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Study of factors influencing the encrustation of indwelling catheters: prospective case series

Sanket Kalpande* , P. R. Saravanan and K. Saravanan

Abstract

Background: Long-term catheterisation is frequently necessary for patients with retention of urine or intractable incontinence who are unfit for definitive treatment or being evaluated for definitive treatment. In this study, the important factors influencing the encrustation of indwelling catheters are analysed.

Methods: A total of 52 patients on catheter drainage for a period ranging from 1 month to 1 year were taken in the study. Patients reported either for problems like catheter block or routine changing of catheter. The catheters were removed, and encrustation was subjected to chemical analysis. Urine was examined for pH, specific gravity, culture sensitivity and appearance. Blood samples were taken for estimation of calcium, phosphorus and uric acid.

Results: Out of 52 patients, 28 with urea splitting and 15 with non-urea splitting had positive urine culture (43 out of 52). Amongst 28, 27 (96%) had encrustation compared to 10 (50%) out of 15 with non-urea splitting bacteria (p value $< .05$). Amongst 24 patients having $pH > 6$, 22 (92%) had encrustation (p value $< .05$). The encrustation was found to be more common in bedridden patients (91%) when compared to physically active patients (54%) (p value $< .05$). The encrustation was more common in patients having single catheter for more than 15 days (86%) when compared to patients having catheter for shorter period (43%) (p value $< .05$).

Conclusion: This study showed definitive influence of the following factors in encrustation formation: infection with urea splitting organism, alkaline pH, physical activity of patient and duration of keeping a particular catheter.

Keywords: Indwelling catheters, Encrustation, UTI, Prolonged catheterisation

1 Background

Complications associated with the use of urinary catheters include infection, bladder spasms, catheter encrustations and retained catheters. This is more so with long-term catheter usage. Long-term catheterisation is frequently necessary for patients with retention of urine or intractable incontinence who are unfit for definitive treatment or being evaluated for definitive treatment. More than 50% patients may have problems associated with encrustation and blockage of catheters.

In 1997, R G Burr et al. published a paper stating encrustations are responsible for catheter blockage due

to various factors which include urine pH, calcium, rate of flow, urinary tract with urease-positive organisms and immobilisation [1]. Encrustation can occur intraluminally or extraluminally. They can give rise to catheter-associated urinary tract infection (CAUTI). Choong et al. analysed urine for pH, urine calcium level in blockers and non-blockers and found significant difference [2].

Till now there exists no definite intervention that will prevent the encrustation in patients with long-term indwelling catheters and prevent morbidity. In this study, the important factors influencing the encrustation of indwelling catheters are analysed. The onset and severity of encrustation depends upon factors relating to patients and catheter. The factors considered in this study are.

1. Nature of the disease

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2. Physical activity of patients
3. Mode of catheterisation
4. Duration of catheterisation
5. Frequency of changing the catheter
6. Urine pH
7. Urine-specific gravity
8. Presence of micro-organisms in urine
9. Chemical analysis of crust

It is important to establish the role of above factors in etiopathogenesis of encrustation so that future research may be directed towards development of effective measure to prevent or lessen the morbidity arising out of long-term use.

2 Methods

This prospective study was started in Institute of Urology, Rajiv Gandhi Government General Hospital, Chennai. Study duration was for 6 months (Dec 2018 to May 2019). A total of 52 patients on catheter drainage for period of 1 month to 1 year were taken for study. All patients were explained about the study, and prior consent to participate was obtained from all. The study was approved by ethics committee prior to its start.

The mode of catheterisation was either supra-pubic or trans-urethral. Standard Foley's catheter of 16 Fr was used for all patients. Many of these patients were on long-term catheterisation due to benign prostatic enlargement who were unfit for definitive treatment due to cardiovascular, pulmonary or other problems. Some patients were on catheterisation temporarily and being evaluated for definitive treatment like urethroplasty. These patients reported either for specific problems related to catheterisation like catheter block or routine changing of the catheter. Many patients were ambulant and taking normal diet and fluid. Most of the patients were not taking regular anti-microbials, while they were on catheter drainage.

Before removing the catheter, the urine was collected and following examinations were done.

1. Clarity of urine
2. pH of urine
3. Specific gravity.
4. Urine culture for bacteria

From all patients, samples were taken for the estimation of serum calcium, phosphorus and uric acid.

The catheters were removed and examined for the presence of encrustation. The presence of encrustation was confirmed by the gritty feeling on palpation of catheter tip. The encrustation was present in the lumen as well as on the surface of the catheters. Catheters were dried at

room temperature, and crust was removed for chemical analysis.

