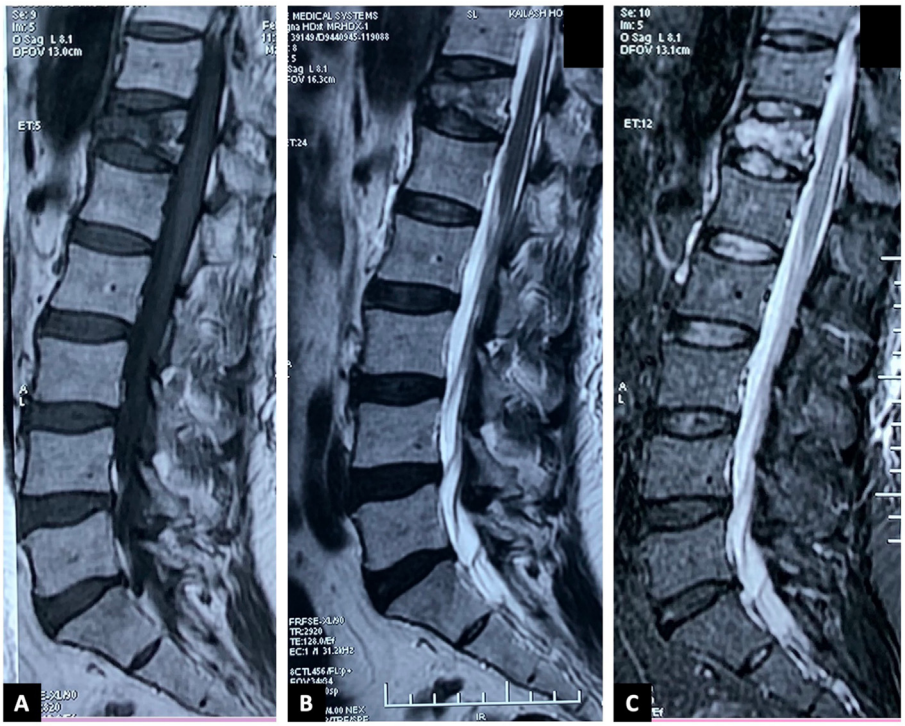

Fig. 4. MRI images of a D12 vertebral compression fracture 4A: T1W image with hypointense signal 4B: T2W image with hyperintense signal foci 4C: T2W/short-tau inversion recovery (STIR) image with more evident hyperintense signal.

methodology. The comparison of analgesic usage before and after the procedure was done by assuming all analgesics as paracetamol-tramadol combination prior to the procedure; this may have affected the analgesic usage comparison, especially immediately and one month after the procedure. Another substantial limitation of our study was that MRI short-tau inversion recovery (STIR) sequences were not available in all the patients; STIR sequences allows better recognition of ongoing fracture healing. Finally, for patients with refractory pain and clinical features suggesting compression fracture as the aetiology of pain, we proceeded with vertebral augmentation if MRI or bone scan showed evidence of ongoing fracture healing. A few of these patients may have benefited from less invasive interventions such as lumbar medial branch blocks or radiofrequency ablation.

6. Conclusion

The present study concluded that vertebral augmentation procedures including vertebroplasty or kyphoplasty provide significant improvements in pain scores, disability, quality of life and analgesic usage in patients of chronic osteoporotic vertebral compression fractures with median fracture age of 36 months. The response to vertebral augmentation seems to be better predicted by evidence of ongoing fracture healing as suggested by imaging, regardless of age of the fracture. Utilization of bone scan imaging with Tc 99m-MDP along with MRI in chronic VCFs may help in better case selection for vertebral augmentation procedures.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Sujeet Gautam reports was provided by Sanjay Gandhi Post Graduate Institute of Medical Sciences. Sujeet Gautam reports a relationship with Sanjay Gandhi Post Graduate Institute of Medical Sciences that includes:. Sujeet Gautam has patent pending to NA. Not Applicable

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