Data collected for all patients in table format and Chi-square test were used for statistical analysis.

3 Results

1. The incidence of encrustation

Among 52 patients with diseases like benign prostatic enlargement, stricture urethra, neurogenic bladder and others, the encrustation was present in 32 patients.

Total no. of patients	52
Benign prostatic enlargement	26
Stricture urethra	22
Neurogenic bladder and others	4
Total patients with encrustation	32 (61.5%)
Benign prostatic enlargement	15 (58%)
Stricture urethra	14 (63.6%)
Neurogenic bladder and others	3 (75%)

Figure 1 shows incidence of catheter encrustation overall and in various diseases. Catheter encrustation was found to be unrelated to the primary disease for which the patient was catheterised. Result was not statistically significant (p value > 0.05).

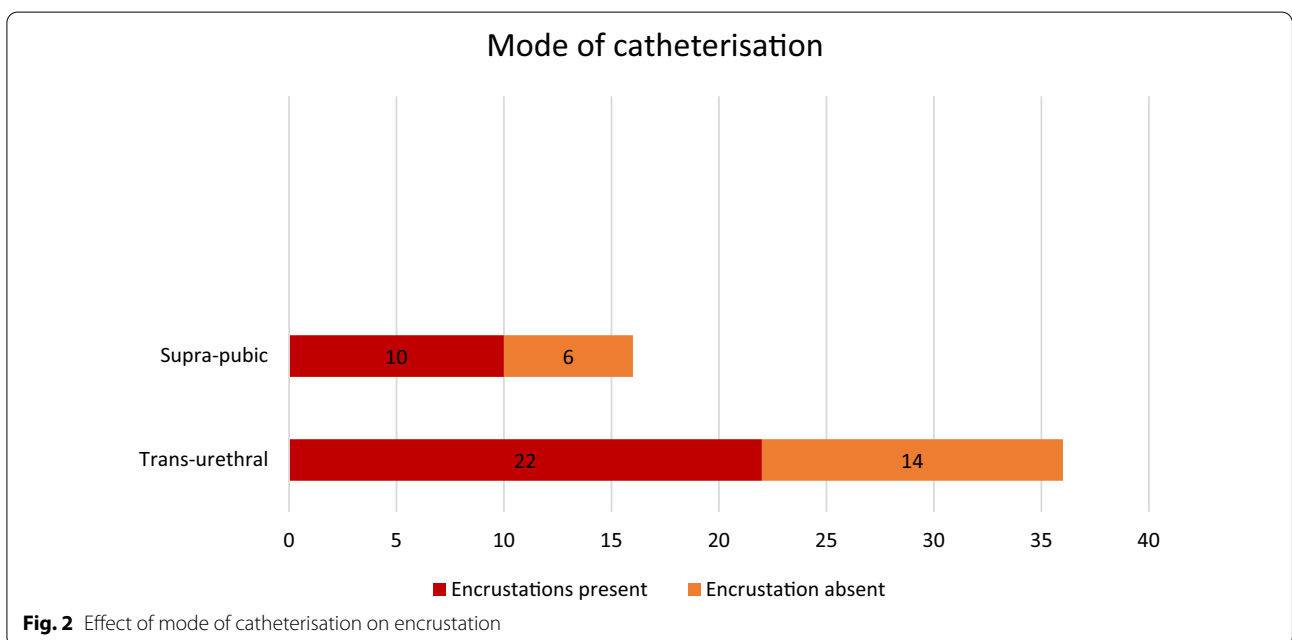
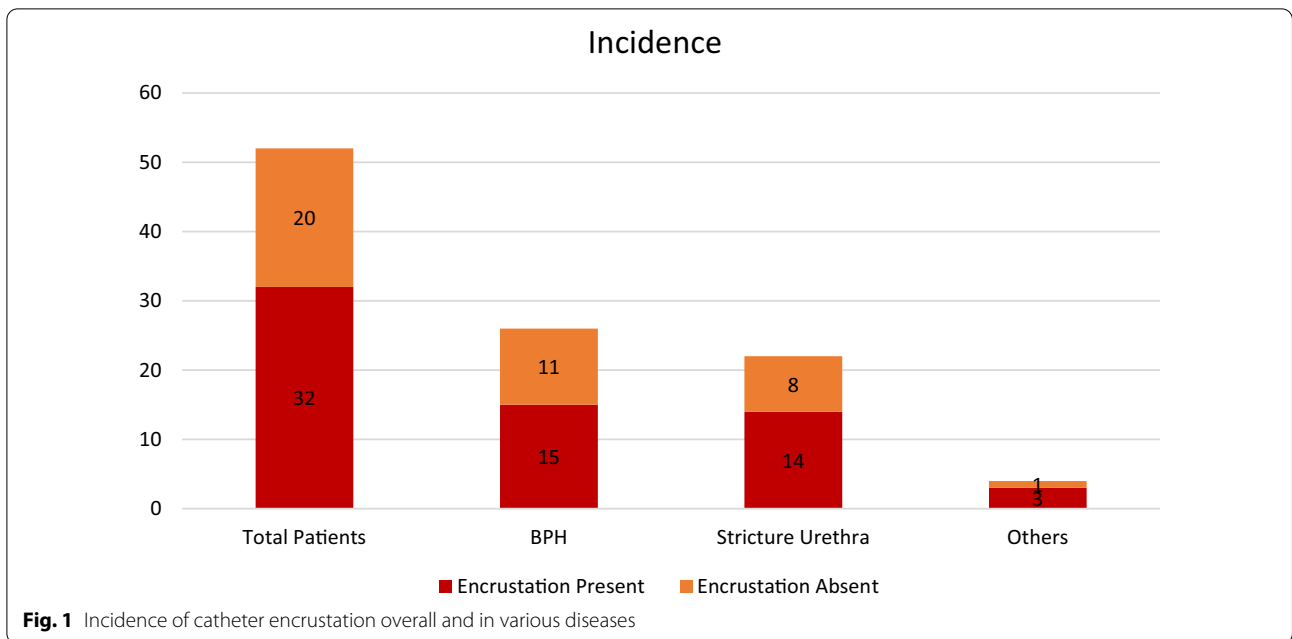
2. Mode of catheterisation

Among 52 patients, 36 had trans-urethral catheter and 16 had supra-pubic catheter. Figure 2 shows that the incidence of encrustation was found to be almost equal in both types of catheterisation. The trans-urethral type had 61% and supra-pubic type had 62.5% of encrustation of the catheters. Statistically, the result was found to be not significant (p value > 0.05).

3. Physical activity of the patient

The physical activity of the patient was found to have significant effect on the development of encrustation of the catheter. Figure 3 suggests that incidence of encrustation was less in physically active patients with catheter compared to hospitalised, bedridden patients. Out of 52, 11 were hospitalised for their disease. The encrustation was found to be more common in bedridden patients (91%) when compared to physically active patients (53.6%). Statistically, result was found to be significant (p value < 0.05).

4. Total duration of catheterisation

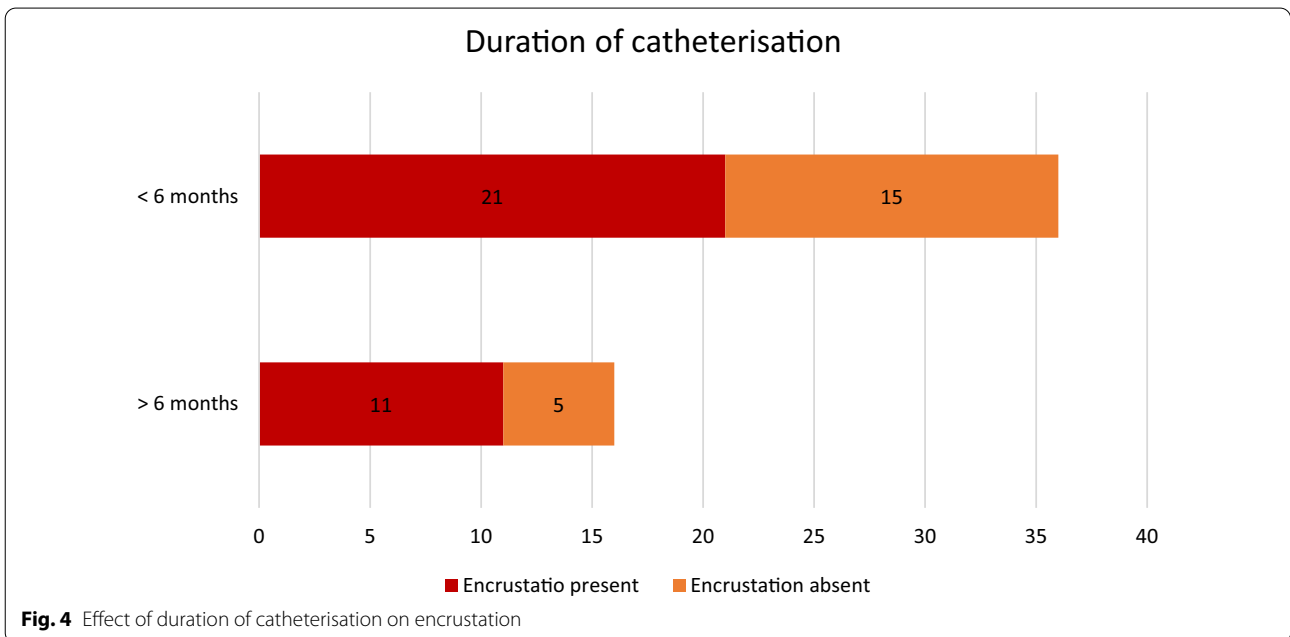
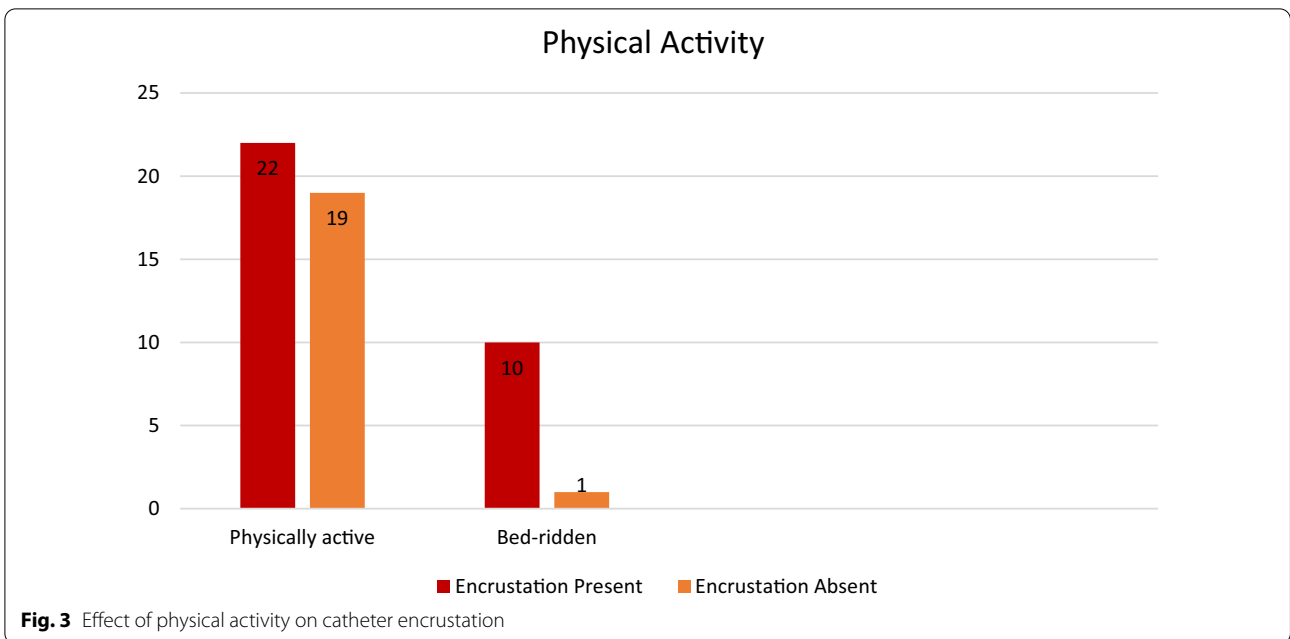


Total duration of catheterisation among patients was 1 month to 1 year. Sixteen patients were on catheter drainage for more than 6 months and were changing the catheter every 15 days. As shown in Fig. 4, incidence of encrustation in those patients (69%) was not significantly increased when compared to patients who were on catheterisation for period less than 6 months (58.3%).

Statistically, result was found to be not significant (p value > 0.05).

5. Frequency of changing the catheter

The presence of encrustation was found to be directly proportional to the duration of keeping the catheter. Figure 5 shows that encrustation was more common in

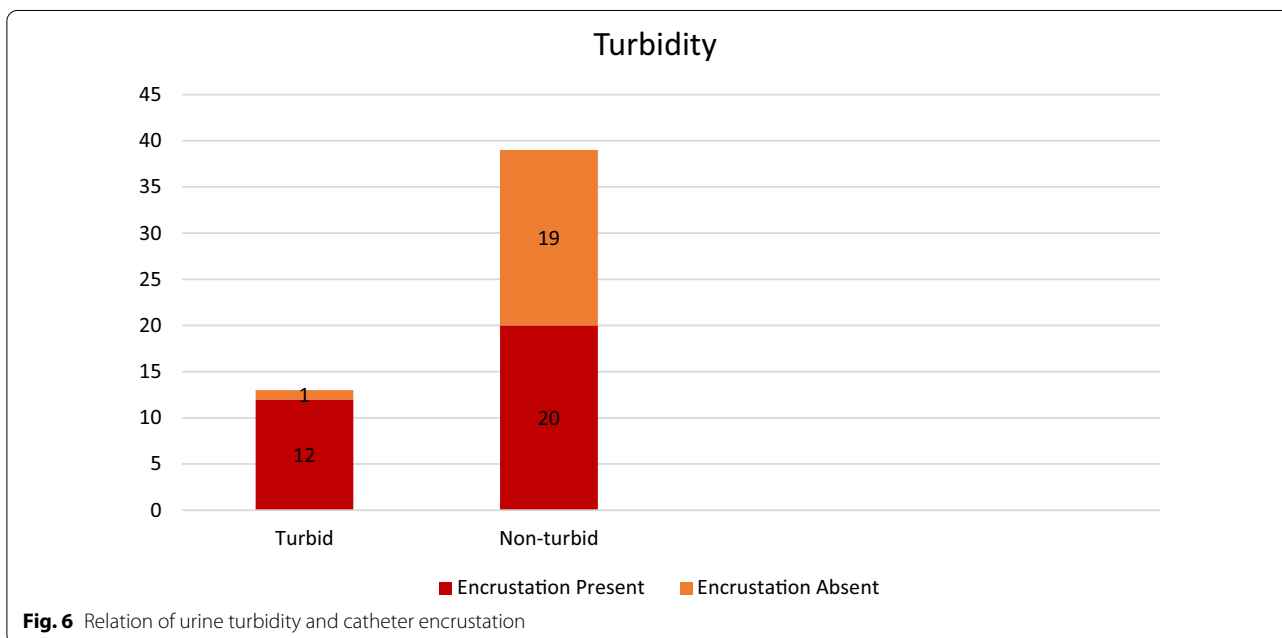
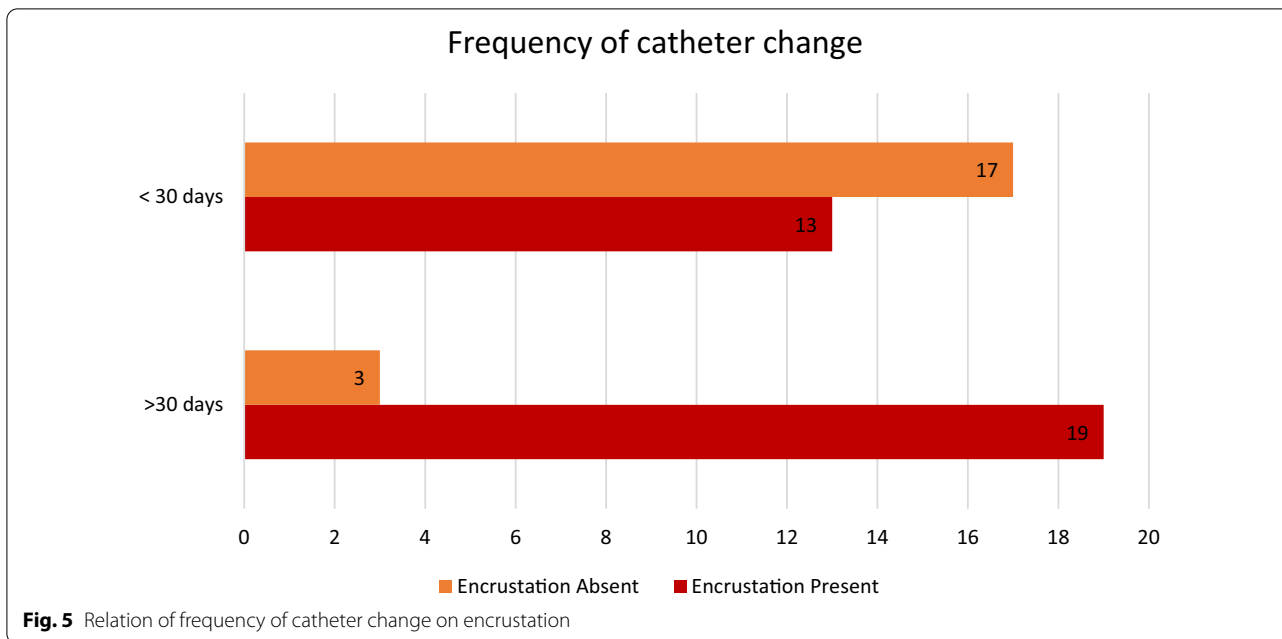


patients having a single catheter for more than 30 days (86%) when compared to patients having of particular catheter for a shorter period less than 30 days (43.3%). Statistically, the result was significant (p value < 0.05).

6. Clarity of urine

Among 52, 13 had turbid urine. The patients with turbid urine had 92.3% encrustation when compared to patients with clear urine who had only 51% encrustation as suggested in Fig. 6. Statistically, the result was significant (p value < 0.05). Patients with turbid urine also had positive culture for micro-organisms.

7. pH of urine

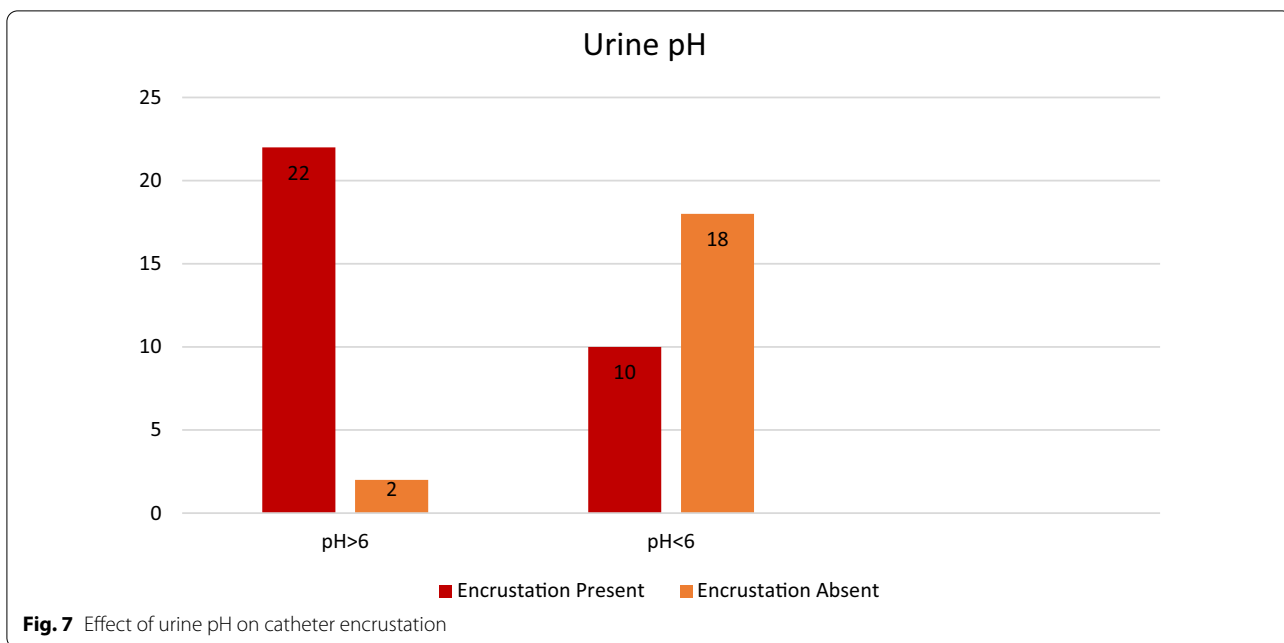


The pH of urine was found to be an important factor. Among 52 patients, 24 had pH > 6. Figure 7 illustrates that, among these 24 patients, 22 (92%) had encrustation. In remaining 28 patients with urine pH < 6, 10 (38%) had encrustation in the catheter. The result was statistically significant (*p* value < 0.05). Majority of patients with alkaline urine has positive urine culture for urea splitting organisms. Most of the patients with acidic urine had

negative urine culture or positive culture for non-urea splitting organisms.

8. Specific gravity of urine

The urine specific gravity of patients was found to be in normal range (1.005–1.020). No relationship was noted between the specific gravity and presence of encrustation. In our study, all patients had normal serum



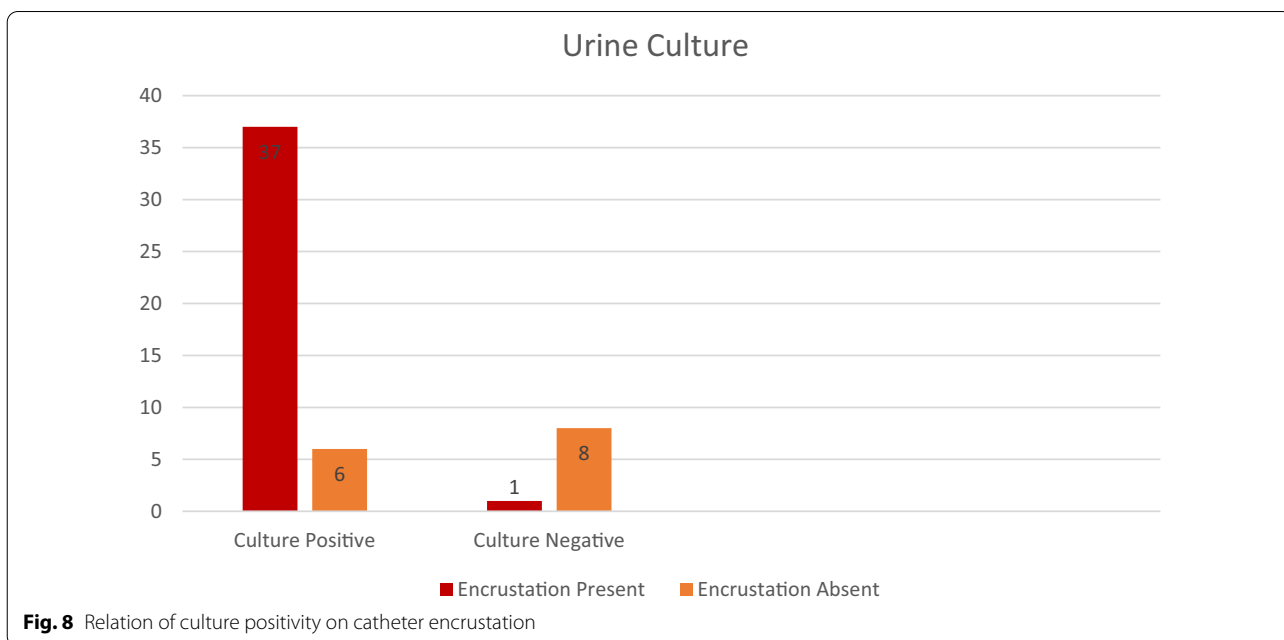
creatinine level and showed normal specific gravity and hence no relationship with encrustation.

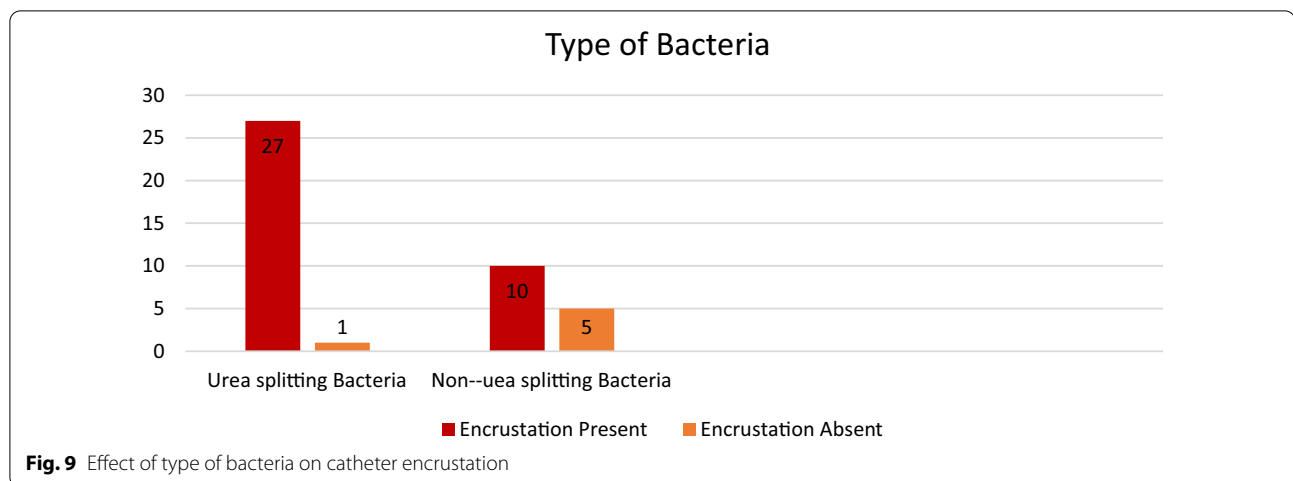
9. Urine culture for micro-organisms

Among 52, 38 patients had positive culture for bacteria in the urine; 28 had positive culture for urea splitting organisms like proteus and klebsiella, and 15 had positive culture with non-urea splitting organism like E. coli.

Figure 8 shows relationship between positive bacterial culture and catheter encrustation.

The incidence of encrustation was more in patients with positive urine culture especially with urea splitting bacteria. Figure 9 shows that among the 28 patients with positive urine culture for urea splitting organisms, 27 (96%) had encrustation. Among the 15 patients with positive culture for non-urea splitting organisms, 10 (66.7%) had encrustation. Among 9 patients with negative





culture, only 1 (11%) had encrustation. Statistically, the result was significant (p value < 0.05).

10. Serum calcium, phosphorus and uric acid

All patients had normal levels of serum calcium, phosphorus and uric acid. No relationship was found between serum levels and presence of encrustation in our study.

11. Composition of the encrusted material

The chemical analysis of crust showed the following substances.

- Calcium
- Phosphate
- Oxalate
- Carbonate
- Ammonium
- Magnesium

4 Discussion

The incidence of encrustation was found to be equal in patients of different diseases like BPH, stricture urethra, neurogenic bladder and others. This is in accordance with other studies which showed no relationship between primary diseases and formation of encrustation [3]. The incidence of encrustation was found to be equal in both supra-pubic and trans-urethral catheterisation [4].

In this study, an increased incidence of encrustation was found in patients who were bedridden for their primary disease when compared to physically active patients. In bedridden patients, the encrustation was found to occur early also. The increased incidence of encrustation in bedridden patients may be due to reduced fluid intake and increased mobilisation of calcium from

the bones though serum calcium and specific gravity of urine did not show possibilities in our study [3].

The total duration of catheterisation did not have any relationship to encrustation, provided the catheter was changed frequently. On the other hand, single catheter kept for more than 15 days showed more incidence of encrustation [5].

The patients with catheter draining turbid urine was found to have encrustation in the catheter. The cloudy turbid urine is due to pyuria or amorphous phosphates. The patients with turbid urine had positive urine culture, especially for urea splitting micro-organisms and alkaline urine pH. In the alkaline urine, phosphates have tendency to precipitate [6].

Specific gravity of urine depends upon kidney function and hydration status. In our study, all patients had normal serum creatinine and showed normal specific gravity. No relationship with encrustation was seen [7].

Among all factors concerned with the patients, presence of infection in the urine and urine pH were found to be important in the development of encrustation. Magnesium ammonium phosphate stone and crystals are always associated with infection urea splitting bacteria and subsequent elevation of urinary pH due to increased bacterial ammonium production. In alkaline pH, phosphates have tendency to precipitate and form magnesium ammonium phosphate (struvite) and calcium phosphate (apatite) [7–10].

The amount of serum calcium, phosphorus and uric acid and their excretion in urine definitely play a major role in stone formation and encrustation. Since all patients had normal serum calcium, phosphorus and uric acid level, no relationship was found with formation of encrustation [11].

5 Conclusion

Many factors related to the catheter and the patient influence the formation of encrustation. This study shows definite influence of the following factors:

- The presence of infection with organisms especially urea splitting ones
- Alkaline pH of urine
- Physical inactivity of patients
- The duration of keeping particular catheter

Despite the potential problems with long-term catheterisation, no practical alternative exists for many patients for their illness. A greater understanding of the factors contributing to catheter encrustation is required to aid the establishment of effective catheter care management.

Authors' contributions

SK is responsible for concept design and preparation of manuscript. PRS is responsible for literature search. KS is responsible for analysis and interpretation. All authors have read and approved the manuscript.

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Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

All patients were explained about the study, and prior written consent to participate was obtained from all. The study was approved by "Madras Medical College Ethics Approval Committee" prior to its start. Ethics committee reference number is not applicable.

Consent for publication

Our study includes patient's data. Appropriate consent to publish the data was obtained from participating candidates. All authors hereby transfer to African Journal of Urology the non-exclusive publication rights. We sign for and accept responsibility for releasing this material. This transfer of publication

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Competing interests

The authors declare that they have no competing interests.

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